

ARLINGTON COUNTY DES ENGINEERING
SUPPLEMENTAL SPECIFICATIONS

- **Section 02614** – Cast In Place Detectable Warning Surfaces
- **Section 07110** – Hot-Applied Rubberized Waterproofing
- **Section 10531** – Assembly and Installation of Transit Station
- **Transitway Extension to Pentagon City Station Design Specifications**
 - **Section 03320** – Concrete Foundations For Transit Stations
 - **Section 05501** – Stainless Steel
 - **Section 10425** – Specialty Signs
 - **Section 16020** – Basic Electrical

SECTION 02614 – CAST IN PLACE DETECTABLE WARNING SURFACES

PART 1 - GENERAL

1.1 Description of Work

- A. Furnish and install prefabricated cast in place ADA compliant detectable warning surfaces at curb ramps and along station platforms as shown on the Approved Plans.

1.2 Related Work Specified Elsewhere

- A. 01330 - Submittal Procedures
- B. 01400 – Quality Requirements
- C. Warranty
 - 1. Cast-In Place Detectable Warning Surfaces shall include a standard manufacturer warranty.

PART 2 - PRODUCTS

2.1 Cast In Place Detectable Warning Surface

Cast In Place detectable warning surfaces shall be 24" x 48" (nominal) prefabricated vitrified polymer composite tiles for cast-in-place construction, as manufactured by, Armor-tile, Williamsville, NY or Owner approved equal.

Cast In Place detectable warnings shall be as indicated on the drawings.

- A. Size: Unless otherwise indicated, dimensions shall be 24 inches in the direction of travel and extend the full width of the curb ramp or flush surface.
- B. Location: The cast in place detectable warning shall be located so that the edge nearest the curb line or other potential hazard is 6 to 8 inches from the curb line or other potential hazard.
- C. Domes: Truncated domes shall have a base diameter of 0.9 inches minimum to 1.4 inches maximum, a top diameter of 50% or 0.45 inch to 0.9 inches at the top, a height of 0.2 inch and a center-to-center spacing of 1.6 inches to 2.4 inches measured along one side of a square arrangement.
- D. Alignment: Domes shall be aligned on a square grid in the predominant direction of travel to permit wheels to roll between domes.
- E. Color Contrast: There shall be a minimum of 70% contrast in light reflectance between the detectable warning and an adjoining surface. The material used to provide visual contrast shall be an integral part of the detectable warning surface.

- F. Color: Dark grey and black. Verify color with Owner prior to ordering.
- G. Water Absorption of Tile when tested by ASTM D 570-98 not to exceed 0.05%
- H. Slip Resistance of Tile when tested by ASTM C 1028-96 Wet/Dry Static Coefficient of Friction values are not to be less than 0.80 on top of domes and field area.
- I. Compressive Strength of Tile when tested by ASTM D 695-02 not to be less than 28,000 psi.
- J. Tensile Strength of Tile when tested by ASTM D 638-03 not to be less than 19,000 psi.
- K. Flexural Strength of Tile when tested by ASTM D 790-03 not to be less than 25,000 psi.
- L. Accelerated Weathering of Tile when tested by ASTM G 155-05a for 3000 hours shall exhibit the following result – $\Delta E < 4.5$, as well as no deterioration, fading or chalking or surface of tile color No 33538.
- M. Accelerated Aging and Freeze Thaw Test of Tile and Structural Embedment Flange System when tested ASTM D 1037-99 shall show no evidence of cracking, delamination, warpage, checking, blistering, color change, loosening of tiles or other detrimental defects.
- N. Salt and Spray Performance of Tile and Structural Embedment Flange System when tested to ASTM B 117-03 not to show any deterioration or other defects after 200 hours of exposure.

PART 3 - EXECUTION

- 3.1 Cast In Place detectable warning surfaces shall be installed in accordance with the manufacturer's specifications.

PART 4 - MEASUREMENT AND PAYMENT

- 4.1 Cast In Place Detectable Warning Surfaces shall be paid by the square foot per the plan dimensions as verified in the field by the Project Officer or his designee. Payment shall include the cost of demolition, excavation, labor, materials, tools, equipment, transportation, supplies, and incidentals required to complete the work as specified.

END OF SECTION 02614

SECTION 07110 – HOT-APPLIED RUBBERIZED WATERPROOFING

PART 1 - GENERAL

1.1 Work Included

- A. The work shall consist of furnishing and installing hot-applied rubberized water proofing system for horizontal and vertical applications on below grade parking and/or other structures to prevent the penetration of water under hydrostatic pressure.

1.2 Related Work Specified Elsewhere

- A. Section 02611 Concrete Walks and Concrete Driveway Entrance
- B. Section 02612 Interlocking Concrete and Brick Pavers
- C. Section 07100 Waterproofing
- D. Warranty
 - 1. Hot-Applied Rubberized Waterproofing shall include a standard manufacturer warranty

1.3 Applicable Standards and Specifications

- A. Virginia Department of Transportation, Road and Bridge Specifications (VDOT)
- B. American Association of State Highway and Transportation Officials (AASHTO)
- C. American Society of Testing and Materials (ASTM)
- D. Canadian General Standards Board (CGSB)

1.4 Submittals

- A. General – Section 01330 Submittal Procedures
- B. Standard Submittal Package – Submit typical waterproofing drawing(s) indicating pertinent dimensions, general construction and product information.
- C. Manufacturer must submit proof of 10 projects with leak-free installations under similar conditions to this project and that have been installed for a minimum of 5 years. Proof of installation shall include addresses of installed system and contact names for owners of each location.
- D. Sample of material to be used in work is required at time of submittal.

1.5 Product Delivery, Storage and Handling

- A. Deliver products to the site in Manufacturer's original, intact, labeled containers. Handle and protect as necessary to prevent damage or deterioration during shipment, handling and storage. Store in accordance with manufacturer's installation instructions.

1.6 Basis of Design

- A. All hot-applied rubberized waterproofing shall be designed to meet the specified performance criteria of the project as manufactured by: Henry Company, 999 North Pacific Coast Highway, Suite 800, El Segundo, CA 90245 Toll Free: 800-486-1278. www.henry.com.
- B. Alternate Manufactures must demonstrate that their project meet or exceed the design criteria. Submittal of alternates must be made three weeks prior to scheduled ordering to allow proper evaluation time.

1.7 Quality Assurance

- A. The installation Contractor shall be certified by the material manufacturer as suitable for the execution of the work. The Contractor shall submit evidence that documents this requirement.
- B. The Contractor shall perform the work in accordance with the printed requirements of the waterproofing membrane manufacturer and this specification. One copy of the manufacturer's instructions shall be available at all times on the site.
- C. All components used in this section shall be produced by one manufacturer, including primary membrane, liquid sealants, primers, mastics, and adhesives.
- D. Warranty – Manufacturer's standard warranty shall apply.

PART 2 - PRODUCTS

2.1 General

- A. Primary Waterproofing Membrane
 - 1. Shall be 790-11 manufactured by Henry Company;
 - 2. or County approved equal.
- B. Asphalt Primer
 - 1. Shall be 930-18 or 910-01 manufactured by Henry Company;
 - 2. Or County approved equal
- C. Polyester Fabric Reinforcement
 - 1. Polyester Fabric unsaturated pun bonded polyester mat reinforcement sheet
- D. Meets ASTM D5329; chemically resistant to water, calcium, chloride, salt, mild acid, alkaline solutions, fertilizer, and animal waste.

