

# LEHIGH ACRES LEE TRAN PARK AND RIDE

LEHIGH ACRES, FLORIDA

## CONTRACT DOCUMENTS

-VOLUME II-

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## SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Transition fittings.
  - 3. Dielectric fittings.
  - 4. Sleeves.
  - 5. Escutcheons.
  - 6. Grout.
  - 7. Plumbing demolition.
  - 8. Equipment installation requirements common to equipment sections.
  - 9. Painting and finishing.
  - 10. Concrete bases.
  - 11. Supports and anchorages.

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, and spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.



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- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. CPVC: Chlorinated polyvinyl chloride plastic.
  - 2. PE: Polyethylene plastic.
  - 3. PVC: Polyvinyl chloride plastic.

## 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Transition fittings.
  - 2. Dielectric fittings.
  - 3. Escutcheons.

## 1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

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## 1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

## PART 2 - PRODUCTS

### 2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.2 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

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## 2.3 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
  - 1. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
- B. Flexible Transition Couplings for Underground No pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

## 2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - 1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

## 2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- D. PVC Pipe: ASTM D 1785, Schedule 40.
- E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

## 2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers

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opening.

- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated and rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated and rough brass.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With hinge, set screw or spring clips, and chrome-plated finish.

## PART 3 - EXECUTION

### 3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.

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- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1. New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
    - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
  - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- P. Verify final equipment locations for roughing-in.
- Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

## 3.2 PIPING JOINT CONSTRUCTION

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- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.

### 3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

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## 3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

## 3.5 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

## 3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7. As specified in Division 03 Section.

## 3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

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## 3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

## 3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 220500



# LEHIGH ACRES LEE TRAN PARK AND RIDE LEHIGH ACRES, FLORIDA

## SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Pipe labels.
  - 3. Stencils.
  - 4. Valve tags.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

#### 1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

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## A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

## B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

## C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 PIPE LABELS

### A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

### B. Pretensioned Pipe Labels: Precoiled, semi rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

### C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches.

## 2.3 VALVE TAGS

### A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

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2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

### 3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7. Identification of potable and nonpotable water.

a. In all buildings where two or more water distribution systems, one potable water and the other nonpotable water, are installed, each system shall be identified either by color marking or metal tags as required by ASME A13.1. Reclaimed water systems shall be identified using color coded Pantone Purple 522C and marked with the statement "NONPOTABLE WATER - NOT FOR HUMAN CONSUMPTION"

B. Pipe Label Color: Refer to ASME (ANSI) Standard A13.1-2007

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3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape: 2 inches round brass tag with stamped or engraved lettering.

END OF SECTION 220553

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## SECTION 220700 - PLUMBING INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Insulation Materials:
    - a. Flexible elastomeric.
    - b. Mineral fiber.
  - 2. Insulating cements.
  - 3. Adhesives.
  - 4. Mastics.
  - 5. Lagging adhesives.
  - 6. Sealants.
  - 7. Factory-applied jackets.
  - 8. Tapes.
  - 9. Corner angles.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

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B. Submittal:

1. For adhesives and sealants, including printed statement of VOC content compliant with South Coast Air Quality Management District (SCAQMD) Rule #1168.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
  1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

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## 1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- F. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000(Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.
    - e. Owens Corning; Fiberglas Pipe Insulation.

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2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Insulco, Division of MFS, Inc.; Triple I.
  - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Aeroflex USA Inc.; Aeroseal.
  - b. Armacell LCC; 520 Adhesive.
  - c. RBX Corporation; Rubatex Contact Adhesive.

- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Products, Division of ITW; CP-82.
  - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
  - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
  - d. Marathon Industries, Inc.; 225.
  - e. Mon-Eco Industries, Inc.; 22-25.

- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Products, Division of ITW; CP-82.
  - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
  - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
  - d. Marathon Industries, Inc.; 225.



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- e. Mon-Eco Industries, Inc.; 22-25.

**2.4 MASTICS**

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-35.
    - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    - c. ITW TACC, Division of Illinois Tool Works; CB-50.
    - d. Marathon Industries, Inc.; 590.
    - e. Mon-Eco Industries, Inc.; 55-40.
    - f. Vimasco Corporation; 749.
  - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
  - 5. Color: White.

**2.5 LAGGING ADHESIVES**

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-52.
    - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
    - c. Marathon Industries, Inc.; 130.
    - d. Mon-Eco Industries, Inc.; 11-30.
    - e. Vimasco Corporation; 136.
  - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
  - 3. Service Temperature Range: Minus 50 to plus 180 deg F.
  - 4. Color: White.

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## 2.6 SEALANTS

### A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.

### B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

## 2.7 FACTORY-APPLIED JACKETS

### A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

## 2.8 TAPES

### A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
  - b. Compac Corp.; 104 and 105.
  - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
  - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.

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7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

## 2.9 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
  1. Verify that systems and equipment to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
  3. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

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- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
  - 3. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere and seal patches similar to butt joints.

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P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Cleanouts.

## 3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

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7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

## 3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.

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2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.6 MINERAL-FIBER INSULATION INSTALLATION

### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

### B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

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2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

## 3.7 FINISHES

- A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
  1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

## 3.8 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

## 3.9 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water:
  1. Insulation shall be one of the following:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Condensate and Equipment Drain Water:
  1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 3/4 inch thick.



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END OF SECTION 220700

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## SECTION 221113 - FACILITY WATER DISTRIBUTION PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 31 apply to the Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract including General Requirements and Division 31 apply to this Section.
- B. Florida Governmental Utility Authority Specifications and Standards.

#### 1.3 SUMMARY

- A. This section describes the Contractor's responsibilities for all labor, materials, equipment and services to complete the water distribution systems and sanitary sewer construction. The work shall comply with the latest Florida Governmental Utility Authority standards.
- B. The intent of this section of the specifications is that the Contractor's bid on the work covered herein shall be based upon the drawings and specification, but that the work shall comply with all applicable codes and regulations as amended by any waiver. The Contractor's attention is directed to the General Requirements
- C. Refer to Section 312300 – Trenching, Backfilling, and Compacting for Utility Systems information.

### PART 2 - EXECUTION

#### 2.1 PIPE BEDDING

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Perform final grading of trench bottoms by hand tools. Carry machine excavation only to such depth that soil bearing for pipes will not be disturbed. Grade the bottom of trenches evenly to insure uniform bearing for all pipes. Cut holes as necessary for joints and joint making.

- A. As an alternate method, optional with the Contractor, excavate trenches to at least 4" below the required bottom levels and refill to the proper grade with sand or gravel firmly compacted.
- B. In rock, cemented gravel, old masonry or other hard material, excavate to at least 4" below the pipe at all points and refill to grade with sand and or gravel firmly compacted.
- C. In fill containing refuse, organic matter or similar substances, or any other material deemed unsuitable by the Engineer and/or Owner, remove such material to a depth of at least 6" below the pipe at all points and refill to grade with sand or gravel firmly compacted.

## 2.2 SHORING

Unless trench banks are cut back on a stable slope, sheet and brace trenches as necessary to prevent caving or sliding, to provide protection for workmen and in the pipe, and to protect adjacent structures and facilities. Do not brace sheeting against the pipe, but brace it so that no concentrated loads of horizontal thrust are transmitted to the pipe. If a portable metal box is used for bracing the slopes, take care not to disturb the pipe when the box is removed.

## 2.3 DISPOSITION OF UTILITIES

Rules and Regulations governing the respective utilities shall be observed in executing all work under this heading. Active utilities, if encountered, shall be protected in accordance with written instructions of the Engineer. Inactive and abandoned utilities encountered in trenching operations shall be removed, plugged or capped. In absence of specific requirements, plug or cap such utility lines at least 5' from utility line to be installed or as required by local and state regulations.

## 2.4 SPECIFICATIONS

The utilities in this section shall be installed in accordance with the requirement and specifications of Lee County Utilities and Florida Governmental Utility Authority.

## 2.5 MEASUREMENT AND PAYMENT

All utilities shall be measured in accordance with the units set forth in the bid schedule. The lengths shall be centered to center of boxes, manhole connections, etc. Payment shall include all work necessary to install the lines or facilities, test them and have them accepted by Engineer, Lee County Utilities and Florida Governmental Utility Authority.

END OF SECTION 221113

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## SECTION 221116 - DOMESTIC WATER PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.

#### 1.3 SUBMITTALS

- A. Product Data: For the following products:
  - 1. Backflow preventers and vacuum breakers.

#### 1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.
- C. Comply with NSF 61 for potable domestic water piping and components.

#### 1.5 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by

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Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Architect's, Construction Manager's and Owner's written permission.

## 1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

### 2.2 CPVC PIPING (INTERIOR DOMESTIC WATER PIPING) Retain one of three paragraphs below.

- A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40.

1. CPVC Socket Fittings: ASTM F 438 for Schedule 40.
2. PVC PIPE AND FITTINGS

- B. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.

1. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.
2. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

### 2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

- B. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

1. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- C. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

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1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- F. Install domestic water piping level without pitch and plumb.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

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- K. Install piping adjacent to equipment and specialties to allow service and maintenance.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- R. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
- S. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

## 3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- E. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

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- G. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Piping: Join according to ASTM D 2855.
- H. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

## 3.4 HANGER AND SUPPORT INSTALLATION

- 1. Vertical Piping: MSS Type 8 or 42, clamps.
  - 2. Individual, Straight, Horizontal Piping Runs:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
  - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
  - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
  - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
  - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
  - 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
- G. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- H. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing



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and minimum rod diameters:

1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.

- I. Install supports for vertical PVC piping every 48 inches.
- J. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

## 3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
  3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

## 3.6 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

## 3.7 ADJUSTING

- A. Perform the following adjustments before operation:
  1. Close drain valves, hydrants, and hose bibbs.
  2. Open shutoff valves to fully open position.
  3. Open throttling valves to proper setting.
  4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.

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- b. Adjust calibrated balancing valves to flows indicated.
- 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
- 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
- 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
- 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

## 3.8 CLEANING

### A. Clean and disinfect potable and non-potable domestic water piping as follows:

- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
- 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
  - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - b. Fill and isolate system according to either of the following:
    - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
    - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
  - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

### B. Prepare and submit reports of purging and disinfecting activities.

### C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

## 3.9 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, shall be one of the following:

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1. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.
- E. Aboveground domestic water piping, shall be one of the following:
1. CPVC, Schedule 40 pipe; CPVC, Schedule 40 socket fittings; and solvent-cemented joints.
- 3.10 VALVE SCHEDULE (PVC PLASTIC VALVES ARE NOT ALLOWED)
- 3.11 Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller.
  2. Use ball or globe valves for piping NPS 2 and smaller.
  3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
  4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

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## SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
  - 1. Vacuum breakers.
  - 2. Backflow preventers.
  - 3. Hose bibbs.
  - 4. Wall hydrants.
  - 5. Water hammer arresters.
  - 6. Trap-seal primer valves.
- B. Related Sections include the following:
  - 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
  - 2. Division 22 Section "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
  - 3. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.
  - 4. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

#### 1.3 PERFORMANCE REQUIREMENTS

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- A. Minimum Working Pressure for Domestic Water Piping Specialties: **125 psig**, unless otherwise indicated.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

#### 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.
- B. NSF Compliance:
  - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
  - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

### PART 2 - PRODUCTS

#### 2.1 VACUUM BREAKERS

- A. Hose-Connection Vacuum Breakers:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Watts Industries, Inc.; Water Products Div.
    - b. Woodford Manufacturing Company.
    - c. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1011.
  - 3. Body: Bronze, nonremovable, with manual drain.
  - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
  - 5. Finish: Chrome or nickel plated.
- B. Laboratory-Faucet Vacuum Breakers:

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1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Conbraco Industries, Inc.
  - b. Watts Industries, Inc.; Water Products Div.
  - c. Woodford Manufacturing Company.
  - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1035.
3. Size: **NPS 1/4 or NPS 3/8** matching faucet size.
4. Body: Bronze.
5. End Connections: Threaded.
6. Finish: Chrome plated.

## 2.2 BACKFLOW PREVENTERS

### A. Hose-Connection Backflow Preventers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Conbraco Industries, Inc.
  - b. Watts Industries, Inc.; Water Products Div.
  - c. Woodford Manufacturing Company.
2. Standard: ASSE 1052.
3. Operation: Up to **10-foot head of water** back pressure.
4. Inlet Size: **NPS 1/2 or NPS 3/4**.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least **3-gpm** flow.

## 2.3 HOSE BIBBS

### A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: **NPS 1/2 or NPS 3/4** threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: **125 psig**.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.

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12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

## 2.4 WALL HYDRANTS

### A. Moderate-Climate Wall Hydrants:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - b. Watts Drainage Products Inc.
  - c. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig .
4. Operation: Loose key.
5. Inlet: NPS 3/4 or NPS 1 .
6. Outlet: Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounting with cover.
8. Box and Cover Finish: Chrome plated.
9. Outlet: Exposed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Keys(s): One with each wall hydrant.

### B. Vacuum Breaker Wall Hydrants:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
  - b. Watts Industries, Inc.; Water Products Div.
  - c. Woodford Manufacturing Company.
  - d. Zurn Plumbing Products Group; Light Commercial Operation.
2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig .
6. Operation: Loose key or wheel handle.

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7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: **NPS 1/2 or NPS 3/4**.
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

## 2.5 WATER HAMMER ARRESTERS

### A. Water Hammer Arresters:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Sioux Chief Manufacturing Company, Inc.
  - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - c. Watts Drainage Products Inc.
  - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

## 2.6 TRAP-SEAL PRIMER VALVES

### A. Supply-Type, Trap-Seal Primer Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. PPP Inc.
  - b. Sioux Chief Manufacturing Company, Inc.
  - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - d. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1018.
3. Pressure Rating: **125 psig** minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: **NPS 1/2** threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: **NPS 1/2** threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

### B. Drainage-Type, Trap-Seal Primer Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.



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2. Standard: ASSE 1044, lavatory P-trap with **NPS 3/8** minimum, trap makeup connection.
3. Size: **NPS 1-1/4** minimum.
4. Material: Chrome-plated, cast brass.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  1. Locate backflow preventers in same room as connected equipment or system.
  2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
  3. Do not install bypass piping around backflow preventers.
- C. Install water hammer arresters in water piping according to PDI-WH 201.
- D. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- E. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- F. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 221119

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## SECTION 221313 – FACILITY SANITARY SEWER DISTRIBUTION PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 31 apply to the Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract including General Requirements apply to this Section.
- B. Florida Governmental Utility Authority Specifications and Standards.

#### 1.3 SUMMARY

- A. This section describes the Contractor's responsibilities for all labor, materials, equipment and services to complete the water distribution systems and sanitary sewer construction. The work shall comply with the latest Florida Governmental Utility Authority standards.
- B. The intent of this section of the specifications is that the Contractor's bid on the work covered herein shall be based upon the drawings and specification, but that the work shall comply with all applicable codes and regulations as amended by any waiver. The Contractor's attention is directed to the General Requirements
- C. Refer to Section 312300 – Trenching, Backfilling, and Compacting for Utility Systems information.

### PART 2 - EXECUTION

#### 2.1 PIPE BEDDING

Perform final grading of trench bottoms by hand tools. Carry machine excavation only to such depth that soil bearing for pipes will not be disturbed. Grade the bottom of trenches evenly to insure uniform bearing for all pipes. Cut holes as necessary for joints and joint making.

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- A. As an alternate method, optional with the Contractor, excavate trenches to at least 4" below the required bottom levels and refill to the proper grade with sand or gravel firmly compacted.
- B. In rock, cemented gravel, old masonry or other hard material, excavate to at least 4" below the pipe at all points and refill to grade with sand and or gravel firmly compacted.
- C. In fill containing refuse, organic matter or similar substances, or any other material deemed unsuitable by the Engineer and/or Owner, remove such material to a depth of at least 6" below the pipe at all points and refill to grade with sand or gravel firmly compacted.

## 2.2 SHORING

Unless trench banks are cut back on a stable slope, sheet and brace trenches as necessary to prevent caving or sliding, to provide protection for workmen and in the pipe, and to protect adjacent structures and facilities. Do not brace sheeting against the pipe, but brace it so that no concentrated loads of horizontal thrust are transmitted to the pipe. If a portable metal box is used for bracing the slopes, take care not to disturb the pipe when the box is removed.

## 2.3 DISPOSITION OF UTILITIES

Rules and Regulations governing the respective utilities shall be observed in executing all work under this heading. Active utilities, if encountered, shall be protected in accordance with written instructions of the Engineer. Inactive and abandoned utilities encountered in trenching operations shall be removed, plugged or capped. In absence of specific requirements, plug or cap such utility lines at least 5' from utility line to be installed or as required by local and state regulations.