PART 3 - EXECUTION

3.1 Examination

- A. It is the installing Subcontractor's responsibility to verify the substrate is dry and in accordance with Section 1.2 Related Work Specified Elsewhere and Section 1.3 Applicable Standards and Specifications prior to installation of waterproofing. Commencement of the Work or any parts thereof, indicates installer acceptance of the substrate.
 - 1. Verify substrates are in accordance with Waterproofing Manufacturer's published literature and as specified in this Section prior to installation.
 - 2. Substrates must be continuous and secured.
 - 3. Fill spalled areas with appropriate repair mortar to provide an even plane.
 - 4. Remove curing compounds or foreign matter detrimental to the adhesion.
- B. The installing Subcontractor must verify the following:
 - 1. Moisture detection survey:
 - a. Visual inspection
 - b. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
 - 2. Adhesion/Pull Test:
 - a. Complete a waterproofing adhesion test in accordance with Waterproofing Manufacturer's published literature prior to installation of waterproofing assembly.
- C. Do not apply waterproofing assembly components until substrate and environmental conditions are in accordance with Waterproofing Manufacturer's product specific Technical Data Sheets (TDS), and as specified in this Section.

3.2 Preparation

- A. Surfaces must be sound, dry, clean, and free of oil, grease, dirt, excess mortar, frost, laitance, loose and flaking particles, or other contaminants.
- B. Waterproofing Membrane Preparation:
 - 1. Heat waterproofing membrane in a mechanically agitating melter specifically designed for the preparation of hot rubberized asphalt membranes to a consistent temperature:
 - 2. Heating temperature: 356 °F (180 °C) to 392 °F (200 °C)

3.3 Installation

- A. Verify substrate is ready to receive the waterproofing assembly in accordance with the Waterproofing Manufacturer's TDS and guide specification.
- B. Air and substrate temperature limitations:
 - 1. None
- C. Primer:
 - 1. Apply primer in accordance with Waterproofing Manufacturer's TDS.
 - 2. Do not over spray primer; excessive and/or ponding primer is not recommended.

- D. Detailing/Flashing:
1. Install detailing and flashings per Waterproofing Manufacturer's details.
 2. Install prefabricated expansion joint assemblies prior to installation of waterproofing.
 3. Set drains at proper deck height and do not impede drainage.
 4. Secure flashing at drain with an integral clamping ring.
- E. Installation of Waterproofing Assembly:
1. Install one layer of waterproofing membrane at ninety (90) mils minimum to form a continuous monolithic membrane over horizontal and vertical surfaces.
 2. Fully embed polyester fabric into waterproofing membrane.
 3. Coat side and end laps of embedded polyester fabric with waterproofing membrane. Overlap of dry polyester fabric is not acceptable.
 4. Overlap polyester fabric a minimum of one-quarter (1/4) inch.
 5. Apply second layer of waterproofing membrane at one-hundred twenty-five (125) mils minimum to form a continuous monolithic membrane over previously coated areas.
 6. Total reinforced waterproofing membrane thickness shall be two-hundred and fifteen (215) mils minimum.
- F. Installation of Protection Course:
1. Install protection course in a shingle pattern starting at the low point(s) or drain location(s).
 2. Install protection course while waterproofing membrane is partially cured to a warm and tacky consistency.
 3. Install protection course in full continuous sheets.
 4. Overlap protection course dry adjoining edges approximately two (2) inches.
- G. Waterproofing Integrity Test; choose from the following:
1. Electronic Leak Detection (Alternate to Flood Test):
 - a. Conduct electronic leak detection upon waterproofing assembly completion and prior to overburden placement.
 - b. Contact pre-approved test provider several weeks in advance to coordinate schedule.
 - c. In the event of a breach of the membrane, repair and retest the system in accordance with project specifications.
 - d. Report results of testing to the Project Officer and Waterproofing Manufacturer. Submit results with the warranty application.
 - e. No other Work is to proceed without prior direction from the Project Officer.
- H. Flood Test:
1. Conduct flood test upon waterproofing assembly completion prior to overburden placement.
 2. Provide temporary stops and plugs for the roof drain(s) or scupper(s) within the test area.
 3. Flood test with a minimum of two (2) inches of water for no less than twenty-four (24) hours.
 4. In the event of a breach of the membrane, repair, and retest the system for no less than twenty-four (24) hours.
 5. Remove temporary stops and plugs.
 6. Report results of testing to the Project Officer and Waterproofing Manufacturer. Submit results with the warranty application.
 7. No other Work is to proceed without prior direction from the Project Officer.
- I. Installation of Insulation:

1. Refer to Insulation Manufacturer's published literature for a complete guide to required installation practices and exposure limitations.
 2. Loose lay insulation in full continuous sheets completely covering the field membrane to provide a continuous thermal resistance layer:
 - a. Stagger and firmly abut adjacent insulation.
 - b. Stagger board joints between layers.
 3. Cut insulation to fit around penetrations and drain(s).
 4. Provide temporary ballasting until installing permanent covering material.
- J. Installation of Drainage Composite:
1. Loose lay drainage composite in full continuous sheets completely covering the membrane to promote water drainage.
 2. Abut adjacent drainage composite panels overlapping the fabric approximately one (1) inch.
 3. Cut drainage composite to fit around penetrations and drain(s).
 4. Provide temporary ballasting until installing permanent covering material.
- K. Installation of Filter Fabric:
1. Install filter fabric in a shingle pattern starting at the low point(s) or drain location(s).
 2. Loose lay filter fabric in full continuous sheets completely covering the field membrane and all vertical waterproofed surfaces to promote debris obstruction.
 3. Overlap the filter fabric adjoining edges approximately six (6) inches.
 4. Provide temporary ballasting until installing permanent covering material.
- L. Installation of Paver Ballast:
1. Install paver ballast in accordance with Paver Ballast Manufacturer's published literature.
 2. Install paver ballast ensuring pavers are accurately aligned and leveled with upper surface of pavers in plane with adjacent units.
 3. Cut paver ballast to fit irregularly shaped areas and around protrusions.
 4. Refer to project specific drawings for specified location and layout.
- 3.4 Field Quality Control
- A. Final Observation and Verification:
1. Project Officer and Waterproofing Manufacturer to complete final inspection of waterproofing assembly as required by warranty.
 2. Contact Waterproofing Manufacturer for warranty issuance requirements.
- 3.5 Clean and Protect
- A. As the Work proceeds, and upon completion, promptly clean up and remove from the premises all rubbish and surplus materials resulting from the foregoing Work.
- B. Clean soiled surfaces, spatters, and damage caused by Work of this Section.
- C. Check area to ensure cleanliness and remove debris, equipment, and excess material from the site

PART 4 - MEASUREMENT AND PAYMENT

- 4.1 Hot-Applied Rubberized Waterproofing shall be installed in accordance with the approved plans. In an event, it becomes necessary to deviate from the dimensions indicated on the approved drawings, the contractor must obtain approval by the Project Officer in advance prior to installation. Payment for HOT-APPLIED RUBBERIZED WATERPROOFING shall be in square foot of the waterproofing material installed and shall include the necessary excavation, preparation of the surface and all other items listed in the PART 2 – PRODUCTS as indicated on approved plans.