## 2.4 SPECIFICATIONS

The utilities in this section shall be installed in accordance with the requirement and specifications of Lee County Utilities and Florida Governmental Utility Authority.

## 2.5 MEASUREMENT AND PAYMENT

All utilities shall be measured in accordance with the units set forth in the bid schedule. The lengths shall be centered to center of boxes, manhole connections, etc. Payment shall include all work necessary to install the lines or facilities, test them and have them accepted by Engineer, Lee County Utilities and Florida Governmental Utility Authority.

END OF SECTION 221313

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## SECTION 221316 - SANITARY WASTE AND VENT PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
  - 1. Pipe, tube, and fittings.

#### 1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

#### 1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings:

#### 1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

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- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

### 2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
  - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- B. Solvent Cement and Adhesive Primer:
  - 1. Use PVC ASTM D 2564 solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## PART 3 - EXECUTION

### 3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

### 3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil and waste piping shall be the following:
  - 1. Schedule 40 Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Aboveground, vent piping shall be the following:

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1. Schedule 40 Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Underground, soil, waste, and vent piping shall be the following:

1. Schedule 40 Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

**3.3 PIPING INSTALLATION**

A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

I. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

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- J. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

#### 3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665 with solvent cement conforming to ASTM D 2321.

#### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
  - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
  - 2. Install individual, straight, horizontal piping runs according to the following:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
  - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
  - 2. NPS 3: 60 inches with 1/2-inch rod.
  - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
  - 4. NPS 6: 60 inches with 3/4-inch rod.
- F. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
  - 2. NPS 3: 48 inches with 1/2-inch rod.

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- 3. NPS 4 and 5: 48 inches with 5/8-inch rod.
- 4. NPS 6: 48 inches with 3/4-inch rod.

- G. Install supports for vertical PVC piping every 48 inches.
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect drainage and vent piping to the following:
  - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
  - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction..
  - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
  - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.8 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 221316



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## SECTION 223300 - ELECTRIC DOMESTIC WATER HEATERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes the following electric water heaters:
  - 1. Household, storage electric water heaters.
  - 2. Household, collector-to-tank, solar-electric water heaters.
  - 3. Flow-control, instantaneous electric water heaters.
  - 4. Thermostat-control, instantaneous electric water heaters.
  - 5. Light-commercial electric water heaters.
  - 6. Commercial, storage electric water heaters.
  - 7. Compression tanks.
  - 8. Water heater accessories.

#### 1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. LEED Submittal:
  - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1-2004, Section 7 - "Service Water Heating."
- C. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.

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- D. Warranty: Special warranty specified in this Section.

## 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. 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.
- D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
- E. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

## 1.5 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including storage tank and supports.
    - b. Faulty operation of controls.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
  - 2. Warranty Period(s): From date of Substantial Completion:
    - a. Household Electric Water Heaters:
      - 1) Storage Tank: Five years.
      - 2) Controls and Other Components: Three years.
    - b. Instantaneous Electric Water Heaters: Five years.
    - c. Light-Commercial Electric Water Heaters:

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- 1) Storage Tank: Three years.
- 2) Controls and Other Components: Three years.
- d. Commercial Electric Water Heaters:
  - 1) Storage Tank: Five years.
  - 2) Controls and Other Components: Three years.
- e. Compression Tanks: One year.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 HOUSEHOLD ELECTRIC WATER HEATERS

- A. Household, Standard, Storage Electric Water Heaters: Comply with UL 174.
  - 1. Manufacturers:
    - a. Bradford White Corporation.
    - b. Lochinvar Corporation.
    - c. Rheem Water Heater Div.; Rheem Manufacturing Company.
    - d. Smith, A. O. Water Products Company.
    - e. State Industries, Inc.
  - 2. Storage-Tank Construction: Steel.
    - a. Tappings: ASME B1.20.1 pipe thread.
    - b. Pressure Rating: .
    - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
  - 3. Factory-Installed Storage-Tank Appurtenances:
    - a. Anode Rod: Replaceable magnesium.
    - b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
    - c. Drain Valve: ASSE 1005.
    - d. Insulation: Comply with ASHRAE/IESNA 90.1-2004.
    - e. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
    - f. Temperature Control: Adjustable thermostat for each element.
    - g. Safety Control: High-temperature-limit cutoff device or system.

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- h. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
  - 4. Capacity and Characteristics: (Refer to Drawings)
- B. Household, Collector-to-Tank, Solar-Electric Water Heaters: Comply with UL 174 with piping and electrical connections for UL 1279 solar collector system.
  - 1. Manufacturers:
    - a. Bradford White Corporation.
    - b. Rheem Water Heater Div.; Rheem Manufacturing Company.
    - c. Ruud Water Heater Div.; Rheem Manufacturing Company.
  - 2. Storage-Tank Construction: Steel.
    - a. Tappings: ASME B1.20.1 pipe thread.
    - b. Pressure Rating: .
    - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
  - 3. Factory-Installed Storage-Tank Appurtenances:
    - a. Sensor electrical connections and tank stud for sensor.
    - b. Anode Rod: Replaceable magnesium.
    - c. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
    - d. Drain Valve: ASSE 1005.
    - e. Insulation: Comply with ASHRAE/IESNA 90.1-2004.
    - f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
    - g. Temperature Control: Adjustable thermostat for each element.
    - h. Safety Control: High-temperature-limit cutoff device or system.
    - i. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
  - 4. Capacity and Characteristics: (Refer to Drawings)

## 2.3 INSTANTANEOUS ELECTRIC WATER HEATERS

- A. Flow-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
  - 1. Manufacturers:

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- a. Chronomite Laboratories, Inc.
    - b. Eemax, Inc.
    - c. Stiebel Eltron, Inc.
  2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
    - a. Connections: ASME B1.20.1 pipe thread.
    - b. Pressure Rating: 1035 kPa.
    - c. Heating Element: Resistance heating system.
    - d. Temperature Control: Flow-control fitting.
    - e. Safety Control: High-temperature-limit cutoff device or system.
  3. Support: Bracket for wall mounting.
- B. Thermostat-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
1. Manufacturers:
    - a. Chronomite Laboratories, Inc.
    - b. Eemax, Inc.
    - c. Stiebel Eltron, Inc.
  2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
    - a. Connections: ASME B1.20.1 pipe thread.
    - b. Pressure Rating: 1035 kPa.
    - c. Heating Element: Resistance heating system.
    - d. Temperature Control: Thermostat.
    - e. Safety Control: High-temperature-limit cutoff device or system.
  3. Support: Bracket for wall mounting.
  4. Capacity and Characteristics: (Refer to Drawings)
    - a. Temperature Control: Adjustable thermostat.
    - b. Electrical Characteristics: (Refer to Drawings)
- 2.4 LIGHT-COMMERCIAL ELECTRIC WATER HEATERS
- A. Description: Comply with UL 174 for household, storage electric water heaters.
1. Manufacturers:
    - a. Bradford White Corporation.
    - b. Lochinvar Corporation.
    - c. Rheem Water Heater Div.; Rheem Manufacturing Company.
    - d. Smith, A. O. Water Products Company.

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- e. State Industries, Inc.
- 2. Storage-Tank Construction: Steel, vertical arrangement.
  - a. Tappings: ASME B1.20.1 pipe thread.
  - b. Pressure Rating: .
  - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
- 3. Factory-Installed Storage-Tank Appurtenances:
  - a. Anode Rod: Replaceable magnesium.
  - b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
  - c. Drain Valve: ASSE 1005.
  - d. Insulation: Comply with ASHRAE/IESNA 90.1-2004.
  - e. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
  - f. Temperature Control: Adjustable thermostat for each element.
  - g. Safety Control: High-temperature-limit cutoff device or system.
  - h. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

## 2.5 COMMERCIAL ELECTRIC WATER HEATERS

- A. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.
  - 1. Manufacturers:
    - a. Bradford White Corporation.
    - b. Lochinvar Corporation.
    - c. Rheem Water Heater Div.; Rheem Manufacturing Company.
    - d. Smith, A. O. Water Products Company.
    - e. State Industries, Inc
    - f. PVI Industries Inc.
  - 2. Storage-Tank Construction: ASME-code, steel horizontal or vertical arrangement.
    - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      - 1) and Smaller: Threaded ends according to ASME B1.20.1.
      - 2) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

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- b. Pressure Rating: 1035 kPa.
  - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
  - d. Tank lining material shall be listed for maximum system design temperature, see drawings.
3. Factory-Installed Storage-Tank Appurtenances:
- a. Anode Rod: Replaceable magnesium.
  - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
  - c. Insulation: Comply with ASHRAE/IESNA 90.1.
  - d. Jacket: Steel with enameled finish.
  - e. Heating Elements: Shall be immersion type.
- 1) Staging: Input not exceeding 18 kW per step.
- f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet
  - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
  - h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
4. Special Requirements: NSF 5 construction.
5. Capacity and Characteristics: (Refer to Drawings)
- a. Electrical Characteristics: (Refer to Drawings)

## 2.6 COMPRESSION TANKS

- A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
1. Manufacturers:
- a. AMTROL Inc.
  - b. Armstrong Pumps, Inc.
  - c. Taco, Inc.
  - d. Watts Regulator Co.
  - e. Wessels Co.
2. Construction:
- a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
  - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
  - c. Air-Charging Valve: Factory installed.

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## 2.7 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- B. Drain-Pan Units: Where water heaters or hot water storage tanks are installed in habitable space, the tank or water heater shall be installed in a galvanized steel drain pan of a minimum thickness of 24 gauge. Electric water heater drain pans may be high impact plastic of at least 0.0625 inch thickness.
- C. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
- D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1-2004.

## 2.8 SOURCE QUALITY CONTROL

- A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
- C. Prepare test reports.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

### 3.2 WATER HEATER INSTALLATION

- A. Install commercial water heaters on concrete bases.
  - 1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
  - 2. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.



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- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain in the same room as water heater.
- D. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain in the same room as water heater.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
- F. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- G. Install thermometers on inlet and outlet piping of household, collector-to-tank, solar-electric water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- H. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- I. Fill water heaters with water.
- J. Charge compression tanks with air.

## 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

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- B. Perform the following field tests and inspections and prepare test reports:
1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
  2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial electric water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 223300

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#### SECTION 224000 - PLUMBING FIXTURES

##### PART 1 - GENERAL

###### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements:  
<https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

###### 1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
  - 1. Faucets.
  - 2. Protective shielding guards.
  - 3. Fixture supports.
  - 4. Water closets.
  - 5. Urinals.
  - 6. Lavatories.

###### 1.3 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- C. Warranty: Special warranty specified in this Section.

###### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

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1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- 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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.
- G. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- H. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.
- I. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- J. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
  1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
  2. Plastic Laundry Trays: ANSI Z124.6.
  3. Plastic Mop-Service Basins: ANSI Z124.6.
  4. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
  5. Vitreous-China Fixtures: ASME A112.19.2M.
  6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
  7. Water-Closet, Flushometer Tank Trim: ASSE 1037.

**1.5 WARRANTY**

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:

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- a. Structural failures of unit shell.
- b. Faulty operation of controls, blowers, pumps, heaters, and timers.
- c. Deterioration of metals, metal finishes, and other materials beyond normal use.

- 2. 1 year Warranty Period for Commercial Applications.

## PART 2 - PRODUCTS

### 2.1 LAVATORY ( REFER TO PLUMBING DRAWINGS)

#### A. Lavatory and Sink Faucets:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Kohler Co.
  - b. Moen.
  - c. Zurn Plumbing Products Group; Commercial Brass Operation.

### 2.2 FLUSHOMETERS URINAL ONLY

#### A. Flushometers:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Hydrotek International, Inc.
  - b. Sloan Valve Company.
  - c. TOTO USA, Inc.
  - d. Zurn Plumbing Products Group; Commercial Brass Operation.

### 2.3 TOILET SEATS BY ARCH

#### A. Toilet Seats:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. American Standard Companies, Inc.
  - b. Bemis Manufacturing Company.
  - c. Centoco Manufacturing Corp.
  - d. Church Seats.
  - e. Eljer.
  - f. Kohler Co.
  - g. Olsonite Corp

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**2.4 PROTECTIVE SHIELDING GUARDS LAVATORY**

**A. Protective Shielding Covers:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Truebro.
  - b. TCI Products.
  - c. TRUEBRO, Inc.

**2.5 FIXTURE SUPPORTS**

**A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:**

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Zurn Plumbing Products Group; Specification Drainage Operation.

**2.6 WATER CLOSETS**

**A. Water Closets:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Kohler Co.
  - b. Zurn
  - c. American Standard Companies, Inc.

**2.7 KITCHEN SINKS ( REFER TO PLUMBING DRAWINGS)**

**A. Kitchen Sinks:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Kohler Co.
  - b. Zurn
  - c. Elkay

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#### PART 3 - EXECUTION

##### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

##### 3.2 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

##### 3.3 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
  - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
  - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
  - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- D. Install wall-mounting fixtures with tubular waste piping attached to supports.
- E. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
- F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- G. Install counter-mounting fixtures in and attached to casework.
- H. Install fixtures level and plumbing according to roughing-in drawings.
- I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

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- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- M. Install toilet seats on water closets.
- N. Install trap-seal liquid in waterless urinals.
- O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- Q. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- R. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- S. Install traps on fixture outlets.
  - 1. Exception: Omit trap on fixtures with integral traps.
  - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- T. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- U. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.
- V. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- W. Mop sinks in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."
- X. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

#### 3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.



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- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

#### 3.5 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.
- F. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
  - 1. Remove and replace malfunctioning units and retest as specified above.
  - 2. Report test results in writing.

#### 3.6 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers, hot-water dispensers and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Install fresh batteries in sensor-operated mechanisms.
- F. Adjust fixture flow regulators for proper flow and stream height.
- G. Adjust water cooler temperature settings.

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**3.7 CLEANING**

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
  - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
  - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.
- C. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- D. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

**3.8 PROTECTION**

- A. Provide protective covering for installed fixtures and fittings.

END OF SECTION 224000

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## SECTION 230100 - BASIC MECHANICAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

- C. Conflicts: Nothing contained in this Section shall be construed to conflict in any way with other provisions or requirements of the Contract documents. The intent is that this Section will take precedence. Where differences arise, the Architect shall decide which directions or instructions take precedence.

#### 1.2 SUMMARY

- A. General: Unless an item is specifically mentioned as being provided by others, the requirements of Division 23 Contract Documents shall be completed. The systems, equipment, devices and accessories shall be installed, finished, tested and adjusted for continuous and proper operation. Any apparatus, material or device not shown on the Drawings but mentioned in these Specifications, or vice versa, or any incidental accessories necessary to make the project complete and operational in all respects, shall be furnished, delivered and installed without additional expense to the Owner. Include all materials, equipment, supervision, operation, methods and labor for the fabrication, installation, start-up and tests necessary for complete and properly functioning systems.

#### 1.3 APPLICABLE STANDARDS

- A. Code Compliance: Refer to Division 1. As a minimum, unless otherwise indicated, comply with all rules, regulations, standards, codes, ordinances and laws of local, state and federal governments and the amendments and interpretation of such rules, regulations, standards, codes, ordinances and laws of local, state and federal governments by the authorities having lawful jurisdiction.
- B. ADA: Comply with the requirements of the Americans with Disabilities Act (ADA).
- C. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards as adopted by the Local Authority having Jurisdiction.

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- D. Florida Building Code 7<sup>th</sup> Edition (2020): Conform in strict compliance to the Florida Building Code (FBC) and the amendments which are enforced by the local authority having jurisdiction.
  - 1. Florida Building Code 7th Edition (2020) Building
  - 2. Florida Building Code 7th Edition (2020) Mechanical
  - 3. Florida Building Code 7th Edition (2020) Energy Conservation
  - 4. Florida Fire Prevention Code 7th Edition (2020)
  - 5. NFPA 1, Fire Code, 2012
  - 6. NFPA 101, Life Safety Code, 2012
- E. Notification: Comply with all of the requirements of the Federal "Right-To-Know" Regulations and the Florida "Right-To-Know" Law and provide notification to all parties concerned as to the use of toxic substances.
- F. Owner Design Guidelines: Comply with all the requirements of the latest Owner MEP Engineering Design Guidelines and the latest Owner Architectural Construction Standards.

#### 1.4 DRAWINGS AND SPECIFICATIONS

- A. Intent: The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.
- B. Equipment Placement: The drawings are diagrammatic, intended to show general arrangement, capacity and location of various components, equipment and devices. Each location shall be determined by reference to the general building plans and by actual measurements in the building as built. Reasonable changes in locations ordered by the Architect prior to the performance of the affected Work shall be provided at no additional cost to the Owner.
- C. Drawing Scale: Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets, transitions and fittings may not be shown but shall be provided at no additional cost.
- D. Conflict: In the event of a conflict, the Architect will render an interpretation in accordance with the General Conditions.