END OF SECTION 07110

SECTION 10531 – ASSEMBLY AND INSTALLATION OF TRANSIT STATIONS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide all labor, material and equipment to furnish and install, complete in place, the transit shelter unit and site furnishings in accordance with these specifications and to the lines, grades and dimensions shown on the approved plans.
- B. Coordinate delivery and storage of all transit station components as described on the approved plans.
- C. Contractor is responsible for construction of all works shown on the approved plans.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01330: Submittal Procedures
- B. Section 01400 – Quality Requirements
- C. Section 02611 – Concrete Walks and Concrete Driveway Entrance
- D. Section 03100 – Concrete Formwork, Reinforcement and Materials
- E. Section 05501 –Stainless Steel
- F. Section 16020 – Basic Electrical
- G. Warranty
 - 1. Items discussed under this specification shall include a standard manufacturer warranty.

1.3 Protection of Property

- A. Protect property pipes, stones and monuments from damage. The Contractor will be responsible for replacing disturbed markers by a registered surveyor of Virginia at no expense to the County.
- B. Protect street, roads, historical objects, adjacent property, vegetation and streetlights, transit stop amenities and other works to remain throughout the contract.

1.4 Delivery and Storage

- A. The Contractor is responsible for the storage and security of equipment and materials and that of their subcontractor(s). The County will not provide storage of equipment or materials provided by the Contractor and/or their subcontractor(s). Store Materials in clean, dry area in accordance

with manufacturer's instructions. Keep materials in original, unopened containers and packaging until installation. Do not store in direct contact with the sun or rain.

- B. Handle products to prevent breakage of containers and damage to products.
- C. Deliver products to the jobsite in original unopened containers or wrappings clearly labeled with manufacturer's name and brand designation, referenced specification number, type and class as applicable. If storing material on site, ensure it is safe and secure as such is the Contractors responsibility. County will not take position of materials until final completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Transit Station Shelters

- A. Assemble and install transit shelters in accordance with Manufacturer's instructions.
- B. Transit shelters will generally conform to that shown on the drawings; however, minor variations are to be expected. Contractor shall provide Manufacture's drawings to the County for review prior to ordering.
- C. Transit Station Shelters include the assemble of the Solar-powered LED Light Panel Kit and the Shelter Name Box. Contractor to coordinate with the Project Officer prior to ordering Shelter Name Box.

3.2 Transit Station Amenities

- A. Assemble and install transit station amenities (benches, litter and recycling receptacles, bicycle racks, and other amenities) in accordance with manufacturer's instructions.

3.3 Transit Station Signs

- A. Assemble and install stainless steel flag station sign per the Transitway Extension To Pentagon City Station Design approved drawings.

3.4 Transit Station LCD Monitor Stanchion

- A. Assemble and install LCD Monitor Stanchion per the Transitway Extension To Pentagon City Station Design approved drawings.
- B. Transit Station LCD Monitor Stanchion will generally conform to that shown on the approved drawings; however, minor variations are to be expected. The Contractor shall provide the County with cut sheets from the Fabricator for review and approval.
- C. Contractor to have the LCD Monitor to be approved by the Project Officer prior to ordering.

3.5 Curb Rub Rail Installation

- A. Contractor to coordinate with the Project Officer to schedule the County's procurement of the Rub Rails. This shall be done at with ample time to allow for the fabrication and delivery to the Job Site.
- B. The Contractor shall provide accommodations to enable the Project Officer to inspect all materials upon delivery to the side and prior to utilizing the materials in the Work. The Contractor shall ensure that materials are stockpiled or otherwise stored such that the Project Officer has access to all aspects and components.
- C. Installation procedures shall confirm to the specifications and practices of the Rub Rail Provider.

PART 4 - MEASUREMENT AND PAYMENT

- 4.1 Transit Station Shelters shall be measured as each. Shelter Name Box shall be measured as each. Solar-powered LED Light Panel Kit shall be measured as each. Payment shall be at the unit price stated in the bid proposal and shall include all materials, labor and incidentals necessary for a complete installation of the Transit Station Shelter. Contractor pick-up from providers facility, delivery to the project site, and rigging of furnished Transit Station Shelters shall also be included for payment.
- 4.2 Transit Station Amenities (benches, litter and recycling receptacles, bicycle racks, and other amenities) shall be measured as each. Payment shall be at the unit price stated in the bid proposal and shall include all materials, labor and incidentals necessary for a complete installation of the Transit Station Amenities. Contractor pick-up from providers facility, delivery to the project site, and rigging of furnished Transit Station Amenities shall also be included for payment.
- 4.3 Transit Station Sign shall be measured as each. Payment shall be at the unit price stated in the bid proposal and shall include all materials, labor and incidentals necessary for a complete installation of the Transit Station Sign. Contractor pick-up from manufacture facility, delivery to the project site, and rigging of furnished Transit Station Shelters shall also be included for payment.
- 4.4 Transit Station LCD Monitor Stanchion shall be measured as each. Payment shall be at the unit price stated in the bid proposal and shall include all materials, labor and incidentals necessary for a complete installation of the Transit Station Shelter. Contractor pick-up from manufactures facility, delivery to the project site, and rigging of furnished Transit Station Shelters shall also be included for payment.
- 4.5 Curb Rub Rail Installation shall be measured as a Lump Sum. Payment shall be at the unit price stated in the bid proposal and shall include all materials, labor and incidentals necessary for a

complete installation of the Curb Rub Rails. Contractor to pick-up from County facility, delivery to the project site, and fasteners to the Curb Rub Rails shall also be included for payment.

END OF SECTION 10531

Transitway Extension to Pentagon City Station Design

Specifications

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DEPARTMENT OF ENVIRONMENTAL SERVICES

Division of Transportation

2100 Clarendon Boulevard, Suite 900 Arlington, VA 22201

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SECTION 03320 CONCRETE FOUNDATIONS FOR TRANSIT STATIONS

PART 1 GENERAL

1.1 Description of Work

- A. This work is for spread footing foundations to support station flag signs as shown on the plans.

1.2 References

- A. Section 01330 Submittal Procedures
- B. Section 01400 Quality Requirements
- C. Section 03100 Concrete Formwork, Reinforcement and Materials

1.3 Submittals

- A. Conform to the requirements of Section 03100 Concrete Formwork, Reinforcement and Materials and the drawings.

PART 2 PRODUCTS

2.1 Materials

- A. Conform to the requirements of Section 03100 Concrete Formwork, Reinforcement and Materials and the drawings.

PART 3 EXECUTION

3.1 Construction of Spread Footing Foundations

- A. Conform to the requirements of Section 03100 Concrete Formwork, Reinforcement and Materials and the drawings.

3.2 Testing of Spread Footing Foundations

- A. Conform to the requirements of Section 03100 Concrete Formwork, Reinforcement and Materials and the drawings.

PART 4 MEASUREMENT AND PAYMENT

4.1 Flag Sign Foundations

- A. Flag sign foundations shall be measured and paid for by cubic yards of concrete based on the dimensions shown on the drawings. Payment will include formwork, reinforcement and other items necessary for spread footing construction. Payment shall include all labor, equipment, and materials necessary to for spread footing construction.

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SECTION 05501 STAINLESS STEEL

PART 1 – GENERAL

1.1 Description of Work

- A. Provide all plant labor, supervision, material and equipment to furnish and install all structural steel and miscellaneous metal items, with accessories, fasteners, anchors, etc., complete in place as shown on the approved plans.

1.2 Related Work Specified Elsewhere

- A. Section 01330 Submittal Procedures
- B. Section 01400 Quality Requirements
- C. Section 10425 - Specialty Signs

1.3 Applicable Specifications

- A. American Institute of Steel Construction (AISC)
- B. American Society for Testing and Materials (ASTM)
- C. American Welding Society (AWS)
- D. Nickel Development Institute (NiDI).
- E. Virginia Department of Transportation, Road and Bridges Specifications (VDOT)

1.4 Submittals

- A. Before any fabrication is begun, submit detailed shop drawings of all miscellaneous metal items showing sizes of metal components, method of assembly, hardware, and anchorage or connection to other work.
- B. Submittals shall include detailed descriptive literature of manufactured items specified herein.

1.5 Quality Assurance

- A. Fabrication and installation procedures shall conform to the specifications and practices of the American Institute of Steel Construction.

1.6 Delivery, Storage and Handling

- A. Delivery, storage, and handling of stainless-steel products should comply with guidelines set forth in Chapter 7 of NiDI “Design Manual for Structural Stainless Steel” and in “Stainless Steel Fabrication” published by the Specialty Steel Industry of North America.
- B. Deliver materials to site at such times and intervals to ensure continuity of installation and uninterrupted progress of work.
- C. Store materials to permit easy access for inspection and identification. Support stainless- steel members off ground on racks made from carbon steel-free surfaces such as wood, rubber or plastic. Materials showing evidence of damage will be rejected and shall be immediately removed from the site.

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- D. Handle stainless-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 over stressing the steelwork.
- E. Mark weight on all members. Match-mark all shop pre-fitted members.
- F. 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.
- G. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Replace damaged materials or structures as directed.
- H. Use isolating material to protect structural stainless-steel when using carbon steel lifting chains, hooks, cleats, and fork lifts. Avoid using chemicals such as oils and grease. Care shall be exercised to avoid abrasions and other damage.
- I. All fasteners and washers shall be delivered to the site, where they will be installed, in unopened containers.
- J. Quarantine tools as necessary to prevent contaminating or impregnating structural stainless-steel members and components with carbon steel.

PART 2 – MATERIALS

2.1 General

- A. Welding Electrodes for Stainless-Steel:
 - 1. Conform to AWS D1.6. Base selection of electrodes on the actual properties of the metal connected.
 - 2. Filler Metal Group A-70 ksi Minimum Tensile Strength
- B. Stainless-Steel Shapes and Bars shall be in conformance with ASTM A 276 Type 316.
- C. Stainless-Steel Tubes and Pipes shall be in conformance with ASTM A 554 Type 316.
- D. Stainless Steel Plate, Sheet, and Strip shall be in conformance with ASTM A 240, Type 316
- E. Stainless Steel Fasteners
 - 1. Anchor Bolts
 - a ASTM F593 H, Type S31600 (Alloy Group 2)
 - 2. Bolts
 - a ASTM F593
 - 3. Nuts and washers
 - a ASTM F594

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2.2 Expansion Anchors

- A. Expansion Anchors shall Hilti Kwik Bolt TZ – SS 316 or approved equal.

PART 3 – EXECUTION

3.1 General

- A. Furnish all bolts, nuts, screws, clips, washers, and any other fasteners necessary for proper installation of items specified or called for on the approved plans. For ferrous metal, use stainless steel.
- B. Metal for shop-fabricated items shall be well formed to shape and size, with crisp lines or angles. Shearing and punching shall leave clean, true lines and surfaces. Weld permanent connections and grind smooth where exposed to view. Dress all sharp edges.
- C. Verify all measurements at job.
- D. Field drilled or punched holes; do not use cutting torch. Shearing and punching shall leave true lines and surfaces.
- E. Construct to sizes indicated using rolled shapes and/or plates as detailed. Include wall and sill anchors for construction indicated.
- F. Set all work plumb, true, rigid, and neatly trimmed out.
- G. Grout plates, bolts, and similar items with non-shrink grout.
- H. Castings subject to foot or street traffic shall have bearing surfaces machined to prevent rocking and rattling.
- I. Protect all dissimilar metals from galvanized corrosion by pressure tapes, coatings or isolators.

3.2 Welding

A. Stainless Steel Welding

1. Welding shall be in accordance with AWS D1.6 "Structural Welding Code "Stainless Steel".
2. Contractor is responsible for selection of specific materials and procedures except as specifically noted in contract documents.
3. Connections have varying levels of restraint and thus necessary steps shall be taken by Contractor to control or accommodate the restraint.
4. Welding and fabrication procedures shall incorporate measures necessary to eliminate cracking.
5. When selecting materials and procedures, consideration shall be given to the need for materials and procedures in excess of code requirements.
6. The need for pre-heat and other procedures are to be based on the actual chemistry and mechanical properties of the steel and not solely on the specified properties of the steel.
7. Limit maximum interpass temperatures so as not to decrease toughness and

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strength of the weld metal.

8. Weld variables shall be consistent with the recommendations of the electrode manufacturer.
9. Welding Procedure Specifications shall be readily available to all welders, inspectors, and supervisors during the production process.

B. Field Welding:

1. Provide only where approved by the Engineer.
2. Protect adjacent fabrications and finished surfaces from marring or damage caused by field welding. Provide finish of field welds in conformance with the Architectural finish specified herein for exposed stainless steel.

3.3 Bolted Connections

- A. In general, use bolts for field connections only and then only as detailed. Draw all nuts tight and nick threads of permanent connections to prevent loosening. Use beveled washers where bearing is on sloped surfaces.

3.4 Protection of Surfaces

- A. Provide protection by strippable coating, protective sleeves, polyethylene sheets, boarding, or other suitable means during fabrication, shipment, site storage, and erection to prevent damage to the finished work due to stains, discolorations, scratches, or any other cause. Replace damaged elements at no expense to the County.
- B. After installation, and after danger of subsequent damage has passed, remove all protective coverings from all exposed surfaces, and clean those surfaces of all soil and discoloration, ready for acceptance.

3.5 Architecturally Exposed Steel

- A. All members exposed to view in the completed structure shall be classified as "Architecturally Exposed Structural Steel".
- B. Comply with the provisions of Section 10 of the AISC Code of Standard Practice for Steel Buildings and Bridges regarding architecturally exposed structural steel.
 1. Abutting cross sectional configurations shall match.
 2. Remove backing bars.
 3. Remove weld runoff tabs and grind smooth with stainless steel brush or other inert material.
 4. All surfaces and welds exposed to view shall be treated as finished surfaces.
- C. Exposed Welds:
 5. All exposed fillet welds shall be made smooth of uniform convex contour, radius and dimension for their full length; grind smooth using a stainless-steel brush or other inert material, if welds were not made to this criterion.
 6. Dressing of any welds for finish shall not reduce the specified effective throat

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or structural integrity of the weld.

- D. Weld show-through shall not be permitted.
- E. Remove weld splatter on architecturally exposed steel.
- F. All exposed corners shall be square and sharp, eased to a radius of 1/4 in.