#### 1.5 DEFINITIONS

- A. Provide/Install: The word "provide" shall mean furnish, install, connect, test, complete, and leave ready for operation. The word "install" where used in conjunction with equipment furnished by the Owner or under another contract shall mean mount, connect, complete, and leave ready for operation.
- B. Concealed: The surface of insulated or non-insulated piping, ductwork or equipment is concealed from view when standing inside a finished room, such as inside a chase or above a ceiling.
- C. Exposed: The surface of insulated or non-insulated piping, ductwork or equipment is seen from inside a finished room, such as inside an equipment or air handling unit room.
- D. Protected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building but protected from direct exposure to rain by an overhang, eave, in an unconditioned parking garage or building crawl space.

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- E. Unprotected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building and exposed to rain.
- F. Abbreviations: Abbreviations, where not defined in the Contract Documents, shall be interpreted to mean the normal construction industry terminology, as determined by the Architect. Plural words shall be interpreted as singular and singular words shall be interpreted as plural where applicable for context of the Contract Documents.

#### 1.6 SHOP DRAWINGS

- A. General: Refer to paragraph entitled "SUBMITTAL" in this section. Include the following data:
  - 1. Shop Drawings:
    - a. Submit shop drawings for the following:
      - (1) Each piping system
      - (2) Ductwork systems as defined in Section 23 31 13
      - (3) Coordination drawings

#### 1.7 RECORD DRAWINGS

- A. Production: Maintain one set of black or blue line on white project record "as-built" drawings at the site. At all times the set shall be accurate, clear, and complete, indicating the actual installation. Record drawings shall be updated weekly to record the present stage of progress. These drawings shall be available to the Architect at all times. Equipment schedules, control diagrams, sequences of operation shall also be updated.
- B. Completion: Prior to substantial completion, transfer onto an unmarked second set of drawings all changes, marked in colored pencil, and submit them to the Architect. Upon completion of all punch lists, transfer all "As-Built" conditions to the AutoCAD drawing files, package three (3) print sets of full size drawings and two (2) CDs of the AutoCAD drawing files with associated reference files and submit them to the Architect for review and approval.

#### 1.8 SUBMITTAL

- A. General: The provisions of this section are supplemental to the requirements in Division 1, and only apply to the material and equipment covered in Division 23.
- B. Time: Submit manufacturer's literature, performance data and installation instructions covered in each Section of Division 23 under an individual letter of transmittal within 30 days after Notice to Proceed unless otherwise indicated.
- C. Submitter's Review: All items required for each section shall be reviewed before submittal. Submittal information for each item shall bear a review stamp of approval, indicating the name of the Contractor and Subcontractor (where applicable), the material suppliers, the initials of submitter and date checked. Responsibility for errors or omissions in submittals shall not be relieved by the Architect's review of submittals. Responsibility for submittals cannot be subrogated to material suppliers by Contractors or Subcontractors.
  - 1. Review of the submittal data, whether indicated with "APPROVED" or with review comments, does not constitute authorization for or acceptance of a change in the contract price.

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- D. Architect's Review: The submittal data shall be reviewed only for general conformance with the design concept of the project and for general compliance with the Contract Documents. Any action indicated is subject to the requirements of the Contract Documents. Reviews of submittal data review shall not include quantities; dimensions (which shall be confirmed and correlated at the job site); fabrication processes; techniques of construction; and co-ordination of the submittal data with all other trades. Copies of the submittal data will be returned marked "ACCEPTED AS SUBMITTED", "ACCEPTED AS NOTED", "REVISED AS NOTED AND RESUBMIT", "REJECTED, REVISED AS NOTED AND RESUBMIT".
- E. Submittal Items: Submittal items shall be inserted in a Technical Information Brochure. Mark the appropriate specification section or drawing reference number in the right hand corner of each item. All typewritten pages shall be on the product or equipment manufacturer's printed letterhead.
1. Manufacturer's Literature: Where indicated, include the manufacturer's printed literature. Literature shall be clearly marked to indicate the item intended for use.
  2. Performance Data: Provide performance data, wiring and control diagrams and scale drawings which show that proposed equipment will fit into allotted space (indicate areas required for service access, connections, etc.), and other data required for the Architect to determine that the equipment complies with the Contract Documents. Where noted, performance data shall be certified by the manufacturer at the design rating points.
  3. Installation Instructions: Where requested, each product submittal shall include the manufacturer's installation instructions. Generic installation instructions are not acceptable. Instructions shall be the same as those included with the product when it is shipped from the factory.
  4. Written Operating Instructions: Instructions shall be the manufacturer's written operating instructions for the specified product. If the instructions cover more than one model or type of product they shall be clearly marked to identify the instructions that cover the product delivered to the project. Operating Instructions shall be submitted immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".
  5. Maintenance Instructions: Information shall be the manufacturer's printed instructions and parts lists for the equipment furnished. If the instructions cover more than one model or type of equipment they shall be marked to identify the instructions for the furnished product. Submit maintenance instructions immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".
- F. Substitutions:
1. General: Refer to Division 1. Substitutions may be considered for any product or equipment of a manufacturer. See paragraph entitled "MANUFACTURER" in this Section. Any product or equipment may be submitted for review; however, only one substitution per item will be considered. If a substituted product or equipment item is rejected, provide the specified product or equipment.
    - a. All substitution requests for products not listed as Basis of Design or Approved Equal shall be accompanied by testimonials from at least two (2) separate State Agencies, Counties, Municipalities, or Federal Facilities where the proposed substituted equipment has been in operation for no less than twelve (12) consecutive months.

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- b. Submittal shall include the name of the material or equipment to be substituted, equipment model numbers, drawings, catalog cuts, performance and test data and any other data or information necessary for the Architect to determine that the equipment meets the specification requirements. If the Architect accepts any proposed substitutions, such acceptance will be set forth in writing.
  - c. Substituted equipment with all accessories installed or optional equipment where permitted and found acceptable, must conform to space requirements. Substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at no additional expense to the Owner. If the substituted item affects the work of other trades, the Request for Substitution form shall include a list of the necessary modifications.
- 2. Deviations: The Request for Substitution form shall include a complete list of deviations from the scheduled item stating both the features and functions of the scheduled item and the comparable features and functions of the proposed substitution.
  - a. Any deviation not indicated in writing will be assumed to be identical to the specified item even if it is shown otherwise on the submittal data.
  - b. If a deviation not listed is found anytime after review and acceptance by the Architect and that deviation, in the opinion of the Architect, renders the substituted item as unacceptable, the item shall be removed and replaced by the scheduled item at no additional cost to the Owner.
  - c. The Architect shall retain the right to specify modifications to the substituted item, correcting or adjusting for the deviation, if the Architect deems it to be in the best interest of the Owner.
- 3. Scheduled Item: A scheduled item is a product or item of equipment indicated in the Contract Documents by manufacturer's name and model number identifying a single item. The manufacturer's trade name for a group of products that does not signify a single item including type, style, quality, performance, and sound rating shall not be classified as a scheduled item. Where more than one manufacturer and product model number are indicated, each shall be considered as a scheduled item.
- 4. Form: When a product or item of equipment is proposed as a substitution a "REQUEST FOR SUBSTITUTION" form shall be completed and submitted with the required data. A copy of the form is included after the end of this section.
- 5. Rejection: Substituted products or equipment will be rejected if, in the opinion of the Architect, the submittal does not meet any one of the following conditions or requirements:
  - a. The submittal data is insufficient or not clearly identified. The Architect may or may not request additional information.
  - b. The product or equipment will not fit the space available and still provide the manufacturers published service area requirements.
  - c. The product or equipment submitted is not equivalent to or better than the specified item. Products or equipment of lesser quality may be considered provided an equitable financial rebate, satisfactory to the Architect, is to be returned to the Owner.
  - d. The product or equipment submitted has less capacity, efficiency and safety provisions than the specified item.
  - e. The product or equipment submitted does not have warranty, service and factory representation equivalent to that specified.
  - f. The Owner prefers not to accept the submitted product.

G. Technical Information Brochure:

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1. Binder: Include binders with the first submittal for the Technical Information Brochure. Each binder shall be size 3 inch, hardcover, 3-ring type for 8-1/2" X 11" sheets. Provide correct designation on outside cover and on spine of each binder, i.e., MECHANICAL SUBMITTAL DATA, MECHANICAL OPERATION INSTRUCTION and MECHANICAL MAINTENANCE INSTRUCTIONS.
2. Number: Submit not less than five sets of binders for each of the three mechanical brochures indicated above. Each set shall consist of a minimum of two binders for submittal data and 1 binder each for operating instructions and for maintenance instructions. Additional binders shall be submitted at the request of the Architect. One set of binders shall be retained by the Architect. Three sets of binders shall be maintained for the Owner and the remaining set shall become the property of the Engineer.
3. Index: First sheet in each brochure shall be a photocopy of the "Division 23 Index" of the specifications. Second sheet shall list the firm name, address, phone number, superintendent's name for the contractor and all major subcontractors and suppliers associated with the project.
4. Dividers: Provide reinforced separation sheets tabbed with the appropriate specifications Section reference number for each Section in which submittal data or operation and maintenance instructions is required.
5. Specifications: Insert a copy of the specifications for each Section and all addenda applicable to the Section between each of the Section dividers.

#### 1.9 SHOP DRAWINGS FOR PIPING SYSTEMS

- A. Requirements: Make Shop Drawings for piping systems at a minimum scale of 1/4 inch per foot in AutoCAD Version 2006 (or later) and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
  1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
  2. Fabrication and erection dimensions.
  3. Arrangements and sectional views.
  4. Necessary details, including complete information for making connections to equipment.
  5. Descriptive names of equipment.
  6. Modifications and options to standard equipment required by Contract Documents.
- B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and equipment connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.
- C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- D. Additional Requirements: See specific Sections for additional requirements.

#### 1.10 SHOP DRAWINGS FOR DUCT SYSTEMS

- A. Requirements: Make Shop Drawings for duct systems at a minimum scale of 1/4 inch per foot in AutoCAD Version 2006 (or later) and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop



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Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:

1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
  2. Fabrication and erection dimensions.
  3. Arrangements and sectional views.
  4. Necessary details, including complete information for making connections to air distribution devices and air handling equipment.
  5. Kinds of materials and finishes.
  6. Descriptive names of equipment.
  7. Modifications and options to standard equipment required.
- B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.
- C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- D. Ceiling Plans: Provide Shop Drawings, using sepias of architectural reflected ceiling plans, which indicate locations of exposed air distribution devices, sprinkler heads, lights and access panel.
- E. Additional Requirements: See specific Sections for additional requirements.

#### 1.11 COORDINATION DRAWINGS

- A. General: Provide detailed (minimum 1/4 inch per foot) scaled coordination drawings showing locations and positions of all architectural, structural, (FF&E) equipment, electrical, plumbing, fire protection and mechanical elements for all installations. Provide overlay drawings, prior to beginning work, indicating work in and above ceilings and in mechanical and electrical rooms with horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions and other services. Accommodate phasing and temporary conditions indicated on the contract drawings as necessary to complete the work without disruption to the Owner's use of the existing occupied areas of the building(s).
- B. Coordination of Space: Coordinate use of project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

In finished areas except as otherwise shown, conceal pipes, ducts, and wiring in construction. Coordinate locations of fixtures and outlets with finish elements. Contractor shall provide background drawings showing partitions, ceiling heights, and structural framing locations and elevations, and existing obstructions. Contractor shall resolve major interferences at initial coordination meeting prior to production of coordination drawings.

- C. Precedence of Services: In event of conflicts and interferences involving location and layout of work, use the following priority to resolve interferences:

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1. Structure has highest priority.
  2. Walls systems.
  3. Ceiling grid/light fixtures.
  4. Gravity drainage lines.
  5. Large pipe mains.
  6. Ductwork/diffusers, registers and grilles.
  7. Sprinkler heads.
  8. Small piping and tubing/electrical conduit.
  9. Access panels.
- D. Drawings shall be developed on AutoCAD Version 2006 (or later), and utilize AIA Standard layering conventions. At the completion of the project construction, the Contractor shall provide two (2) full-sized print sets and two (2) CDs of all drawing files with related reference files representing as-built installations for Architect review. Upon approval that the submitted information is complete, a similar submittal shall be provided to the Owner.
- E. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp.
- F. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- G. Additional Requirements: See specific Sections for additional requirements.

#### 1.12 MANUFACTURER'S CHECKOUT

- A. Start-up and Checkout: At completion of installation and prior to performance verification, a factory-trained representative of the manufacturer shall provide start-up and checkout service. After the performance verification the manufacturer's representative shall examine performance information and check the equipment in operation, and sign "Check-Out Memo" for the record. Submit a copy of Memo on each item of equipment where indicated in individual sections of these specifications for inclusion in each Technical Information Brochure. The "Check-Out Memo" shall be included with the performance verification data. Do not request "Instruction in Operation Conference" or request final inspection until Memos have been submitted and found acceptable.

#### 1.13 INSTRUCTION TO OWNER

- A. General: Instructions to the Owner shall be by competent representatives of the manufacturers involved, with time allowed for complete coverage of all operating procedures. Provide classroom instruction and field training in the design, operation and maintenance of the equipment and troubleshooting procedures. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar provisions of the systems. On the date of substantial completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel.
- B. Training Period: Unless otherwise indicated training periods shall encompass the following number of hours of classroom and hands-on instructions with a maximum period of 4 hours per day for either. Mixing classroom instructions and hands on training in the same day is unacceptable.
1. Training periods:

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- a. 4 hours Classroom
  - b. 4 hours Hands-on
- C. Scheduling: Submit any remaining required items for checking at least one week before final inspection of building. When submittal items are found acceptable, notify Owner, in writing, that an "Instruction in Operation Conference" may proceed. Conference will be scheduled by the Owner. After the conference, copies of a memo certifying that the "Instruction in Operation Conference" and "Completed Demonstration" have been made will be signed by Owner and the instructors, and one copy will be inserted in each Technical Information Brochure.

#### 1.14 ALTERNATES

- A. Refer to Division 1.

#### PART 2 - PRODUCTS

##### 2.1 MANUFACTURERS

- A. Specified Products: Manufacturer's names and product model numbers indicated on the drawings and in these specifications establish the type, style, quality, performance, and sound rating of the desired product. Listing of other manufacturers indicates that their equivalent products would be acceptable if they meet the specification requirements, the specific use and installation shown on the drawings, including space and clearance requirements, and the energy consumption and efficiency of the specified product. The listing of additional manufacturers in no way indicates that the manufacturer can provide an acceptable product.
- B. Space Requirements: All manufactured products furnished on this project must have the required space and service areas indicated in the manufacturer's printed literature or shown on their shop drawing. When the manufacturer does not indicate the space required for servicing the equipment, the space shown on the drawings or as required by the Architect must be provided.

##### 2.2 MATERIAL AND EQUIPMENT

- A. General: Material and equipment used shall be produced by manufacturers regularly engaged in the production of similar items, and with a history of satisfactory use as judged by the Architect.
- B. Specified Equipment: Equipment shall be the capacity and types indicated or shall be equivalent in the opinion of the Architect. Material and equipment furnished and installed shall be new, recently manufactured, of standard first grade quality and designed for the specific purpose. Equipment and material furnished shall be the manufacturer's standard item of production unless specified or required to be modified to suit job conditions. Sizes, material, finish, dimensions and the capacities for the specified application shall be published in catalogs for national distribution. Ratings and capacities shall be certified by a recognized rating bureau. Products shall be complete with accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.
- C. Compatibility: Material and equipment of one and the same kind, type or classification and used for identical or similar purposes shall be made by the same manufacturer. Where more than one choice is available, select the options which are compatible with other products already selected. Compatibility is a basic general requirement of product selection.

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#### PART 3 - EXECUTION

##### 3.1 WORKMANSHIP

- A. General: The installation of materials and equipment shall be done in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a first-quality installation. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks. All materials and equipment shall be installed per the manufacturer's written requirements.
- B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function which conforms to applicable standards of building system construction and exhibits a degree of quality and proficiency which is judged by the Architect as equivalent or better than that ordinarily produced by qualified industry tradesmen.
- C. Performance: Personnel shall not be used in the performance of the installation of material and equipment who, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship in the opinion of the Architect, shall be removed and reinstalled by qualified craftsmen at no change in the contract price.