3.6 Finishes

A. Cleaning:

- 1. After fabrication, clean and remove deposits of oil and grease from stainless-steel surfaces in accordance with AISC's "Code of Standard Practice."

B. Finishes of Architecturally Exposed Steel

- 1. All surfaces of architecturally exposed structural steel members shall be uniform in appearance, including smoothness and texture, when viewed in direct sunlight at a distance of 10 feet, at angles of incidence 0 degree to 90 degree at completion.
- 2. Surface Appearance: The condition of the steel to be exposed in use shall conform to a non-directional satin finish. The exposed surfaces, edges and ends of all plates and other components shall be free of any surface defects including weld splatter, burrs, dents, gouges, occlusions, streak, ridges and recesses.

3.7 Temporary Shoring and Bracing:

- A. Provide temporary shores, guys, braces, and other supports during erection to protect the structure against damage and to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads including, but not limited to, other loads such as wind and seismic forces.
- B. Leave temporary bracing in place as long as required for safety.
- C. Provide temporary works as necessary to erect the structure.
- D. Contractor is responsible for identifying need for temporary construction.

PART 4 - MEASUREMENT AND PAYMENT

- 4.1 This work is included in Section 10425 Specialty Signs and will not be measured and paid separately.

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SECTION 10425 SPECIALTY SIGNS

PART 1 – GENERAL

1.1 Description

A. This section specifies work pertaining to Specialty Signs. The extent and location of “Specialty Signs” is indicated on the contract drawings and includes:

1. LCD Monitor Stanchion
2. LCD Monitor
3. Station Flag Sign

1.2 Related Work Specified Elsewhere

- A. Section 01330 Submittal Procedures
- B. Section 01400 Quality Requirements
- C. Specification Section 03100– Concrete Formwork, Reinforcement and Materials
- D. Specification Section 05501 Stainless Steel
- E. Specification Section 16020 Basic Electrical

1.3 Quality Assurance

A. Codes, Regulations, Reference Standards, and Specifications

1. Comply with codes and regulations of the Authority Having Jurisdiction.
2. Americans with Disabilities Act (ADA): Accessibility Guidelines.
3. American Society for Testing and Materials (ASTM)
4. National Fire Protection Agency (NFPA): 70

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Authorities Having Jurisdiction and marked for intended use.

C. Fabricator Qualifications: The sign company shall be an established firm regularly engaged in the fabrication and installation of specialty signs, having a minimum of five years’ experience in fabricating and installing signage units of a type and size similar to those shown in the contract drawings. The company shall also submit a list of sizable installations in which they provided signs and have successfully completed over a period of at least the last five years.

D. Performance Requirements:

1. Structural performance: Provide signs capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

a Wind Loads: Determine loads based on the following minimum design wind pressures:

- 1) Uniform Pressure of 25 lb./sq.ft. acting in any direction

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- b. Seismic Performance: Provide signs capable of withstanding effects of earthquake motions as determined by the Virginia Uniform Statewide Building Code.
- c. Thermal Movements: Provide signs that allow for thermal movements resulting from the following maximum change: -5 degrees F to 105 degrees F, in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections and other detrimental effects.

1.4 Submittals

A. Submit three sets of the following for approval in accordance with the Contract Documents and with the additional requirements as specified for each:

1. Manufacturer's Data: Submit manufacturer's technical data, catalog cuts, installation, and maintenance instructions for all sign types required, including sign materials, finishes, fillers and fasteners.
2. Shop Drawings: Submit shop drawings of all sign components, fittings, parts, wiring, and installation procedures, jointing, and complete anchoring and supporting systems for the various applications and mounting details. Drawings shall clearly show provisions for all performance functions described herein. Provide details and sections at full size. Differences from the contract drawings shall be clearly identified in writing. Show general assembly of components; relationship to adjoining construction; complete fabrication details of sign housing, hangers, mounting, lighting, and schematic and wiring diagrams for each type sign. Include calculations substantiating conformance with design criteria.
3. Samples: Submit samples of the color and finish of exposed materials and accessories required for signs for approval before proceeding. The review of samples will be for color, gloss, finish, and texture. When requested, furnish full-size samples of sign materials.
4. Certifications: Submit manufacturer's certificate indicating that all materials and products used on the project meet or exceed specified requirements.

1.5 Product Delivery, Storage, And Handling

- A. Ensure that all signs are adequately protected from damage during fabrication and installation. Deliver specialty signs in cartons or crates to provide protection during transit and storage at the work site. Storage of fabricated items is the responsibility of the Sign Subcontractor. Protect stored materials against corrosion, deterioration of any kind, and damage.
- B. Inspect specialty signs upon delivery for damage. Repair minor damages provided that the finished items are equal in all respects to new work; otherwise, remove and replace damaged items as indicated.
- C. Specialty signs shall be delivered to the work site in original unopened packages, clearly labeled with manufacturer's name, brand, specification identification data, and identification as shown on approved shop drawings or submittals.

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- D. Packaging shall be made with fixed labels clearly identifying the type and quantity of the specialty signs, and the station where these signs will be installed.
- E. Store specialty signs under cover. Place all units on at least 4-inch high sills on floors in a manner that will prevent damage and rusting. Avoid the use of non-vented plastic or canvas shelters, which could create a humidity chamber or contact with soil or exposure to the elements.
- F. Protect specialty signs to prevent scratches, stains, discoloration, or other damage. Protect finished surfaces from soiling and damage during delivery, storage, handling, and installation. Keep covered with polyethylene film or other protective covering. Replace items damaged during fabrication, handling, shipment, storage, or erection.
- G. Keep cementitious and bulk materials, such as cement and sand, dry and protected from contamination by foreign materials.

PART 2 – PRODUCTS

2.1 Framing, Fastening, Hardware, And Adhesives

A. Materials

1. Stainless Steel

B. Exposed Fasteners and Screw Heads: Tamper-resistant, Allen head type. Finish to match color of sign to which applied.

C. Nylon Washers: Manufacturer's standard.

D. Silicone Adhesive Sealant: Non-acid curing silicone adhesive sealant, either clear color or match the substrate, General Electric brand or equal.

2.2 LCD Monitor

The LCD (liquid crystal display) monitor shall consist of an MRI, Vartech, or equal screen with integral central processing unit (CPU) with the following features:

- 2000 nit Brightness for 5 years
- Dynamic Block Dimming
- Current Monitoring / Control
- Modular Access of Internal Components for Servicing
- Thermal Management System
- Digital Image Verification
- Performance Monitoring
- Aluminum frame with powder coat finish
- Electrical: 85-270 VAC, 47-63 Hz
- Operating Max Temperature: +40°C (+104°F)
- Operating Min Temperature: -30°C (-22°F)
- Internal, On-Board Media Player
 - Two full HD HDMI outputs
 - 1920 x 1200-pixel resolution @ 60Hz

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- Front side bus speed of 1066 MHz
- 100M Ethernet Port
- USB 2.0 and USB 3.0 ports
- Intel i5 Quad Core operating at 2.5Ghz
- 4GB DDR3 1333
- Solid State 40 GB SATA 3Ghz Disk Drive
- Windows 7 64-bit OS
- -20 to 70 degrees C operating
- -40 to 70 degrees C storage
- 5 to 95% humidity noncondensing

A 4G card shall be installed in the CPU located in the LCD display cabinet, capable of providing a 4G wireless internet connection.