##### 3.2 CLEANING AND PROTECTION

- A. General: Refer to Division 1.
- B. Emergency Contacts: Prior to the beginning of the project, provide the Owner with a list of names, emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period if leaks, equipment failure or other damages occur. Update the list throughout installation and warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may effect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.
- C. Emergency Contacts: Along with the operating and maintenance manual submittal, provide the Owner with a list of the names and emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period should leaks, equipment failure or other damage occur. Update the list throughout warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may effect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.
- D. Housekeeping: Keep interiors of duct and pipe systems clean and free from dirt, rubbish and foreign matter. Close open ends of piping and ductwork at all times throughout the installation. Install 30% efficient filter media over each return air grille and open return duct opening; change media regularly during construction when dirty to keep duct interiors clean. Prevent dust, debris and foreign material from entering the piping and ductwork.
- E. Equipment Protection: Protect fan motors, switches, equipment, fixtures, and other items from dirt, rubbish and foreign matter. Do not operate air-handling equipment if the building is not clean or if dust can enter the coils or the fan housings.

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- F. Equipment Cleaning: Thoroughly clean equipment and entire piping systems internally upon completion of installation and immediately prior to final acceptance. Open dirt pockets and strainers, blow down each piping system and clean strainer screens of accumulated debris. Remove accumulated dirt, scale, oil and foreign substances. Thoroughly wipe clean internal surfaces of ductwork and air handling units prior to request for substantial completion. (See para. 3.2 above.)
- G. Building Cleanup: Remove debris, rubbish, leftover materials, tools and equipment from work areas and site. Clean tunnels and closed off spaces of packing boxes, wood frame members and other waste materials used in the installation. Final acceptance shall not be approved until site is cleaned.
- H. Fixture Cleanup: Remove temporary labels, stickers, etc., from fixtures and equipment. Do not remove permanent nameplates, equipment model numbers, ratings, etc.
- I. Filter Replacement: Provide filters, with the same efficiency rating as required for the final installation, for the protection of the air moving equipment and ductwork continuously throughout the construction phase. Provide a new set of clean filters for the test and balance of the air side equipment.
- J. Protection of Finished Installation: Where installation is required in areas previously finished by other trades, protect the area from marring, soiling or other damage.
- K. Air Handling Unit Operation During Construction Phase: Do not operate air handling equipment during building construction phase unless filter fabric is fastened to all duct systems' inlets and all specified and scheduled air filters are installed to minimize dirt entry into ductwork and air moving equipment. When running air handling units to dry out the building, control the building temperature to drop very slowly, and verify all HVAC insulation is completed and doors and windows are installed and closed, to prevent condensation of water from humid air on building interior surfaces, equipment, materials and ductwork.

#### 3.3 CORRECTION OF WORK

- A. General: At no additional cost to the Owner, rectify discrepancies between the actual installation and contract documents when in the opinion of the T&B Agency or the Architect the discrepancies will affect system balance and performance.
- B. Drive Changes: Include the cost of all pulley, belt, and drive changes, as well as balancing dampers, valves and fittings, and access panels to achieve proper system balance recommended by the T&B Agency.

#### 3.4 COORDINATION AND ASSISTANCE

- A. General: Provide all labor, equipment, tools and material required to operate the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all electric or pneumatic automated control devices and components. These services shall be available on each working day during the period of final testing and balancing.
- B. Drawings and Specifications: Provide to the T&B Agency a complete set of project record drawings and specifications and an approved copy of all HVAC shop drawings and equipment submittals. The T&B Agency shall be informed of all changes made to the system during construction, including applicable change orders.

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- C. Coordination: Coordinate the work of all trades and equipment suppliers to complete the modifications recommended by the T&B Agency and accepted by the Architect. Cut or drill holes for the insertion of air measuring devices as directed for test purposes; repair to as-new condition, inserting plastic caps or covers to prevent air leakage. Repair or replace insulation and re-establish the integrity of the vapor retardant.

#### 3.5 PREPARATIONS FOR PERFORMANCE VERIFICATION

- A. Verification: Prior to commencement of the balancing by the T&B Agency, the Contractor shall verify in writing:
  - 1. That air filters have been replaced and are in clean condition.
  - 2. That linkages between dampers and their actuators are secure, non-overloading and non-binding.
  - 3. That ductwork specialties are in their normal operating positions.
  - 4. That fans are operating at the correct rotation and specified RPM.
  - 5. That ductwork has been pressure tested and accepted.
  - 6. That strainers have been removed, cleaned and replaced, and that temporary construction strainers have been removed.
  - 7. That compression or expansion tanks have been inspected, are not air-bound or water-logged and are pre-charged, and that the piping systems have been completely vented and filled with water.
  - 8. That air vents at coils and high points of the piping systems have been inspected and installed and operating freely.
  - 9. That automatic valves, hand valves, and balancing valves have been placed in a fixed open position for full flow through all devices.
  - 10. That linkages between valves and their actuators are secure, non-overloading and non-binding.
  - 11. That pressures for hydronic reducing valves have been set.
  - 12. That operating temperatures have been set for chillers, regulating valves, etc.
  - 13. That pumps are operating at the correct rotation and specified horsepower.
  - 14. That piping has been pressure tested and accepted and piping systems have been cleaned, flushed, sterilized and refilled with chemicals and prescribed treated water and vented.
  - 15. That operating temperatures have been set for boilers, regulating valves, etc.
  - 16. That the operating safeties (thermal overloads, firestat/freezestats, smoke detectors, relief valves, etc.), are installed and fully functional.
  - 17. That equipment has been lubricated and can be operated without damage.
  - 18. That the systems are operational and complete.
  - 19. That no latent residual work remains to be completed.

#### 3.6 ACCEPTANCE TESTING PROCEDURE

- A. General: Each HVAC system shall be tested to confirm proper operation and function in accordance with the construction documents and control sequence of operations.
- B. The enclosed checklists shall be completed for each system and signed off by the mechanical sub-contractor project representative, then verified and signed-off by the mechanical sub-contractor project supervisor and the construction manager systems engineer. All checklists shall be incorporated into the project's close-out manuals submitted for Owner record.
- C. On-site testing by the Architect and Engineer shall be performed at the discretion of the Architect/Engineer for any or all systems to confirm test results and system function.

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- D. The Contractor is responsible to provide adequate time in the completion of the construction to perform these system tests prior to the AHCA final inspections in the affected areas/systems.
- E. The Contractor is responsible for ensuring all required system tests are conducted successfully and recording associated test data and results.
- F. The Contractor is responsible for contacting the Architect and Engineer at least two weeks prior to system test availability and schedule acceptable to Architect/Engineer for on-site testing.
- G. If, in the Architect's and Engineer's opinion, the test results indicate that the systems' installation is not adequately complete for testing, the testing shall be re-scheduled and the Contractor shall be responsible to prepare for such re-test.
- H. Prior to Owner occupancy, all system testing shall be completed and approved.

**3.7 PROTECTION OF MATERIALS AND EQUIPMENT**

- A. Requirements: Do not store fiberglass insulation or any equipment within the building until it has been "dried in". If dry space is unavailable and the insulation and equipment must be installed or stored before the building is "dried in" and completely enclosed, provide polyethylene film cover for protection.
- B. Replacement of Damaged Stored Material and Equipment: Any material and equipment that has been wet or otherwise damaged prior to installation, in the opinion of the Architect, shall be replaced with new material regardless of the condition of the material and equipment at the time of installation.
- C. Repair of Damaged Installed Material and Equipment: After installation correct or repair dents, scratches and other visible blemishes. At the direction of Architect replace or repair to "as new" condition equipment which has been damaged during construction.
- D. During construction, all piping and ductwork system openings shall be capped with at least two layers of polyethylene film, fastened tightly in place with banding material or foil tape until connection of the continuation of such piping or ductwork is occurring.

**3.8 ASBESTOS AND HAZARDOUS MATERIALS**

- A. General: Should asbestos or other hazardous material be encountered during execution of the work, or should the presence of asbestos or other hazardous material be suspected, immediately notify the Architect and suspend work in the affected area. The Owner will initiate a study to determine if asbestos or other hazardous materials are present and will determine what action will be taken. Removal of asbestos or other hazardous materials will be done under a separate contract.

**3.9 COORDINATION OF SERVICES**

- A. General: Coordinate interruption of services to Owner-occupied areas in writing in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.
- B. General: Coordinate interruption of existing services in writing at least 1 week in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.

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- C. Fire Safety in Existing facilities: Do not decrease the fire rating of walls, partitions, ceilings, floors, doors or combinations thereof in adjacent areas or means of egress. Do not interrupt fire sprinkling or life safety systems without prior coordination with the Architect. Inform all necessary parties (Fire Department, Owner's insurance carrier, etc.) in advance, prior to and immediately after shutdown, disconnection or isolation of any portion of life safety or fire sprinkler system.
- D. Protection of Facilities: Portions of the building may be operational during construction. Maintain operation of the equipment and systems whenever the installation interfaces with existing equipment or systems. Provide protection for the building, its contents and occupants wherever installation under the contract is performed. As necessary, move, store, and protect furniture, office fixtures and carpets. Provide acoustical isolation of the work area with temporary doors, partitions, etc., to allow normal work functions. Provide exhaust fans, temporary dust barrier partitions and any containment measures required to prevent dirt, dust or fumes from reaching adjacent occupied spaces as required by the Owner or Architect. Access to the building, including exit stairs, doors and passageways, and loading dock and other delivery areas shall be kept open and continuously accessible to the occupants. Workmen shall be confined to those areas directly involved in the project installation, and only during time periods indicated and approved by the Owner.

3.10 CLEAN-UP

- A. General: Debris and rubbish shall not be disposed into the Owner's containers.

END OF SECTION 230100



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REQUEST FOR SUBSTITUTION (Must be Submitted Prior to Bid)

Project Name: \_\_\_\_\_ Location: \_\_\_\_\_

Date of Request: \_\_\_\_\_

Name of Party Requesting Substitute:

\_\_\_\_\_

Reason for Substitution Request:

\_\_\_\_\_

<u>Drawing</u>	<u>Spec. Sect. No.</u>	<u>Paragraph</u>	<u>Specified Item</u>	<u>Manu</u>	<u>Model</u>
_____	_____	_____	_____	_____	_____

Proposed Substitute: \_\_\_\_\_

Manufacturer and Model Number:

\_\_\_\_\_

Deviations from the Specified Item: (See paragraph entitled "Deviations".)

Reason for Substitution:

Changes to Other Systems to Permit Use of Proposed Substitute:  
(List changes. Submit drawings if required for clarity.)

Technical Data to Support Request for Acceptance:  
(List ASTM or other standards designations, testing laboratory reports, experience records, etc.)

Other Supporting Data:  
(Submit brochures, samples, drawings, etc.)  
REQUEST FOR SUBSTITUTION (Continued)

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Certification: In making request for substitution, the party whose authorized signature appears below, certifies that all of the following statements are correct and are accepted without exception:

The proposed substitution has been personally investigated and is equal or superior in all significant respects to the product specified for the specific applications required;

The proposed substitution will be warranted under the same terms required for the specified product;

Coordination aspects necessitated by the proposed substitution will be accomplished in a complete and proper fashion by the party signing this form without any additional cost to the Owner; and

Claims against the Owner for additional costs related to the proposed substitution which subsequently become apparent after acceptance by the Architect are hereby waived.

Credit: If this substitution is acceptable the following credit shall be given to the Owner;

\$ \_\_\_\_\_

**CERTIFICATION OF EQUIVALENT PERFORMANCE AND ASSUMPTION OF LIABILITY FOR EQUIVALENT PERFORMANCE**

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted by: \_\_\_\_\_  
Signature Title

Typed Name: \_\_\_\_\_

Company: \_\_\_\_\_

Signature shall be by person having authority to legally bind his firm to the above terms. Failure to provide a legally binding signature will invalidate this request.

# LEHIGH ACRES LEE TRAN PARK AND RIDE LEHIGH ACRES, FLORIDA

## SECTION 230500 - COMMON WORK RESULTS FOR HVAC

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements:  
<https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Dielectric fittings.
  - 2. Sleeves.
  - 3. Escutcheons.
  - 4. Grout.
  - 5. Equipment installation requirements common to equipment sections.
  - 6. Painting and finishing.
  - 7. Concrete bases.
  - 8. Supports and anchorages.

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

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- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. CPVC: Chlorinated polyvinyl chloride plastic.
  - 2. PE: Polyethylene plastic.
  - 3. PVC: Polyvinyl chloride plastic.

## 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Dielectric fittings.
  - 2. Escutcheons.
- B. Welding certificates.

## 1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

## 1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

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- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

#### PART 2 - PRODUCTS

##### 2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

##### 2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

##### 2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

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## 2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - 1. Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Pipeline Seal and Insulator, Inc.
  - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- D. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F .
  - 1. Manufacturers:
    - a. Precision Plumbing Products, Inc.
    - b. Victaulic Co. of America.

## 2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- D. PVC Pipe: ASTM D 1785, Schedule 40.

## 2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- C. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

## 2.7 GROUT

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- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi , 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1. New Piping:
    - a. Insulated Piping: One-piece, stamped-steel type with spring clips.
- M. Sleeves are not required for core-drilled holes.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.

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- a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
    - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
  - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
  - O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
  - P. Verify final equipment locations for roughing-in.
  - Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- 3.2 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
  - B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  - C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
  - D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
  - E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
  - F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.



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- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

## 3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

## 3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

## 3.5 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

## 3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

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4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

## 3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

## 3.8 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 230500

# LEHIGH ACRES LEE TRAN PARK AND RIDE LEHIGH ACRES, FLORIDA

## SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements:  
<https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### 1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

### PART 2 - PRODUCTS

#### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

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- C. Comply with IEEE 841 for severe-duty motors.

#### 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

#### 2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

#### 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

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1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

**2.5 SINGLE-PHASE MOTORS**

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
  2. Capacitor start, inductor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION 230513**

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## SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Sleeves.
  - 2. Sleeve-seal fittings.
  - 3. Grout.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

### PART 2 - PRODUCTS

#### 2.1 SLEEVES

- A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

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- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

## 2.2 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

## 2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi , 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
  - 2. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
  - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- C. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
  - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

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- D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  - 1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6 : Galvanized-steel wall sleeves.
  - 2. Interior Partitions:
    - a. Piping Smaller Than NPS 6 : PVC-pipe sleeves.

END OF SECTION 230517



# LEHIGH ACRES LEE TRAN PARK AND RIDE LEHIGH ACRES, FLORIDA

## SECTION 230518 – ESCUTCHEONS FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Escutcheons.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

### PART 2 - PRODUCTS

#### 2.1 ESCUTCHEONS

- A. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- C. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

### PART 3 - EXECUTION

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## 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

## 3.2 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.

## 3.3 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

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## SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements:  
<https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Metal pipe hangers and supports.
  - 2. Trapeze pipe hangers.
- B. Related Sections:
  - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
  - 2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
  - 3. Division 23 Section "Vibration Controls for HVAC Piping and Equipment" for vibration isolation devices.
  - 4. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

#### 1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

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1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Welding certificates.

#### 1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

### PART 2 - PRODUCTS

#### 2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
  1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
  3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  5. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized carbon steel.
- B. Copper Pipe Hangers:
  1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
  2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

#### 2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

#### 2.3 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

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1. Properties: Non-staining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

#### PART 3 - EXECUTION

##### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Install lateral bracing with pipe hangers and supports to prevent swaying.
- F. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- H. Insulated Piping:
  1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
  2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

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- a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - b. NPS 4: 12 inches long and 0.06 inch thick.
- 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

#### 3.2 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

#### 3.3 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

#### 3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

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- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

#### 3.5 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- D. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- E. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- F. Use padded hangers for piping that is subject to scratching.
- G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
- H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 4.
- I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
- K. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

END OF SECTION 230529

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## SECTION 230548 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Isolation pads.
  - 2. Freestanding and restrained spring isolators.
  - 3. Spring hangers.
  - 4. Steel and inertia, vibration isolation equipment bases.

#### 1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
  - 1. Basic Wind Speed: Per Building Code Requirement, Verify with Structural Drawings.
  - 2. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.



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#### 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Delegated-Design Submittal: For vibration isolation restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, and wind forces required to select vibration isolators, and wind restraints, and for designing vibration isolation bases.
    - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
  - 2. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
- C. Welding certificates.
- D. Qualification Data: For professional engineer.
- E. Field quality-control test reports.

#### 1.6 QUALITY ASSURANCE

- A. Comply with restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

### PART 2 - PRODUCTS

#### 2.1 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Ace Mountings Co., Inc.
  - 2. Amber/Booth Company, Inc.
  - 3. California Dynamics Corporation.
  - 4. Isolation Technology, Inc.
  - 5. Kinetics Noise Control.