The Contractor shall provide two (2) years of service and support for all display equipment included in the contract price.

PART 3 – EXECUTION

3.1 General

- A. The Sign Subcontractor shall furnish all labor, tools, materials, equipment, facilities, connections, brackets and accessories to fabricate, assemble, package, ship, deliver, handle, unload and install at the work site specialty signs and miscellaneous accessories in accordance with this section.
- B. Specialty Signs with the miscellaneous accessories shall be new, finished as specified, in full compliance with the specification, fully assembled as appropriate, securely packaged to prevent damage and containing all attachments, connection and brackets necessary to complete the installation without field modifications or additional materials.
- C. Inspection: Inspect surfaces and conditions under which the work will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected.
- D. Prepare surfaces and apply County provided signage film and number plaque in strict accordance with the product manufacturer's printed instructions.
- E. Fabricate signs of the material and to the dimensions shown, with straight lines and flat planes.
- F. Install work plumb, level, true, and straight with no distortion, Shim as required using concealed stainless-steel shims.
- G. Electrical supply and connections to be internal to sign and sign support system, concealed from view. Provide flush access panels with tamper- proof fasteners.

PART 4 – MEASUREMENT AND PAYMENT

4.1 Signs

- A. Station Flag Sign will be measured and paid for at the Contract unit price per each. The payment will be full compensation for all material, labor, equipment,

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tools, and incidentals necessary to complete the work, including furnishing and installing all wiring and attachments as shown in the drawings and required by the LED sign manufacturer.

B. LCD Monitor Stanchion will be measured and paid for at the Contract unit price per each. The payment will be full compensation for all material, labor, equipment, tools, mounting supports and hardware, and incidentals necessary to complete the work.

C. LCD Monitor will be measured and paid for at the Contract unit price per each. The payment will be full compensation for all material, labor, equipment, tools, mounting supports and hardware, and incidentals necessary to complete the work, including furnishing and installing the LCD Monitor and all wiring and attachments as shown in the drawings and required by the manufacturer.

SECTION 16020 BASIC ELECTRICAL

PART 1 - GENERAL

1.1 Description of Work

- A. This work shall consist of furnishing and installing the following electrical components:
1. Raceways
 2. Sleeves for raceways and cables.
 3. Conductors.
 4. Connectors.
 5. Grounding.
 6. Supporting devices for electrical components.
 7. Electrical identification.
 8. Boxes, enclosures, and cabinets include the following:
 9. Pull and junction boxes.
 10. Enclosures and cabinets.
 11. Panelboards
 12. Overcurrent Protective Devices
 13. General Purpose Transformers
 14. Common electrical installation requirements.
 15. Cutting and patching for electrical construction.
- B. Work includes coordination with Dominion Energy, Arlington County and residents, business owners and property owners that are affected by the electrical work.
- C. All existing electrical service(s) shall be maintained during the construction period.

1.2 General

- A. Drawings and general provisions of the Contract apply to this Section.

1.3 Definitions

- A. EPDM: Ethylene-propylene-diene monomer rubber.
- B. EMT: Electrical metallic tubing.
- C. FMC: Flexible metal conduit.
- D. GFCI: Ground-fault circuit interrupter.
- E. HDPE: High Density Polyethylene
- F. IMC: Intermediate metal conduit.

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G. LFMC: Liquid-tight flexible metal conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. PVC: Polyvinyl Chloride

J. RGS: Rigid galvanized steel conduit.

K. RMS: Root mean square.

L. RNC: Rigid nonmetallic conduit.

1.4 Submittals

A. General Submittals shall comply with Arlington County and Virginia Department of Transportation Codes.

B. Product Data: For each type of product indicated.

C. Shop Drawings and Manufacturer's Data: Shop drawings shall be submitted to the Engineer and include, but not be limited to, the following:

1. Outline drawing showing plan, elevation views and mounting dimensions including locations of control cabinet, terminals, conduit entry, ground connections and weights.
2. Drawing of nameplate data with nameplate data filled in.
3. Enclosure types and details for types other than NEMA 250, Type 1.
4. Bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. UL listing for series rating of installed devices.
7. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

D. Certified Laboratory Test Reports: Submit to the Engineer, in triplicate, certified copies of reports for all tests required in accordance with referenced standards and as specified herein.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Spare Parts Data: As soon as practicable after acceptance of materials and equipment, furnish to the Engineer spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and source of supply. The foregoing shall not relieve the Contractor of any responsibilities under the Warranty.

G. Maintenance Data: For panelboards and components to include in maintenance manuals.

16. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

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17. Time-current curves, including selectable ranges for each type of overcurrent protective device.

H. Field Test Reports: Test reports shall conform to the criteria defined in NETA ATS-1995, and shall include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. List of equipment required to set up and perform the procedure.
4. Description of the required procedure setup, including diagrams illustrating test equipment connections and identifying test points, where applicable.
5. Step-by-step instructions for performing the procedure identifying the points where data is to be recorded and the limits for acceptable data.
6. Provisions for recording pertinent test conditions and environment at time of test.
7. Instructions for recording data on data sheets and verifying that procedure steps have been completed.
8. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 Quality Assurance

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with NFPA 101, Life Safety Code.
2. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
3. American National Standards Institute (ANSI) Publications:
 - A13.1 Pipe Marking Standards
 - C2 National Electrical Safety Code
 - C57.12.01 General Requirements for Dry-Type Distribution and Power Transformers
 - C57.12.91 Test Code for Dry-Type Distribution and Power Transformers
 - C57.94 Recommended Practices for Installation, Application, Operation and Maintenance of Dry-Type General Purpose Distribution and Power Transformers
 - C57.96 Guide for Loading Dry-Type Transformers
 - C80.1 Rigid Galvanized Steel Conduit
 - C80.3 Electric Metallic Tubing
 - C80.6 Intermediate Metallic Conduit
 - Z55.1 Gray Finishes for Industrial Apparatus and Equipment

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4. National Electrical Manufacturers Association (NEMA) Publication:

- ST20 Dry Type Transformers for General Applications
- PB1 Panelboards
- AB1 Molded Case Circuit Breakers and Molded Case Switches
- FB1 Fittings, Cast Metal Boxes Metal Bodies for Conduits
- OS1 Sheet Steel Outlet Boxes, Device Boxes, Device Boxes, Covers, and Box Supports.
- TC2 PVC Conduit
- TC3 PVC Fittings
- 250 Enclosures for Electrical Equipment

5. Underwriter's Laboratories Inc. (UL) Publications:

- 924 Standard for Safety of Emergency Lighting and Power Equipment
- 1561 Dry-Type General Purpose and Power Transformers
- ST20 Dry Type Transformers for General Applications

6. Institute of Electrical and Electronic Engineers (IEEE) Publication:

- C57.12.58 Guide of Conducting a Transient Voltage Analysis for a Dry-Type Transformer Coil
- 467 Grounding and Bonding
- 468 Electrical Insulation System

1.6 Product Delivery, Storage and Handling

- A. Ship unit(s) securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- B. Where necessary, brace electrical equipment housing for hoisting, lowering and skidding into position. Label temporary internal bracing:
- C. Store electrical equipment in secure and dry storage facility.