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6. Mason Industries.
  7. Vibration Eliminator Co., Inc.
  8. Vibration Isolation.
  9. Vibration Mountings & Controls, Inc.
  10. Vibro-Acoustics
- B. Pads Neoprene: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
  6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  2. Restraint: limit stop as required for equipment and authorities having jurisdiction.
  3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- E. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

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5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

#### 2.2 VIBRATION ISOLATION EQUIPMENT BASES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. Amber/Booth Company, Inc.
  2. California Dynamics Corporation.
  3. Isolation Technology, Inc.
  4. Kinetics Noise Control.
  5. Mason Industries.
  6. Vibration Eliminator Co., Inc.
  7. Vibration Isolation.
  8. Vibration Mountings & Controls, Inc.
  9. Vibro-Acoustics
- B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
  1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
  4. Grout: Provide grout as required.
- C. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
  1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

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4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

#### 2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
  1. Powder coating on springs and housings.
  2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
  3. Baked enamel or powder coat for metal components on isolators for interior use.
  4. Color-code or otherwise mark vibration isolation and wind-control devices to indicate capacity range.

#### PART 3 - EXECUTION

##### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

##### 3.2 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

##### 3.3 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

##### 3.4 VIBRATION-CONTROL-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 7 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance

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between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
3. Brace a change of direction longer than 12 feet (3.7 m).

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

## 3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

## 3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 230548

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## SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Pipe labels.
  - 3. Duct labels.
  - 4. Valve tags.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

#### 1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.

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- C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  - 1. Material and Thickness: anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 4. Fasteners: Stainless-steel rivets.
  - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

### 2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches.

### 2.3 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.

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- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches.
- J. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

## 2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1. Tag Material: anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

## PART 3 - EXECUTION

### 3.1 PREPARATION



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- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

## 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

## 3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:
  - 1. Chilled-Water Piping:
    - a. Background Color: Blue.
    - b. Letter Color: White.

## 3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
  - 1. Blue: For cold-air supply ducts.
  - 2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
  - 3. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

## 3.5 VALVE-TAG INSTALLATION

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- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape:
    - a. Chilled Water: 1-1/2 inches, round.
  - 2. Valve-Tag Color:
    - a. Chilled Water: Natural.
  - 3. Letter Color:
    - a. Chilled Water: Black.

END OF SECTION 230553

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## SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-air-volume systems.

#### 1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

#### 1.4 SUBMITTALS

- A. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

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- B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.
- E. Sample report forms.
- F. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

## 1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.
- B. TAB Conference: Meet with Architect, Owner, Construction Manager, Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
  - 1. Agenda Items:
    - a. The Contract Documents examination report.
    - b. The TAB plan.
    - c. Coordination and cooperation of trades and subcontractors.
    - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Commissioning Authority.

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- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

## 1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

## 1.7 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

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- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- J. Examine operating safety interlocks and controls on HVAC equipment.
- K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

## 3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
  - 1. Permanent electrical-power wiring is complete.
  - 2. Automatic temperature-control systems are operational.
  - 3. Equipment and duct access doors are securely closed.
  - 4. Balancing and fire dampers are open.
  - 5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 6. Windows and doors can be closed so indicated conditions for system operations can be met.

## 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
  - 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
  - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

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- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

## 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

## 3.5 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: 2 percent.
  - 2. Air Outlets and Inlets: Plus or minus 2 percent.

## 3.6 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

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- B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

## 3.7 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

- 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - 2. Include a list of instruments used for procedures, along with proof of calibration.

- B. Final Report Contents: In addition to certified field-report data, include the following:

- 1. Fan curves.
  - 2. Manufacturers' test data.
  - 3. Field test reports prepared by system and equipment installers.
  - 4. Other information relative to equipment performance; do not include Shop Drawings and product data.

- C. General Report Data: In addition to form titles and entries, include the following data:

- 1. Title page.
  - 2. Name and address of the TAB contractor.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB supervisor who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  - 12. Nomenclature sheets for each item of equipment.
  - 13. Notes to explain why certain final data in the body of reports vary from indicated values.
  - 14. Test conditions for fans performance forms including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.



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- d. Face and bypass damper settings at coils.
  - e. Fan drive settings including settings and percentage of maximum pitch diameter.
  - f. Settings for supply-air, static-pressure controller.
  - g. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
  - 1. Quantities of outdoor, supply, return, and exhaust airflows.
  - 2. Duct, outlet, and inlet sizes.
  - 3. Balancing stations.
  - 4. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
  - 1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Unit arrangement and class.
    - g. Discharge arrangement.
    - h. Sheave make, size in inches, and bore.
    - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    - j. Number, make, and size of belts.
    - k. Number, type, and size of filters.
  - 2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
  - 3. Test Data (Indicated and Actual Values):
    - a. Total air flow rate in cfm.
    - b. Total system static pressure in inches wg.
    - c. Fan rpm.
    - d. Discharge static pressure in inches wg.
    - e. Filter static-pressure differential in inches wg.
    - f. Preheat-coil static-pressure differential in inches wg.
    - g. Cooling-coil static-pressure differential in inches wg.
    - h. Heating-coil static-pressure differential in inches wg.
    - i. Outdoor airflow in cfm.

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- j. Return airflow in cfm.
- k. Outdoor-air damper position.
- l. Return-air damper position.

## F. Apparatus-Coil Test Reports:

### 1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft.
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

### 2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Refrigerant expansion valve and refrigerant types.
- i. Refrigerant suction pressure in psig .
- j. Refrigerant suction temperature in deg F.

## G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

### 1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches, and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

### 2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.

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- c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    - g. Number, make, and size of belts.
  - 3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.
    - b. Total system static pressure in inches wg.
    - c. Fan rpm.
    - d. Discharge static pressure in inches wg.
    - e. Suction static pressure in inches wg.
  - H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
    - 1. Report Data:
      - a. System and air-handling-unit number.
      - b. Location and zone.
      - c. Traverse air temperature in deg F.
      - d. Duct static pressure in inches wg.
      - e. Duct size in inches.
      - f. Duct area in sq. ft.
      - g. Indicated air flow rate in cfm.
      - h. Indicated velocity in fpm.
      - i. Actual air flow rate in cfm.
      - j. Actual average velocity in fpm.
      - k. Barometric pressure in psig.
  - I. Instrument Calibration Reports:
    - 1. Report Data:
      - a. Instrument type and make.
      - b. Serial number.
      - c. Application.
      - d. Dates of use.
      - e. Dates of calibration.
- 3.8 INSPECTIONS
- A. Initial Inspection:
    - 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
    - 2. Check the following for each system:

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- a. Measure airflow of at least 10 percent of air outlets.
- b. Measure water flow of at least 50 percent of terminals.
- c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
- d. Verify that balancing devices are marked with final balance position.
- e. Note deviations from the Contract Documents in the final report.

## B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Commissioning Authority.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.
3. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

## C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

## D. Prepare test and inspection reports.

### 3.9 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

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## SECTION 230700 - HVAC INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements:  
<https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link:  
<https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

##### A. Section Includes:

- 1. Insulation Materials:
  - a. Cellular glass.
  - b. Flexible elastomeric.
  - c. Mineral fiber.
- 2. Adhesives.
- 3. Mastics.
- 4. Sealants.
- 5. Field-applied jackets.
- 6. Tapes.
- 7. Securements.

##### B. Related Sections:

- 1. Division 21 Section "Fire-Suppression Systems Insulation."
- 2. Division 22 Section "Plumbing Insulation."
- 3. Division 23 Section "Metal Ducts" for duct liners.

#### 1.3 SUBMITTALS

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- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
  - 1. Piping Mockups:
    - a. One 10-foot section of NPS 2 straight pipe.
    - b. One each of a 90-degree threaded, welded, and flanged elbow.
    - c. One each of a threaded, welded, and flanged tee fitting.
    - d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
    - e. Four support hangers including hanger shield and insert.
    - f. One threaded strainer and one flanged strainer with removable portion of insulation.
    - g. One threaded reducer and one welded reducer.
    - h. One pressure temperature tap.
    - i. One mechanical coupling.
  - 2. Ductwork Mockups:
    - a. One 10-foot section each of rectangular and round straight duct.
    - b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
    - c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
    - d. One rectangular and round transition fitting.
    - e. Four support hangers for round and rectangular ductwork.

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3. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
4. Notify Architect seven days in advance of dates and times when mockups will be constructed.
5. Obtain Architect's approval of mockups before starting insulation application.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
8. Demolish and remove mockups when directed.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### 1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

### PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

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- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cell-U-Foam Corporation; Ultra-CUF.
    - b. Pittsburgh Corning Corporation; Foamglas Super K.
  - 2. Block Insulation: ASTM C 552, Type I.
  - 3. Special-Shaped Insulation: ASTM C 552, Type III.
  - 4. Board Insulation: ASTM C 552, Type IV.
  - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  - 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
  - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; All-Service Duct Wrap.
- I. Mineral-Fiber, Preformed Pipe Insulation:



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1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Fibrex Insulations Inc.; Coreplus 1200.
  - b. Johns Manville; Micro-Lok.
  - c. Knauf Insulation; 1000-Degree Pipe Insulation.
  - d. Manson Insulation Inc.; Alley-K.
  - e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- J. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Knauf Insulation; Permawick Pipe Insulation.
  - b. Owens Corning; VaporWick Pipe Insulation.

- K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Armacell LLC; Tubolit.
  - b. Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.

## 2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass, Adhesive: Water based adhesive, with a service temperature range of minus 75 to plus 300 deg F .

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1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-96.
    - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA Inc.; Aeroseal.
    - b. Armacell LCC; 520 Adhesive.
    - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
    - d. RBX Corporation; Rubatex Contact Adhesive.
    - e.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
  2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

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- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-35.
    - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    - c. ITW TACC, Division of Illinois Tool Works; CB-50.
    - d. Marathon Industries, Inc.; 590.
    - e. Mon-Eco Industries, Inc.; 55-40.
    - f. Vimasco Corporation; 749.
  - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
  - 5. Color: White.

#### 2.4 SEALANTS

- A. Joint Sealants:
  - 1. Joint Sealants for Cellular-Glass, Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-76.
    - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
    - c. Marathon Industries, Inc.; 405.
    - d. Mon-Eco Industries, Inc.; 44-05.
    - e. Pittsburgh Corning Corporation; Pittseal 444.
    - f. Vimasco Corporation; 750.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Permanently flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 100 to plus 300 deg F.
  - 5. Color: White or gray.
  - 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. FSK and Metal Jacket Flashing Sealants:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-76-8.

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- b. Foster Products Corporation, H. B. Fuller Company; 95-44.
  - c. Marathon Industries, Inc.; 405.
  - d. Mon-Eco Industries, Inc.; 44-05.
  - e. Vimasco Corporation; 750.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
  - 5. Color: Aluminum.
  - 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, Jacket Flashing Sealants:
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-76.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
  - 5. Color: White.
  - 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

#### 2.5 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal Jacket:
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; Metal Jacketing Systems.
    - b. PABCO Metals Corporation; Surefit.
    - c. RPR Products, Inc.; Insul-Mate.
  - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
    - a. Factory cut and rolled to size.
    - b. Finish and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications:
    - d. Factory-Fabricated Fitting Covers:
      - 1) Same material, finish, and thickness as jacket.
      - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      - 3) Tee covers.
      - 4) Flange and union covers.
      - 5) End caps.

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- 6) Beveled collars.
- 7) Valve covers.
- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

#### 2.6 SECUREMENTS

##### A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Products; Bands.
  - b. PABCO Metals Corporation; Bands.
  - c. RPR Products, Inc.; Bands.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209 , Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

##### B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
  - a. Products: Subject to compliance with requirements, provide one of the following:
    - 1) AGM Industries, Inc.; CWP-1.
    - 2) GEMCO; CD.
    - 3) Midwest Fasteners, Inc.; CD.
    - 4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - a. Products: Subject to compliance with requirements, provide one of the following:
    - 1) AGM Industries, Inc.; CWP-1.
    - 2) GEMCO; Cupped Head Weld Pin.
    - 3) Midwest Fasteners, Inc.; Cupped Head.
    - 4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. Products: Subject to compliance with requirements, provide one of the following:

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- 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
  - 2) GEMCO; Perforated Base.
  - 3) Midwest Fasteners, Inc.; Spindle.
- b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - a. Products: Subject to compliance with requirements, provide one of the following:
      - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
      - 2) GEMCO; Press and Peel.
      - 3) Midwest Fasteners, Inc.; Self Stick.
    - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    - d. Adhesive-backed base with a peel-off protective cover.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
  - D. Wire: 0.062-inch soft-annealed, stainless steel.
1. Manufacturers: Subject to compliance with requirements,:
    - a. Childers Products.
    - b. PABCO Metals Corporation.
    - c. RPR Products, Inc.

#### PART 3 - EXECUTION

##### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
  1. Verify that systems and equipment to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
  3. Proceed with installation only after unsatisfactory conditions have been corrected.

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#### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

#### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

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1. Install insulation continuously through hangers and around anchor attachments.
  2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
  2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
1. Testing agency labels and stamps.
  2. Nameplates and data plates.
  3. Manholes.
  4. Handholes.
  5. Cleanouts.

#### 3.4 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):  
Install insulation continuously through walls and partitions.



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- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
  - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- C. Insulation Installation at Floor Penetrations:
  - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
  - 2. Pipe: Install insulation continuously through floor penetrations.
  - 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

#### 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
  - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

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6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 CELLULAR-GLASS INSULATION INSTALLATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### B. Insulation Installation on Pipe Flanges:

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1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch , and seal joints with flashing sealant.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

### 3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

#### A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

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2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### 3.8 MINERAL-FIBER INSULATION INSTALLATION

##### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

##### B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

##### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

##### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

##### E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

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1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
  - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Impale insulation over pins and attach speed washers.
  - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
  - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

#### 3.9 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

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2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

#### 3.10 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
  - a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

#### 3.11 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

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**B. Items Not Insulated:**

1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and casings.
3. Flexible connectors.
4. Vibration-control devices.
5. Factory-insulated access panels and doors.

**3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE**

**A. Concealed, rectangular, supply-air duct insulation shall be the following:**

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

**B. Concealed, rectangular, return-air duct insulation shall be the following:**

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

**C. Concealed, rectangular, outdoor-air duct insulation shall be the following:**

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

**3.13 PIPING INSULATION SCHEDULE, GENERAL**

**A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.**

**B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:**

1. Drainage piping located in crawl spaces.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

**3.14 INDOOR PIPING INSULATION SCHEDULE**

**A. Condensate and Equipment Drain Water below 60 Deg F :**

1. All Pipe Sizes: Insulation shall be the following:
  - a. Flexible Elastomeric: 3/4 inch thick.

**B. Refrigerant Suction, Liquid (Heat Pump only), and Hot-Gas Piping: Flexible elastomeric Mineral-fiber, preformed pipe insulation or Polyolefin, 1 inch thick.**

**C. Refrigerant Suction, Liquid (Heat Pump only), and Hot-Gas Flexible Tubing: Flexible elastomeric or Polyolefin, 1 inch thick.**

**3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE**

**A. Refrigerant Suction, Liquid (Heat Pump only), and Hot-Gas Piping: Insulation shall be one of the following:**

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1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 2 inches thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
4. Polyolefin: 2 inches thick.

**3.16 OUTDOOR AND UNCONDITIONED SPACES, FIELD-APPLIED JACKET SCHEDULE**

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
  1. Aluminum, Corrugated: 0.016 inch thick.

END OF SECTION 230700



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## SECTION 230900 - INSTRUMENTATION AND CONTROLS FOR HVAC

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements:  
<https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections: Other Sections of Division 23 which relate to the requirements of this Section may include but are not limited to the following:
  - 1. 23 01 00, BASIC MECHANICAL REQUIREMENTS
  - 2. 26 09 43, RELAY-BASED LIGHTING CONTROLS

#### 1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. I/O: Input/output.
- C. MS/TP: Master slave/token passing.
- D. PID: Proportional plus integral plus derivative.
- E. RTD: Resistance temperature detector.

#### 1.4 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:

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1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
  - a. Space Temperature: Plus or minus 1 deg F.
  - b. Ducted Air Temperature: Plus or minus 1 deg F.
  - c. Outside Air Temperature: Plus or minus 2 deg F.
  - d. Dew Point Temperature: Plus or minus 3 deg F.
  - e. Temperature Differential: Plus or minus 0.25 deg F.
  - f. Relative Humidity: Plus or minus 5 percent.
  - g. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
  - h. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
  - i. Air Pressure (Space): Plus or minus 0.01-inch wg.
  - j. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
  - k. Carbon Dioxide: Plus or minus 50 ppm.
  - l. Electrical: Plus or minus 5 percent of reading.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
  1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
  2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
  3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

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1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:
  - a. Wiring diagrams for control units with termination numbers.
  - b. Schematic diagrams and floor plans for field sensors and control hardware.
  - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:
  - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
  - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
  - c. Written description of sequence of operation including schematic diagram.
  - d. Points list.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- B. Qualification Data: For Installer and manufacturer.
- C. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- D. Field quality-control test reports.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
  2. Interconnection wiring diagrams with identified and numbered system components and devices.
  3. Keyboard illustrations and step-by-step procedures indexed for each operator function.