1.7 Coordination

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
- B. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- C. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work.
- D. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead

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utilities and services, including provision for electricity- metering components.

2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- E. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.
- F. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- G. Submit written notice as to when the installed systems will be tested so that the Construction manager may be present to witness the tests.
- H. Coordinate arrangement, mounting, and support of electrical equipment:
 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping and conduit installed at required slope.
 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- I. A representative of the manufacturer may be present to witness the tests and verify the results.

PART 2 - PRODUCTS

2.1 Raceways

- A. EMT: ANSI C80.3, zinc-coated steel, compression fittings.
- B. FMC: Zinc-coated steel.
- C. IMC: ANSI C80.6, zinc-coated steel, with threaded fittings.
- D. LFMC: Zinc-coated steel with sunlight-resistant and mineral-oil-resistant plastic jacket.
- E. RNC: NEMA TC 2, Schedule 40 PVC, with NEMA TC3 fittings.
- F. Raceway Fitting: Specifically designed for the raceway type with which used.
- G. RGS: ANSI C80.1 with threaded fittings.

2.2 Sleeves for Raceways and Cables

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

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C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

D. Grouts: Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

E. Sleeve Seals: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

2. Pressure Plates: Plastic, carbon steel or stainless steel. Include two for each sealing element.

3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 Conductors

A. Conductors, No. 10 AWG and Smaller: Solid copper.

B. Conductors, Larger Than No. 10 AWG: Stranded copper.

C. Insulation: Thermoplastic, rated at 75 deg C minimum.

D. Equipment Grounding Conductors: Insulated with green-colored insulation.

E. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

G. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.

2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with

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insulators.

2.4 Connector Products

- A. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- B. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.5 Grounding Electrodes

- A. Ground Rods: Copper-clad steel: 80% copper minimum.
 - 1. Size: 3/4 inches in diameter by 120 inches in length.

2.6 Supporting Devices

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: PVC coated hot-galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch diameter slotted holes at a maximum of 2 inches o.c., in webs.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- G. Expansion Anchors: Carbon-steel wedge or sleeve type.
- H. Toggle Bolts: All-steel springhead type.
- I. Powder-Driven Threaded Studs: Heat-treated steel.

2.7 Electrical Identification

- A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Raceway and Cable Labels: Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.
 - 1. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant coating.
 - 2. Color: Black letters on orange background.
- C. Underground Warning Tape: Permanent, bright-colored, continuous- printed,

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vinyl tape with the following features:

1. Not less than 6 inches wide by 4 mils thick.
 2. Compounded for permanent direct-burial service.
 3. Embedded continuous metallic strip or core.
 4. Printed legend that indicates type of underground line.
- D. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- E. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch minimum thickness for larger sizes. Engraved legend in white letters on black background.
- G. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.
- H. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.
- I. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch, galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4- inch grommets in corners for mounting.
- J. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.8 Boxes, Enclosures, And Cabinets

A. Outlet and Device Boxes

1. Sheet Metal Boxes: NEMA OS 1.
2. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.

B. Pull and Junction Boxes

1. Small Sheet Metal Boxes: NEMA OS 1.
2. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

C. Enclosures and Cabinets: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Front: Secured to box with concealed trim clamps. For surface- mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

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3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

2.9 Panelboards

A. Manufacturers: Panelboards and Accessories shall be subject to compliance with requirements, provide products by one of the following:

1. Eaton Corp.; Cutler-Hammer Products.
2. ABB/General Electric Co.; Electrical Distribution & Control Div.
3. Siemens Energy & Automation, Inc.
4. Square D Co.

B. Bus: Hard-drawn copper, 98 percent conductivity.

C. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.

D. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

F. Feed-through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

G. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

H. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

I. Short Circuit Rating: UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

2.10 Overcurrent Protective Devices

A. Manufacturers: Overcurrent Protective Devices, Controllers, Contactors, and Accessories shall be subject to compliance with requirements, provide products by one of the following:

1. Eaton Corp.; Cutler-Hammer Products.
2. ABB/General Electric Co.; Electrical Distribution & Control Div.
3. Siemens Energy & Automation, Inc.
4. Square D Co.

B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.

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1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air- conditioning, and refrigerating equipment.

2.11 General Purpose Transformer

- A. Standards: Shall conform to NEMA ST20. All characteristics, definitions, terminology, voltage designations and tests shall be in accordance with ANSI/IEEE C57.12.01.
- B. Application: Suitable for outdoor application and step down of the incoming 480 volts to 240Y/120 volt.
- C. Listing: UL 1561
- D. Type: Two winding, low voltage, dry-type.
- E. Cooling: Self-cooled.
- F. Ratings:
 1. kVA: As shown on Contract Drawings
 2. Temperature Rise: 115°C
 3. Frequency (Hertz): 60
 4. Primary Volts: 480
 5. Secondary Volts: 240Y/120
 6. Basic Impulse Level (kV): 10
 7. Impedance: 6.4%
- G. Core and Coil Assembly: Coils shall be of the continuous wound construction and shall be impregnated with non- hygroscopic, thermosetting resin. Cores shall be constructed of high grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below the saturation point. The complete coil and core assembly shall be bolted to the base of the enclosure, but isolated therefrom by means of rubber vibration-absorbing mounts.
- H. Insulation System: UL component recognized 220°C insulation system.
- I. Enclosure: Shall be constructed of heavy gauge, sheet- steel, ventilated enclosure. The ventilating openings shall be designed to prevent
- J. accidental access to live parts in accordance with UL, NEMA and National Electrical Code standards for ventilated enclosures.
- K. Factory Tests: Shall be made at the factory and in accordance with ANSI C57.12.91, as applicable. At the conclusion of the tests, the Engineer shall be furnished with copies of all original test data for acceptance. The accuracy of the calibration of all instruments to be employed during the tests shall be ascertained and recorded at the beginning of the tests. Tests for transformers shall include,

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but not be limited to, the following:

1. No-load losses
2. Polarity check
3. Applied potential test
4. Induced potential test
5. Ratio check
6. Sound levels (*)
7. Temperature rise (*)
8. No-load losses (*)
9. Impedance (*)

(*) Certified test results of previously built similar units will be accepted in lieu of actual tests.

PART 3 - EXECUTION

3.1 Electrical Equipment Installation

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right-of-Way: Give to raceways and piping systems installed at a required slope.

3.2 Raceway Application

Use the following raceways for outdoor installations:

1. Exposed: RGS, LFMC or Stainless Steel.
2. Exposed: Flexible.
3. Underground, Grouped Run: PVC
4. Underground, Grouped Run: HDPE
5. Connection to Vibrating Equipment: LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R.

3.3 Sleeve Installation for Electrical Penetrations

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

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- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core- drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Cut sleeves to length for mounting flush with both surfaces of walls.
- E. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- F. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
- I. Sleeve Seal: Install to seal exterior wall penetrations. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 Raceway and Cable Installation

- A. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.
- B. Install raceways and cables at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.
- C. Use temporary raceway caps to prevent foreign matter from entering.
- D. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- E. Use raceway and cable fittings compatible with raceways and cables and suitable for use and location.
- F. Install raceways embedded in slabs in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Install conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where conduit is at right angles to reinforcement, place conduit close to slab support.