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4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

**B. Software and Firmware Operational Documentation: Include the following:**

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

**1.8 QUALITY ASSURANCE**

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- 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. Comply with ASHRAE 135 for DDC system components.

**1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

**1.10 COORDINATION**

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system and with building master clock.
- C. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate equipment with Division 27 Section "Clock Systems" to achieve compatibility with equipment that interfaces with that system.
- E. Coordinate equipment with Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" to achieve compatibility with equipment that interfaces with that system.
- F. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

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- G. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- H. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- I. Coordinate equipment with Division 26 Section "Relay-Based Lighting Controls" to achieve compatibility of communication interfaces.
- J. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- K. Coordinate equipment with Division 26 Section "Switchboards" to achieve connection to building power meter.
- L. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

#### 1.11 SEQUENCE OF OPERATION

- A. Controls display screens shall provide a link directly to equipment sequence of operations.

#### 1.12 SERVICE AGREEMENT

- A. Provide a full one-year service agreement for controls system calibrations, troubleshooting and sequence performance monitoring. Agreement shall include, as a minimum, the following:
  - 1. Quarterly inspections including performing a login review prior to visiting the site and check trending historical data for anomalies and a report of devices needing attention. Inspections shall be for a minimum of 8 hours per quarter.
  - 2. Service technician shall be available to respond within 2 - 4 hours to all issues to take corrective action(s).
  - 3. A full time-stamped report noting calibrations or corrective actions taken shall be provided for each service action call.

### PART 2 - PRODUCTS

#### 2.1 CONTROL SYSTEM

- A. Manufacturers:
  - 1. Automated Logic Corporation.
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

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- C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- D. Control system shall include the following where applicable:
  - 1. Building intrusion detection system specified in Division 28 Section "Intrusion Detection."
  - 2. Building clock control system specified in Division 27 Section "Clock Systems."
  - 3. Building lighting control system specified in Division 26 Section 260943 "Relay-Based Lighting Controls."
  - 4. Building energy monitoring as specified in Division 26 Section 262413, "Switchboards", and Section 263353, "Static Uninterruptable Power Supply".
  - 5. Fire alarm system specified in Division 28 Section 283111 "Digital, Addressable Fire-Alarm System".

## 2.2 DDC EQUIPMENT

- A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
  - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
  - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - a. Global communications.
    - b. Discrete/digital, analog, and pulse I/O.
    - c. Monitoring, controlling, or addressing data points.
    - d. Software applications, scheduling, and alarm processing.
    - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
  - 3. Standard Application Programs:
    - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
    - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
    - c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
    - d. Remote communications.
    - e. Maintenance management.

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- f. Units of Measure: Inch-pound and SI (metric).
- 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
- 5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
  - 1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
  - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - a. Global communications.
    - b. Discrete/digital, analog, and pulse I/O.
    - c. Monitoring, controlling, or addressing data points.
  - 3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
  - 4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
  - 1. Binary Inputs: Allow monitoring of on-off signals without external power.
  - 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
  - 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
  - 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
  - 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
  - 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
  - 7. Universal I/Os: Provide software selectable binary or analog outputs.
- D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
  - 1. Output ripple of 5.0 mV maximum peak to peak.
  - 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
  - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

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- E. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
  - 1. Minimum dielectric strength of 1000 V.
  - 2. Maximum response time of 10 nanoseconds.
  - 3. Minimum transverse-mode noise attenuation of 65 dB.
  - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

#### 2.3 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
  - 1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
  - 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
  - 3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
  - 4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
  - 5. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

#### 2.4 ALARM PANELS

- A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch-thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.
- B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
  - 1. Alarm Condition: Indicating light flashes and horn sounds.
  - 2. Acknowledge Switch: Horn is silent and indicating light is steady.
  - 3. Second Alarm: Horn sounds and indicating light is steady.
  - 4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
  - 5. Contacts in alarm panel allow remote monitoring by independent alarm company.

#### 2.5 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.



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- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
  - 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
  - 1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
  - 2. Proportional band shall extend from 2 to 20 percent for 5 psig.
  - 3. Authority shall be 20 to 200 percent.
  - 4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.
  - 5. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

#### 2.6 TIME CLOCKS

- A. Manufacturers:
  - 1. ATC-Diversified Electronics.
  - 2. Grasslin Controls Corporation.
  - 3. Theben AG - Lumilite Control Technology, Inc.
- B. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

#### 2.7 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
  - 1. Manufacturers:
    - a. BEC Controls Corporation.
    - b. Ebtron, Inc.
    - c. MAMAC Systems, Inc.
  - 2. Accuracy: Plus or minus 0.5 deg F at calibration point.
  - 3. Wire: Twisted, shielded-pair cable.
  - 4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.

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5. Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
  - a. Set-Point Adjustment: Exposed.
  - b. Set-Point Indication: Exposed.
  - c. Thermometer: Exposed.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

#### C. RTDs and Transmitters:

1. Manufacturers:
  - a. BEC Controls Corporation.
  - b. MAMAC Systems, Inc.
  - c. RDF Corporation.
2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
5. Averaging Elements in Ducts: 24 feet long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft; length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
  - a. Set-Point Adjustment: Exposed.
  - b. Set-Point Indication: Exposed.
  - c. Thermometer: Exposed.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

#### D. Humidity Sensors: Bulk polymer sensor element.

1. Manufacturers:
  - a. BEC Controls Corporation.
  - b. MAMAC Systems, Inc.
  - c. Vaisala.
2. Accuracy: 1 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
  - a. Set-Point Adjustment: Exposed.

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- b. Set-Point Indication: Exposed.
    - c. Thermometer: Exposed.
  - 5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
  - 6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.
  - 7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
- E. Pressure Transmitters/Transducers:
- 1. Manufacturers:
    - a. BEC Controls Corporation.
    - b. MAMAC Systems, Inc.
    - c. Vaisala.
  - 2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
    - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
    - b. Output: 4 to 20 mA.
    - c. Building Static-Pressure Range: 0- to 0.25-inch wg.
    - d. Duct Static-Pressure Range: 0- to 5-inch wg.
  - 3. Differential-Pressure Switch (Air): Snap acting, with pilot-duty rating and with suitable scale range and differential.
  - 4. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.
- F. Room Sensor Cover Construction: Manufacturer's standard locking covers.
- 1. Set-Point Adjustment: Exposed.
  - 2. Set-Point Indication: Exposed.
  - 3. Thermometer: Exposed.
- G. Room sensor accessories include the following:
- 1. Insulating Bases: For sensors located on exterior walls.
  - 2. Guards: Locking, solid metal, ventilated.
  - 3. Adjusting Key: As required for calibration and cover screws.
- 2.8 STATUS SENSORS
- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
  - B. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

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- C. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- D. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- E. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- F. Electronic Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

#### 2.9 THERMOSTATS

- A. Manufacturers:
  - 1. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
  - 2. tekmar Control Systems, Inc.
  - 3. Theben AG - Lumilite Control Technology, Inc.
- B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
  - 1. Automatic switching from heating to cooling.
  - 2. Preferential rate control to minimize overshoot and deviation from set point.
  - 3. Set up for four separate temperatures per day.
  - 4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
  - 5. Short-cycle protection.
  - 6. Programming based on every day of week.
  - 7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
  - 8. Battery replacement without program loss.
  - 9. Thermostat display features include the following:
    - a. Time of day.
    - b. Actual room temperature.
    - c. Programmed temperature.
    - d. Programmed time.
    - e. Duration of timed override.
    - f. Day of week.
    - g. System mode indications include "heating," "off," "fan auto," and "fan on."
- C. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- D. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

#### 2.10 HUMIDISTATS

- A. Manufacturers:

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1. MAMAC Systems, Inc.
2. ROTRONIC Instrument Corp.

- B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

**2.11 ACTUATORS**

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf .
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf .

- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:
  - a. Belimo Aircontrols (USA), Inc.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:
  - a. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F .
12. Run Time: 30 seconds.

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#### 2.12 DAMPERS

##### A. Manufacturers:

1. Air Balance Inc.
2. TAMCO (T. A. Morrison & Co. Inc.).

##### B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches .

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf ; when tested according to AMCA 500D.

#### 2.13 CONTROL CABLE

##### A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

### PART 3 - EXECUTION

#### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third parting testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

#### 3.2 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.

#### 3.3 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
  1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

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- D. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- F. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- G. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- H. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- I. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

#### 3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
  - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  - 2. Install exposed cable in raceway.
  - 3. Install concealed cable in raceway.
  - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

#### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

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B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check DDC system as follows:
  - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
  - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
  - c. Verify that spare I/O capacity has been provided.
  - d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

### 3.6 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:



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- a. Check analog inputs at 0, 50, and 100 percent of span.
  - b. Check analog outputs using milliamper meter at 0, 50, and 100 percent output.
  - c. Check digital inputs using jumper wire.
  - d. Check digital outputs using ohmmeter to test for contact making or breaking.
  - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Pressure:
- a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
  - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
6. Temperature:
- a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
  - b. Calibrate temperature switches to make or break contacts.
7. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
8. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
9. Provide diagnostic and test instruments for calibration and adjustment of system.
10. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.
- 3.7 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 230900

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## SECTION 232300 - REFRIGERANT PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements:  
<https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
  - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
  - 2. Suction Lines for Heat-Pump Applications: 535 psig.
  - 3. Hot-Gas and Liquid Lines: 535 psig.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
  - 1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

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#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.6 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

#### 1.7 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

### PART 2 - PRODUCTS

#### 2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L or ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
  - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
  - 2. End Connections: Socket ends.
  - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
  - 4. Pressure Rating: Factory test at minimum 500 psig.
  - 5. Maximum Operating Temperature: 250 deg F.

#### 2.2 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
  - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
  - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
  - 3. Operator: Rising stem and hand wheel.
  - 4. Seat: Nylon.
  - 5. End Connections: Socket, union, or flanged.

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6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

**B. Packed-Angle Valves:**

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

**C. Check Valves:**

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

**D. Service Valves:**

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

**E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.**

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24, 115 or 208-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

**F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.**

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.

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4. End Connections: Threaded.
  5. Working Pressure Rating: 400 psig.
  6. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
  2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  3. Packing and Gaskets: Non-asbestos.
  4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
  5. Suction Temperature: 40 deg F.
  6. Superheat: Adjustable or Nonadjustable.
  7. Reverse-flow option (for heat-pump applications).
  8. End Connections: Socket, flare, or threaded union.
  9. Working Pressure Rating: 700 psig or 450 psig.
- H. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
  2. Screen: 100-mesh stainless steel.
  3. End Connections: Socket or flare.
  4. Working Pressure Rating: 500 psig.
  5. Maximum Operating Temperature: 275 deg F.
- I. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
  2. Drain Plug: Brass hex plug.
  3. Screen: 100-mesh monel.
  4. End Connections: Socket or flare.
  5. Working Pressure Rating: 500 psig.
  6. Maximum Operating Temperature: 275 deg F.
- J. Moisture/Liquid Indicators:
1. Body: Forged brass.
  2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
  3. Indicator: Color coded to show moisture content in ppm.
  4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
  5. End Connections: Socket or flare.
  6. Working Pressure Rating: 500 psig.
  7. Maximum Operating Temperature: 240 deg F.
- K. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
  2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
  3. Desiccant Media: Activated alumina or charcoal.
  4. Designed for reverse flow (for heat-pump applications).
  5. End Connections: Socket.

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6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: As required for system.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

L. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: As required for system.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

M. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

## 2.3 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

### 3.2 PIPING APPLICATIONS

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- A. Suction Lines NPS 1-1/2 and Smaller or Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR or Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR or Type K or L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
  - 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
  - 2. NPS 1-1/2 and Smaller: Copper, Type ACR or Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
  - 3. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
  - 4. NPS 4: Copper, Type ACR or Type K or L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, Type ACR or Type K or L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- G. Safety-Relief-Valve Discharge Piping:
  - 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
  - 2. NPS 1-1/2 and Smaller: Copper, Type ACR or Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.
  - 3. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
  - 4. NPS 4: Copper, Type ACR or Type K or L, drawn-temper tubing and wrought-copper fittings with soldered joints.

### 3.3 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at strainers if they are not an integral part of strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.

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- F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
  - 1. Install valve so diaphragm case is warmer than bulb.
  - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
  - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
  - 1. Solenoid valves.
  - 2. Thermostatic expansion valves.
  - 3. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install flexible connectors at compressors.

#### 3.4 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.



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- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 23 Section "Direct Digital Control System for HVAC" for solenoid valve controllers and control wiring requirements, and refer to drawings for sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.
  - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

### 3.5 PIPE JOINT CONSTRUCTION

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- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

#### 3.6 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
  - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  - 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  - 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
  - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
- D. Support multi-floor vertical runs at least at each floor.

#### 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. Comply with ASME B31.5, Chapter VI.
  - 2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System shall maintain test pressure at the manifold gage throughout duration of test.

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- c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
- d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

#### 3.8 SYSTEM CHARGING

- A. Charge system using the following procedures:
  - 1. Install core in filter dryers after leak test but before evacuation.
  - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
  - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
  - 4. Charge system with a new filter-dryer core in charging line.

#### 3.9 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  - 1. Open shutoff valves in condenser water circuit.
  - 2. Verify that compressor oil level is correct.
  - 3. Open compressor suction and discharge valves.
  - 4. Open refrigerant valves except bypass valves that are used for other purposes.
  - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

# LEHIGH ACRES LEE TRAN PARK AND RIDE LEHIGH ACRES, FLORIDA

## SECTION 233113 - METAL DUCTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Single-wall rectangular ducts and fittings.
  - 2. Single-wall round ducts and fittings.
  - 3. Double-wall rectangular ducts and fittings.
  - 4. Double-wall spiral ducts and fittings.
  - 5. Sheet metal materials.
  - 6. Sealants and gaskets.
  - 7. Hangers and supports.
- B. Related Sections:
  - 1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
  - 2. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
  - 3. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
  - 4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

#### 1.3 PERFORMANCE REQUIREMENTS

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- A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

## 1.4 SUBMITTALS

- A. Product Data: For each type of the following products:

- 1. Liners and adhesives.
- 2. Sealants and gaskets.

- B. Shop Drawings:

- 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
- 2. Factory- and shop-fabricated ducts and fittings.
- 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
- 4. Elevation of top of ducts.
- 5. Dimensions of main duct runs from building grid lines.
- 6. Fittings.
- 7. Reinforcement and spacing.
- 8. Seam and joint construction.
- 9. Penetrations through fire-rated and other partitions.
- 10. Equipment installation based on equipment being used on Project.
- 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
- 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

- C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

- 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
- 2. Suspended ceiling components.
- 3. Structural members to which duct will be attached.
- 4. Size and location of initial access modules for acoustical tile.
- 5. Penetrations of smoke barriers and fire-rated construction.
- 6. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Perimeter moldings.

## 1.5 QUALITY ASSURANCE

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- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2010, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2010, Section 6.4.4 - "HVAC System Construction and Insulation."

## PART 2 - PRODUCTS

### 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### 2.2 SINGLE-WALL ROUND (AND FLAT OVAL) DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eastern Sheet Metal
    - b. McGill AirFlow LLC.
    - c. Sheet Metal Connectors, Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for

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static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eastern Sheet Metal
  2. McGill AirFlow LLC.
  3. Sheet Metal Connectors, Inc.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  1. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
  2. Coat insulation with antimicrobial coating.

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3. Cover insulation with polyester film complying with UL 181, Class 1.
  - G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
  - H. Inner Duct: Minimum 0.028-inch solid sheet steel.
  - I. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - J. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- 2.4 DOUBLE-WALL ROUND (AND FLAT-OVAL) DUCTS AND FITTINGS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Eastern Sheet Metal.
    2. McGill AirFlow LLC.
    3. SEMCO Incorporated.
    4. Sheet Metal Connectors, Inc.
  - B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
  - C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
    1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements,



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materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- D. Inner Duct: Minimum 0.028-inch solid sheet steel.
- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
  - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
  - 3. Coat insulation with antimicrobial coating.
  - 4. Cover insulation with polyester film complying with UL 181, Class 1.
- F. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
  - 1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

## 2.5 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
  - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:

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1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg , positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

## 2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 , "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

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3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch , plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches .
- J. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

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- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

## 3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Outdoor, Supply-Air Ducts: Seal Class A.
  - 3. Outdoor, Exhaust Ducts: Seal Class C.
  - 4. Outdoor, Return-Air Ducts: Seal Class C.
  - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
  - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg : Seal Class A.
  - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
  - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
  - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
  - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg : Seal Class B.
  - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
  - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

## 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

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3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

## 3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

## 3.7 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

## 3.8 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
- B. Supply Ducts:
1. Ducts Connected to Constant-Volume Air-Handling Units:
    - a. Pressure Class: Positive 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 6.

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2. Ducts Connected to Variable-Air-Volume Air-Handling Units:
    - a. Pressure Class: Positive 3-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 6.
  3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 6.
- C. Return Ducts:
1. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 6.
  2. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 6.
- D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    - a. Pressure Class: Negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    - c. SMACNA Leakage Class for Rectangular: 12.
  2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    - c. SMACNA Leakage Class for Rectangular: 6.
  3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 3-inch wg.
    - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    - c. SMACNA Leakage Class for Rectangular: 6.

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## E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 12.
2. Ducts Connected to Air-Handling Units:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 6.
3. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 6.

## F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
  - a. Exposed to Airstream: Match duct material.
  - b. Not Exposed to Airstream: Match duct material.
2. Stainless-Steel Ducts:
  - a. Exposed to Airstream: Match duct material.
  - b. Not Exposed to Airstream: Match duct material.

## G. Double-Wall Duct Interstitial Insulation:

1. Supply Air Ducts: 1 inch thick.
2. Return Air Ducts: 1 inch thick.

## H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Velocity 1000 fpm or Lower:
    - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
    - 2) Mitered Type RE 4 without vanes.
  - b. Velocity 1000 to 1500 fpm:

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- 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
  - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
  - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- c. Velocity 1500 fpm or Higher:
  - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- I. Branch Configuration:
  1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
    - a. Rectangular Main to Rectangular Branch: 45-degree entry.
    - b. Rectangular Main to Round Branch: Spin in.

END OF SECTION 233113



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## SECTION 233423 - HVAC POWER VENTILATORS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

### PART 2 - PRODUCTS

#### 2.1 CEILING-MOUNTED VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Greenheck Fan Corporation.
  - 2. Loren Cook Company.
- B. Housing: Steel, lined with acoustical insulation.

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- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Painted aluminum louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
  - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  - 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
  - 3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
  - 4. Motion Sensor: Motion detector with adjustable shutoff timer.
  - 5. Filter: Washable aluminum to fit between fan and grille.
  - 6. Isolation: Rubber-in-shear vibration isolators.
  - 7. Manufacturer's standard roof jack or wall cap, and transition fittings.
- G. Capacities and Characteristics: See equipment schedule on drawings.

## 2.2 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Acme Engineering & Manufacturing Corporation.
  - 2. Greenheck Fan Corporation.
  - 3. Loren Cook Company.
- B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- F. Accessories:
  - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  - 2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
  - 3. Companion Flanges: For inlet and outlet duct connections.

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4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

G. Capacities and Characteristics: See equipment schedule on drawings.

## 2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Totally enclosed, fan cooled.

## 2.4 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

### 3.2 INSTALLATION

- A. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- B. Support suspended units from structure using threaded steel rods and elastomeric hangers, or spring hangers. Vibration-control devices are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."
- C. Install units with clearances for service and maintenance.

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- D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

#### 3.3 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

#### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that cleaning and adjusting are complete.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - 5. Adjust belt tension.
  - 6. Adjust damper linkages for proper damper operation.
  - 7. Verify lubrication for bearings and other moving parts.
  - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  - 10. Shut unit down and reconnect automatic temperature-control operators.
  - 11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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- D. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 233423

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## SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Rectangular and square ceiling diffusers.
  - 2. Round ceiling diffusers.
  - 3. Fixed face registers and grilles.
  - 4. Linear slot diffusers.
- B. Related Sections:
  - 1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
  - 2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

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## PART 2 - PRODUCTS

### 2.1 CEILING DIFFUSERS

#### A. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Krueger.
  - b. Price Industries.
  - c. Titus.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Size: 24 by 24 inches.
5. Face Style: Refer to Drawing Schedule.
6. Mounting: Refer to drawing schedule.
7. Pattern: Refer to drawing schedule.
8. Dampers: Refer to drawing schedule.

#### B. Round Ceiling Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Krueger.
  - b. Price Industries.
  - c. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Aluminum.
4. Finish: Baked enamel, color selected by Architect.
5. Face Style: Three cone.
6. Mounting: Duct connection.
7. Pattern: Fully adjustable.
8. Dampers: Combination damper and grid.
9. Accessories:
  - a. Equalizing grid.
  - b. Plaster ring.
  - c. Safety chain.
  - d. Wire guard.
  - e. Sectorizing baffles.
  - f. Operating rod extension.

### 2.2 REGISTERS AND GRILLES

#### A. Fixed Face Register:

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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Krueger.
  - b. Price Industries.
  - c. Titus.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Arrangement: Refer to drawing schedule.
5. Core Construction: Refer to drawing schedule.
6. Frame: Refer to drawing schedule.
7. Mounting: Refer to drawing schedule.
8. Damper Type: Refer to drawing schedule.

## B. Fixed Face Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Krueger.
  - b. Price Industries.
  - c. Titus.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Arrangement: Refer to drawing schedule.
5. Core Construction: Refer to drawing schedule.
6. Frame: Refer to drawing schedule.
7. Mounting: Refer to drawing schedule.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels,



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locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

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## SECTION 234100 - PARTICULATE AIR FILTRATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements:  
<https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Pleated panel filters.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
  - 2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
  - 3. Wiring Diagrams: For power, signal, and control wiring.

#### 1.4 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

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1. Provide one complete set(s) of filters for each filter bank.
2. Provide one container(s) of red oil for inclined manometer filter gage.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
  1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
  2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.
- C. Comply with NFPA 90A and NFPA 90B.

#### 1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

### PART 2 - PRODUCTS

#### 2.1 PLEATED PANEL FILTERS

- A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AAF International.
    - b. Camfil Farr.
    - c. Purafil, Inc.
- B. Filter Unit Class: UL 900, Class 2.
- C. Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.
  1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Media shall be coated with an antimicrobial agent.
  3. Separators shall be bonded to the media to maintain pleat configuration.
  4. Welded wire grid shall be on downstream side to maintain pleat.
  5. Media shall be bonded to frame to prevent air bypass.
  6. Support members on upstream and downstream sides to maintain pleat spacing.
- D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

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- E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
- F. Capacities and Characteristics:
  - 1. Maximum or Rated Face Velocity: 500 fpm.
  - 2. Efficiency: 90 percent on particles 20 micrometers and larger at 500 fpm.
  - 3. Arrestance: 85 percent when tested according to ASHRAE 52.1.
  - 4. Initial Resistance: 0.60-inch wg at 500 fpm.
  - 5. Recommended Final Resistance: 1.0-inch wg.
  - 6. MERV Rating (Pre-filter): 8 when tested according to ASHRAE 52.2.
  - 7. MERV Rating (Final-filter): 13 when tested according to ASHRAE 52.2.

#### PART 3 - EXECUTION

##### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

##### 3.2 INSTALLATION

- A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- B. Install filters in position to prevent passage of unfiltered air.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- D. Coordinate filter installations with duct and air-handling-unit installations.

##### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Operate automatic roll filters to demonstrate compliance with requirements.
  - 2. Test for leakage of unfiltered air while system is operating.
- C. Air filter will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

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3.4 CLEANING

- A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 234100

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## SECTION 238126 – SPLIT-SYSTEM AIR-CONDITIONERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:

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1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

## 1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
  - a. For Compressor: Five years from date of Substantial Completion.
  - b. For Parts: Five years from date of Substantial Completion.
  - c. For Labor: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Addison Company, Inc.
2. AAON
3. Daikin

### 2.2 INDOOR UNITS

A. Concealed Heat Pump Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner with anti-microbial treatment.
3. Unit shall be configured as heat pump. Refrigeration circuit shall be equipped with a thermal expansion with an internal check valve on the indoor coil.
4. Modulating hot gas reheat shall be provided on the refrigeration circuit. Air handling unit shall be provided with hot gas reheat coil, a check valve on the liquid line, and a check valve on the hot gas reheat line. Reheat line connections shall be labeled, extend beyond the unit casing and be located near the suction and liquid line connections for ease of field connection. Connections shall be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.
5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
6. Fan Motors:

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- a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
  8. Filters: Pleated, disposable.
  9. Condensate Drain Pans: Stainless-steel, with connection for drain; insulated.

## B. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive.
5. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - b. Multi-tapped, multispeed with internal thermal protection and permanent lubrication.
  - c. Enclosure Type: Totally enclosed, fan cooled.
  - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
  - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
  - f. Mount unit-mounted disconnect switches on exterior or interior of unit.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans: Stainless-steel, with connection for drain; insulated.
8. Filters: Pleated, disposable.

## 2.3 OUTDOOR UNITS

### A. Air-Cooled Heat Pump, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.



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2. Compressor: Unit shall be provided with one independently circuited R-410A variable capacity scroll compressor with thermal overload protection. Variable capacity scroll compressor shall be capable of modulation from 10-100% of its capacity.
3. Refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided and installed. Field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, insulated liquid line, insulated hot gas reheat line, and insulated suction line.
4. Refrigeration circuit shall be provided with modulating hot gas reheat valve, electronic controller, liquid line receiver, supply air temperature sensor and a dehumidification control signal terminal that enables the dehumidification mode of operation, and includes supply air temperature control to prevent supply air temperature swings and overcooling of the space. The matching indoor air handler must include a hot gas reheat coil and a check valve on the hot gas reheat line.
5. Unit shall be configured as an air-source heat pump. Refrigeration circuit shall be equipped with a bi-flow liquid line filter drier, reversing valve, suction line accumulator, liquid line receiver, and thermal expansion valve with internal check valve. Reversing valve shall de-energize during the heat pump heating mode of operation. The matching indoor air handler must include a thermal expansion valve with internal check valve

**B. Air-Cooled, Cooling Only Compressor-Condenser Components:**

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - a. Compressor Type: Scroll.
  - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
  - c. Refrigerant Charge: R-407C or R-410A.
  - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
  - e. Condenser Coil: Coat all exterior coil surfaces with baked epoxy corrosion resistant coating.
3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to 45 deg F.
6. Mounting Base: Polyethylene.

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## 2.4 ACCESSORIES

- A. Control equipment is specified in Division 23 Sections "Direct Digital Control Systems for HVAC" and the sequence of operations for HVAC controls will be as indicated on the drawings.
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

## 2.5 CAPACITIES AND CHARACTERISTICS

- A. Performance Characteristics: See equipment schedule on drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

### 3.2 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure. HVAC Equipment support is specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment"
- C. Install ground-mounted, compressor-condenser components on 6-inch-thick, reinforced concrete base that is 6 inches larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- E. Provide insulated condensate drain with deep trap and piping sized per manufacturer's recommendations. Where condensate pump is provided, furnish unit complete with high level alarm. Extend drain line to nearest floor drain or as indicated on the plans.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

**3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

**3.5 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

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## SECTION 260010 - BASIC ELECTRICAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

- C. General Provisions: Provide all labor, materials, equipment, and incidentals required to make ready for use complete electrical systems as specified herein and shown on the drawings.
- D. Provide and Install: The word "provide" where used on the Drawings or in the Specifications shall mean "furnish, install, mount, connect, test, complete, and make ready for operation". The word "install" where used on the Drawings or in the Specifications shall mean "mount, connect, test, complete, and make ready for operation". Perform work required by, and in accordance with, the Contract Documents.
- E. Installation: Provide and place in satisfactory condition, ready for proper operation, raceways, wires, cables, and other material needed for all complete electrical systems required by the Contract Documents. Additional raceways and wiring shall be provided to complete the installation of the specific equipment provided. Include auxiliaries and accessories for complete and properly operating systems. Provide electrical systems and accessories to comply with the NEC, state and local codes and ordinances. It is the intent of these Specifications that the electrical systems be suitable in every way for the use intended. Material and work which is incidental to the work of this Contract shall be provided at no additional cost to the Contract.
- F. Field Connections: Provide field connections to remote equipment and control panels provided under other Divisions of these Specifications. Provide raceway, wire, and interconnections between equipment, transmitters, local indicators, and receivers. Provide 120V and low voltage surge protection equipment in accordance with Section 264313 at equipment as required. Install field connections to "packaged" equipment provided under other Divisions of these Specifications.

#### 1.2 SCOPE OF WORK

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- A. General: Provide labor, materials, permits, inspections and re-inspection fees, tools, equipment, transportation, insurance, temporary protection, temporary power and lighting, supervision and incidental items essential for proper installation and operation of the Electrical systems indicated in the Contract Documents. Provide materials not specifically mentioned or indicated but which are usually provided or are essential for proper installation and operation of the Electrical systems indicated in the contract documents.
- B. Notices: Give notices, file Plans, pay fees, and obtain permits and approvals from authorities having jurisdiction. Include all fees in the Bid Price.

#### 1.3 INTERPRETATION OF DRAWINGS

- A. General: The Drawings are diagrammatic and are not intended to show exact locations of Raceway runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment, appliances, fixtures, Raceways, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be determined and coordinated in the field. The right is reserved to change, without additional cost, the location of any outlet within the same room or general area before it is permanently installed. Obtain all information relevant to the placing of electrical work and in case of interference with other work, proceed as directed by the Architect.
- B. Discrepancies: Notify the Architect of any discrepancies found during construction of the project. The Architect will provide written instructions as to how to proceed with that portion of work. If a conflict exists between the Contract Documents and an applicable code or standard, the most stringent requirement shall apply.
- C. Wiring: Each three-phase circuit shall be run in a separate Raceway unless otherwise shown on the Drawings. Unless otherwise accepted by the Architect, Raceway shall not be installed exposed. Where circuits are shown as "home-runs" all necessary fittings, supports, and boxes shall be provided for a complete raceway installation.
- D. Layout: Circuit layouts are not intended to show the number of fittings, or other installation details. Connections to equipment shall be made as required, and in accordance with the accepted shop and manufacturer's setting drawings.
- E. Coordination: Coordinate final equipment locations with drawings or other disciplines. Layout before installation so that all trades may install equipment in available space. Provide coordination as required for installation in a neat and workmanlike manner.

#### 1.4 EQUIPMENT SIZE AND HANDLING

- A. Coordination: Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, ship the equipment in sections of specific sizes to permit the passing through the necessary areas within the structure.
- B. Handling: Equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

#### 1.5 RECORD DRAWINGS

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- A. Production: The Contractor shall provide two (2) sets of black or blue line on white drawings to maintain and submit record "As-Built Documents". Label each sheet of the Record Document set with "Project Record Documents" with company name of the installing contractor in stamped or printed letters. One set shall be maintained at the site and at all times be accurate, clear, and complete. These drawings shall be available at all times to the Architect's field representatives.
- B. Recording: Record information concurrent with construction progress. Make entries within 24 hours upon receipt of information. The "As-Built" drawings shall accurately reflect installed electrical work specified or shown on the Contract Documents.
- C. Completion: At the completion of the Work, transfer changes with a colored pencil onto the second set and submit to the Architect. The "As-Built" drawings shall be made available to the Architect to make the substantial completion punch list.
- D. Final: Upon Contractor's completion of the Engineer's final punch list, transfer all "As-Built" conditions and all requirements by the Engineer to a reproducible set of drawings and CAD files. Submit drawings and CAD disks for review and acceptance. The Contractor shall provide updated disks which include final As-Built conditions.