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4. Make bends in exposed parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for exposed parallel raceways.
- G. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 210-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.
- H. Install telephone and signal system raceways, 2-inch trade size and smaller, in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements, in addition to requirements above.
- I. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inch flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.
- J. Set floor boxes level and trim after installation to fit flush to finished floor surface.

3.5 Wiring Installation

- A. Feeders: Type THHN/THWN insulated conductors in raceway.
- B. Underground Feeders and Branch Circuits: Type XHHW conductors in raceway.
- C. Branch Circuits: Type THHN/THWN insulated conductors in raceway.
- D. Remote-Control Signaling and Power-Limited Circuits: Type THHN/THWN insulated conductors in raceway for Classes 1, 2, and 3, unless otherwise indicated.
- E. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors. Splices shall not be utilized without prior approval of Engineer.
- F. Install wiring at outlets with at least 12 inches of slack conductor at each outlet.
- G. Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.6 Grounding

- A. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
 1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds. Make connections without exposing steel or damaging copper coating.
- B. In raceways, use insulated equipment grounding conductors.

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- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Install equipment grounding conductors in all feeders and circuits.
- F. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- G. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- H. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- I. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

3.7 Connections

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond

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electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.8 Electrical Supporting Device Application

- A. Damp Locations and Outdoors: PVC coated hot-dip galvanized materials, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.9 Support Installation

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed

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conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 3. New Concrete: Concrete inserts with machine screws and bolts.
 - 4. Steel: Welded threaded studs or spring-tension clamps on steel.
 - 5. Field Welding: Comply with AWS D1.1.
 - 6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
 - 7. Light Steel: Sheet-metal screws.
 - 8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load provided by manufacturer.

3.10 Identification Materials and Devices

- A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- C. Self-Adhesive Identification Products: Clean surfaces before applying.
- D. Identify raceways and cables with color banding as follows:
 - 1. Bands: Pretensioned, snap-around, colored plastic sleeves or colored adhesive marking tape. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 - 2. Band Locations: At changes in direction, at penetrations of walls and floors, at

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50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

3. Colors: As follows:

- a. Fire Alarm System: Red.
- b. Security System: Blue and yellow.
- c. Telecommunication System: Green and yellow.

- E. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.
- F. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches, overall, use a single line marker.
- G. Color-code 208/120-V system secondary service, feeder, and branch- circuit conductors throughout the secondary electrical system as follows:
1. Phase A: Black.
 2. Phase B: Red.
 3. Phase C: Blue.
 4. Neutral: White.
 5. Ground: Green.
- H. Color-code 480/277-V system secondary service, feeder, and branch- circuit conductors throughout the secondary electrical system as follows:
1. Phase A: Yellow.
 2. Phase B: Brown.
 3. Phase C: Orange.
 4. Neutral: White with a colored stripe or gray.
 5. Ground: Green.
- I. Install warning, caution, and instruction signs where required to comply with 29 CFR, Chapter XVII, Part 1910.145, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
- J. Install engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

3.11 Panelboards Installation

- A. Install panelboards and accessories according to NEMA PB 1.1.

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- B. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- D. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- E. Install filler plates in unused spaces.
- F. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- G. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.
- H. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- I. Testing Agency: Engage a qualified independent testing agency to perform specified testing.
- J. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.6 for molded- case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- K. Provide a full warranty for a period of two years, unless specified otherwise in the general conditions, materials, workmanship, and services provided. Replace, repair, or adjust any item or workmanship found to be unacceptable to the Owner. Contractor shall be responsible for damages caused by or resulting from defects in workmanship.
- L. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.
- M. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- N. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working

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schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.12 Installation of Transformers

- A. Installation shall comply with ANSI C2, C57.94, and C57.96.
- B. Install transformers in position shown and in accordance with manufacturer's recommendations.
- C. Inspections: Before placing transformer(s) in service perform the following inspections:
 1. Verify selection of taps and ratio connections
 2. Check tightness and clearances of all electrical connections
- D. Tests:
 1. General: Shall be performed in accordance with ANSI C57.12.91, and NETA ATS-1995, as applicable.
 2. Before placing transformer(s) in service, test secondary voltage.

3.13 Lighting Installation

- A. Fixtures: Set level, plumb, and square with ceiling, walls, and structural steel secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.
- B. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- C. Advance Notice: Give dates and times for field tests.
- D. Provide instruments to make and record test results.
- E. Tests: As follows:
 1. Verify normal operation of each fixture after installation.
 2. Report results in writing.
- F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
- G. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.
- H. Corroded Fixtures: Replace during warranty period.

3.14 Cutting and Patching

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other

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surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.15 Field Quality Control

- A. Inspect installed components for damage and faulty work, including the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Grounding.
 - 4. Supporting devices for electrical components.
 - 5. Electrical identification.
 - 6. Boxes, enclosures, and cabinets.
 - 7. Panelboards.
 - 8. General Purpose Transformers.
 - 9. Lighting.
 - 10. Cutting and patching for electrical construction.
 - 11. Touchup painting.
- B. All concealed electrical equipment shall be inspected prior to covering.
- C. Grounding System Verification: Verify and test that grounding system is installed in accordance with Contract Documents and resistance to earth does not exceed five ohms.
- D. Lighting and Receptacle System Operability: Verify by testing the operability of lighting and receptacle circuits.
- E. Verification and Testing for Electrical Door Strikes and Door Position Indicators: Verify by testing the integrity and operation of electric door strikes and door position indicators.

3.16 Refinishing and Touchup Painting

- A. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
- B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
- C. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
- D. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

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3.17 Cleaning and Protection

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

PART 4 - MEASUREMENT AND PAYMENT

4.1 Basic Electrical Materials and Methods

- A. Ground Rods will be measured and paid for at the Contract unit price per each 10 ft length. The payment will be full compensation for lugs and welding, excavation, backfill, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.
- B. Electrical conduit will be measured and paid for at the Contract unit price per linear foot measured along the center line of the conduit from end to end. The payment will be full compensation for all excavation, backfill, encasement concrete, hot mix asphalt, paint, pull wires, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.
- C. Power Distribution Cabinet will be measured and paid for at the Contract unit price per each at the phasing and amperage specified. The payment will be full compensation for the disconnect switch, enclosures, circuit breakers, panels, contactors, photocell, meter socket, meter, shunts, cover plate, lightning arresters, wiring, conduit risers, wiring trough, conduit nipples and adapters, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.
- D. Power Service Pedestal will be measured and paid for at the Contract unit price per each. The payment will be full compensation for all enclosures, panel boards, circuit breakers, internal wiring, wiring devices, concrete collar, meter sockets, meter, shunts, cover plates, wiring, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.
- E. Utility connection coordination with the utility company will not be measured, but the cost will be incidental to other pertinent items.
- F. Trenching and backfilling will not be measured but the cost will be incidental to the Contract unit price for the installation of the pertinent Conduit.
- G. Electrical Cable, Grounding Wire, and Communication Cable will be measured and paid for at the Contract unit price per linear foot for the type and sizes specified.
- H. Electrical Hand Holes, Pull and Junction Boxes will be measured and paid for at the Contract unit price per each unless otherwise specified in the Contract Documents. The payment will be full compensation for all excavation, aggregate drain, concrete, bolts, bricks, pipes, backfill, sealer, frames and covers, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.