#### 1.6 ABBREVIATIONS

- A. Abbreviations: The following abbreviations or initials may be used:

A/C	Air Conditioning
AC	Alternating Current
ABV CLG	Above Ceiling
ADA	Americans with Disabilities Act
AF	Ampere Frame
AFF	Above Finished Floor
AFG	Above Finished Grade
AHU	Air Handler Unit
AIC	Amps Interrupting Capacity
AL	Aluminum
AMP	Ampere
ANSI	American National Standards Institute
ASA	American Standards Association
AT	Ampere Trip
AUX	Auxiliary
AWG	American Wire Gauge
BC	Bare Copper
BIL	Basic Impulse Level
BMS	Building Management System
BRKR or BKR	Breaker
CAB	Cabinet
C	Conduit or Raceway
CB	Circuit Breaker
CBM	Certified Ballast Manufacturers
CCTV	Closed Circuit Television
CKT	Circuit
CLG	Ceiling
CO	Conduit or Raceway Only

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COAX	Coaxial Cable
COND	Conductor
CONN	Connection
CPU	Central Processing Unit
CRT	Cathode Ray Terminal (Video display terminal)
CT	Current Transformer
CU	Copper
CW	Cold Water
DC	Direct Current
DDC	Direct Digital Control
DEG	Degree
DISC	Disconnect
DO	Draw Out
DN	Down
DPST	Double Pole Single Throw
EMT	Electrical Metallic Tubing
EO	Electrically Operated
EOL	End of Line Resistor
EWC	Electric Water Cooler
FAAP	Fire Alarm Annunciator Panel
FACP	Fire Alarm Control Panel
FCU	Fan Coil Unit
FLA	Full Load Amperes
FM	Factory Mutual
GF	Ground Fault
GFCI	Ground Fault Circuits Interrupter
GND	Ground
HOA	Hand-Off-Automatic
HORIZ	Horizontal
HP	Horsepower
IC	Intercom
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IMC	Intermediate Metallic Raceway
IN	Inches
IT	Instantaneous Trip
IPCEA	Insulated Power Cable Engineers Association
JB	Junction Box
KCMIL	Thousand Circular Mills
KV	Kilovolt
KVA	Kilo-Volt-Amps
KW	Kilowatts
LBS	Pounds
LED	Light Emitting Diode
LT	Light
LTD	Long Time Delay
LTT	Long Time Trip
LTG	Lighting
MAX	Maximum
MCB	Main Circuit Breaker
MCP	Motor Circuit Protector

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MIC	Microphone
MIN	Minimum
MLO	Main Lugs Only
MTD	Mounted
MTG	Mounting
MUX	Multiplex (Transponder) Panel
MVA	Mega Volt Amps
N	Neutral
NC	Normally Closed
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIC	Not in Contract
NF	Non Fused
NL	Non Linear
NO	Number or Normally Open
#	Number
0/	Phase
OL	Overload
OSHA	Occupational Safety and Health Administration
P	Pole
PB	Pullbox
PIV	Post Indicator Valve
PNL	Panel
PR	Pair
PWR	Power
PF	Power Factor
PRI	Primary
PT	Potential Transformer
PVC	Polyvinylchloride
REF	Refrigerator
RGC or GRC	Rigid Galvanized Raceway
RMS	Root-Mean-Square
RPM	Revolutions Per Minute
RECPT	Receptacle
SCA	Short Circuit Amps
SD	Smoke Detector
SEC	Secondary
S/N	Solid Neutral
SPKR	Speaker
SPST	Single Pole Single Throw
SST	Solid State Trip
ST	Short Time Trip
STD	Short Time Delay
SW	Switch
SWGR	Switchgear
SWBD	Switchboard
TEL	Telephone
TTB	Telephone Terminal Board
TTC	Telephone Terminal Cabinet



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TVEC	Television Equipment Cabinet
TYP	Typical
UL	Underwriters Laboratories
UON	Unless Otherwise Noted
V	Volt
VFD	Variable Frequency Drive
VSD	Variable Speed Drive
W	Wire
WP	Weatherproof
XFMR	Transformer

#### 1.7 CODES, FEES, AND STANDARDS

- A. Application: The codes, standards and practices listed herein generally apply to the entire project and specification sections. Other codes, standards or practices that are more specific will be referenced within a particular specification.
- B. Requirements: All materials and types of construction covered in the specifications will be required to meet or exceed applicable standards of manufacturer, testing, performance, and installation according to the requirements of UL, ANSI, NEMA, IEEE, and NEC referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents that exceed but are not contrary to governing codes shall be followed
- C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed electrical installation shall be inspected and certified by applicable agencies that it is in compliance with codes.
- D. Applicability: The codes and standards and practices listed herein are furnished as the minimum latest requirements.
  - 1. State of Florida.
  - 2. Lee County.
- E. Utility Company: Comply with latest utility company regulations.
- F. Building Code: Florida Building Code 2020.
- G. Labels: Materials and equipment shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available or desired for certain types of equipment, test data shall be submitted to validate that equipment meets or exceeds available standards.
- H. NFPA: National Fire Protection Association (NFPA) Standards NFPA-1 Uniform Fire Code™
  - NFPA-13 Standard for the Installation of Sprinkler Systems
  - NFPA-70 National Electrical Code
  - NFPA-72 National Fire Alarm Code
  - NFPA-75 Standard for the Protection of Information Technology Equipment

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NFPA-90A	Standard for the Installation of Air Conditioning And Ventilating Systems
NFPA-101A	Guide on Alternative Approaches to Life Safety
NFPA-101B	Standard on Means of Egress for Buildings and Structures
NFPA-780	Installation of Lightning Protection Systems

#### 1.8 SUPERVISION OF THE WORK

- A. Supervision: Provide one field superintendent who has had a minimum of four (4) years previous successful experience on projects of comparable sizes, type and complexity. The Superintendent shall be present at all times when work is being performed. At least one member of the Electrical Contracting Firm shall hold a State Master Certificate of Competency.

#### 1.9 COORDINATION

- A. General: Compare drawings and specifications with those of other trades and report any discrepancies between them to the Architect. Obtain from the Architect written instructions to make the necessary changes in any of the affected work. Work shall be installed in cooperation with other Trades installing interrelated work. Before installation, Trades shall make proper provisions to avoid interferences in a manner approved by the Architect.
- B. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for:
  - 1. Door hardware
  - 2. Signage
  - 3. Sliding or automatic doors
  - 4. Roll-up doors/grilles
  - 5. Mechanical Division of the Specifications
  - 6. Landscape Architect drawings
  - 7. Interior design drawings
  - 8. Millwork design drawings and shop drawings
- C. Obtain set of Contract Documents from Owner's Authorized Representative or Contractor for all areas of work noted above and include all electrical work in bid whether included in Division 26 Contract Documents or not.
- D. Secure approved shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on approved shop drawings differs from that shown or called for in Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed.
- E. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner.
- F. Adjustments: Locations of raceway and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of systems prior to fabrication or installation.

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- G. Priorities: Lines which pitch shall have the right of way over those which do not pitch. For example, plumbing drains shall normally have the right of way. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed.
- H. Modifications: Offsets and changes of direction in raceway systems shall be made to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. Provide elbows, boxes, etc., as required to allow offsets and changes to suit job conditions.
- I. Replacement: Work shall be installed in a way to permit removal (without damage to other parts) of other system components provided under this Contract requiring periodic replacement or maintenance. Raceway shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.
- J. Layout: The Contract Drawings are diagrammatic only intending to show general runs and locations of raceway and equipment, and not necessarily showing required offsets, details and accessories and equipment to be connected. Work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation, which will afford maximum accessibility for operation, maintenance and headroom.
- K. Contract Conflicts: Where discrepancies exist in the Scope of Work as to what Trade provides items such as starters, disconnects, flow switches, etc. such conflicts shall be coordinated between the divisions involved. It is the intent of the Contract Documents that all work shall be provided complete as one bid price.
- L. Drawing Conflicts: Where drawing details, plans or specification requirements are in conflict and where sizes of the same item run are shown to be different within the contract documents, the most stringent requirement shall be included in the Contract. Systems and equipment called for in the specification or as shown on the drawings shall be provided as if it was required by both the drawings and specifications. Prior to ordering or installation of any portion of work, which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.
- M. It is the responsibility of this Contractor to coordinate the exact required location of floor outlets, floor ducts, floor stub-ups, etc. with Owner's Authorized Representative and Designer (and receive their approval) prior to rough-in. Locations indicated in Contract Documents are only approximate locations.
- N. The Contract Documents describe specific sizes of switches, breakers, fuses, Raceways, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Coordinate the requirements of each load with each load's respective circuitry shown and with each load's requirements as noted on its nameplate data and manufacturer's published electrical criteria. Adjust circuit breaker, fuse, Raceway, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes shall be made at no additional cost to the Owner.
- O. Working Clearances: Minimum working clearances about electrical equipment shall be as referenced in the applicable edition NEC Article 110, and shall include equipment installed in ceiling spaces.

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#### 1.10 COORDINATION STUDY

- A. Specified Manufacturers: Coordination and short circuit study shall be submitted for all switchgear, panelboard and circuit breakers prior to approval of shop drawings. Any discrepancies or conflicts in specified equipment shall be corrected prior to final approval. Refer to spec section 260020 for study requirements.

#### PART 2 - PRODUCTS

##### 2.1 MATERIALS

- A. Specified Method: Where several brand names, make or manufacturers are listed as acceptable each shall be regarded as equally acceptable, based on the design selection but each must meet all specification requirements. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance. Where manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance. No substitutions are permitted.
- B. Certification: When a product is specified to be in accordance with a trade association or government standard requested by the Engineer, Contractor shall provide a certificate that the product complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.
- C. Basis of Bid: Each bidder represents that his bid is based upon the manufacturers, materials, and equipment described in the Contract Documents.
- D. Space Requirements: Equipment or optional equipment shall conform to established space requirements within the project. Equipment which does not meet space requirements, shall be replaced at no additional expense to the Contract. Modifications of related systems shall be made at no additional expense to the Contract. Submit modifications to the Architect/Engineer for acceptance.

##### 2.2 SHOP DRAWINGS

- A. General: Shop drawings shall be submitted for every item listed within the Submittals section each individual specification section. One copy shall be submitted to the engineer prior to ordering equipment. Refer to Basis of approval paragraph.
- B. Responsibility: It is the Contractors responsibility to provide material in accordance with the plans and specifications. Material not provided in accordance with the plans and specifications shall be removed and replaced at the Contractors expense.
- C. Official Record: The shop drawing submittal shall become the official record of the materials to be installed. If materials are installed which do not correspond to the record submittal they shall be removed from the project without any additional cost or delays in construction completion.
- D. Information: The shop drawing record submittal shall include the following information to the extent applicable to the particular item;
  - 1. Manufacturer's name and product designation or catalog number.

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2. Standards or specifications of ANSI, ASTM, ICEA, IEEE, ISA, NEMA, NFPA, OSHA, UL, or other organizations, including the type, size, or other designation.
  3. Dimensioned plan, sections, and elevations showing means for mounting, raceway connections, and grounding, and showing layout of components.
  4. Materials and finish specifications, including paints.
  5. List of components including manufacturer's names and catalog numbers.
  6. Internal wiring diagram indicating connections to components and the terminals for external connections.
  7. Manufacturer's instructions and recommendations for installation, operation, and maintenance.
  8. Manufacturer's recommended list of spare parts.
  9. Provide 1/2" = 1'-0" enlarged electrical room layout drawings for all electrical rooms. All equipment shall be indicated at actual size of equipment being provided. All dimensions and required working clearances shall be shown.
- E. Coordination Study: Submit for review prior to final approval of switchgear and panelboard shop drawings.
- F. Preparation: Prior to submittal, shop drawings shall be checked for accuracy and contract requirements. Shop drawings shall bear the date checked and shall be accompanied by a statement that the shop drawings have been examined for conformity to Specifications and Drawings. This statement shall also list discrepancies with the Specifications and Drawings. Shop drawings not so checked and noted shall be returned to Contractor unreviewed.
- G. Basis of Review: Approval is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Contractor is responsible for quantities, dimensions, fabrication processes, and construction techniques.
- H. Responsibility: The responsibility that dimensions are confirmed and correlated with proper coordination of other trades shall be included as part of the Contract Documents. The responsibility and the necessity of providing materials and workmanship required by the Specifications and Drawings which may not be indicated on the shop drawings shall be included as part of the Contract Documents. The Contractor is responsible for any delays in job progress occurring directly or indirectly from late submissions or re-submissions of shop drawings, product data, or samples.
- I. Ordering Equipment: No material shall be ordered or shop work started until the Engineer has officially received the shop drawings record submittal and has formally released the Contractor for submittal requirements.
- J. Brochure Requirements: Submit Technical Information Brochures at the start of construction or no later than 30 days after Award of the Contract. Each brochure shall consist of an adequately sized, hardcover, 3-ring binder for 8-1/2" X 11" sheets. Provide correct designation on outside cover and on end of brochure. When one binder is not enough to adequately catalog all data, an additional binder shall be submitted.
- K. Brochure Contents: First sheet in the brochure shall be a photocopy of the Electrical Index pages in these specifications. Second sheet shall be a list of Project Addresses for this project. Third sheet shall list Project Information. Provide reinforced separation sheets tabbed with the appropriate specification reference number and typed index for each section in the Electrical Schedule. Technical Information consisting of marked catalog sheets or shop drawings shall be inserted in the brochure in proper order on all items specified and shown on drawings. At the end of the brochure, provide and insert a copy of the specifications for this Division and all addenda applicable to this Division.

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- L. Contractor's Review: Review the brochures before submitting to the Engineer. No request for payment shall be considered until the brochure has been reviewed, stamped and submitted for review.
- M. Title Drawings: Title drawings to include identification of project and names of Architect-Engineer, Engineer, Contractors, and/or supplier, data, number sequentially and indicate in general;
  - 1. Fabrication and Erection dimensions.
  - 2. Arrangements and sectional views.
  - 3. Necessary details, including complete information for making connections with other work.
  - 4. Kinds of materials and finishes.
  - 5. Descriptive names of equipment.
  - 6. Modifications and options to standard equipment required by the contract.
  - 7. Leave blank area, size approximately 4 by 2-1/2 inches, near title block (for Engineer's stamp imprint).
  - 8. In order to facilitate review of shop drawings, they shall be noted, indicating by cross-reference the contract drawings, notes, and specification paragraph numbers where items occur in the contract documents.
  - 9. See specific sections of specifications for further requirements.
- N. Technical Data: Submit technical data verifying that the item submitted complies with the requirements of the specifications. Technical data shall include manufacturer's name and model number, dimensions, weights, electrical characteristics, and clearances required. Indicate optional equipment and changes from the standard item as called for in the specifications. Provide drawings, or diagrams, dimensioned and in correct scale, covering equipment, showing arrangement of components and overall coordination.
- O. Same Manufacturer: In general, relays, contactors, starters, motor control centers, switchboards, panelboards, dry type transformers, disconnect switches, circuit breakers, manual motor starter switches, etc., shall be supplied and manufactured by the same manufacturer. This requirement shall apply to same type of electrical components specified in other Divisions.

#### 2.3 EQUIPMENT, MATERIALS, AND SUPPORTS

- A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacturer of the type and size of equipment, shall be suitable for the environment in which it is to be installed, shall be approved for its purpose, environment, and application, and shall bear the UL label.
- B. Installation Requirements: Each item of equipment or material shall be installed in accordance with instructions and recommendations of the manufacturer, however, the methods shall not be less stringent than specified herein.
- C. Required Accessories: Provide all devices and materials, such as expansion bolts, foundation bolts, screws, channels, angles, and other attaching means, required to fasten enclosures, raceways, and other electrical equipment and materials to be mounted on structures which are existing or new.
- D. Protection: Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by the elements. Equipment shall be stored in dry permanent shelters. If apparatus has been damaged, such damage shall be repaired at no additional cost or time extension to the Contract. If apparatus has been subject to possible injury, it shall be thoroughly cleaned, dried

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out and put through tests as directed by the Manufacturer and Engineer, or shall be replaced, if directed by the Engineer, at no additional cost to the Contract.

#### 2.4 IDENTIFICATION OF EQUIPMENT

- A. General: Electrical items shall be identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system, which it serves or controls. Refer to Identification Section of the specifications for additional information.

#### 2.5 CONCRETE PADS

- A. General: Provide reinforced concrete pads for floor mounted electrical equipment. Unless otherwise noted, pads shall be nominal four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by six (6) inches on all sides, except when equipment is flush against a wall, then the side or sides against the wall shall be flush with the equipment. Chamfer top edges 1/2". Trowel surfaces smooth. Reinforce pads with #5 reinforcing bars at 24" centers each way, unless specifically detailed on drawings.

#### 2.6 SURFACE MOUNTED EQUIPMENT

- A. General: Surface mounted fixtures, outlets, cabinets, panels, etc. shall have a factory-applied finish or shall be painted as accepted by Engineer. Raceways and fittings, where allowed to be installed surface mounted, shall be painted to match the finish on which it was installed. Paint shall be in accordance with other applicable sections of these specifications.

#### 2.7 CUTTING AND PATCHING

- A. Core Drilling: The Contractor shall be responsible for core drilling as required for work under this section, but in no case shall the Contractor cut into or weld onto any structural element of the project without the written approval of the Architect.
- B. Cutting and Patching: Cutting, rough patching and finish patching shall be provided as specified in the contract documents. Cutting and patching shall be performed in a neat and workmanlike manner. Upon completion, the patched area shall match adjacent surfaces.
- C. Openings and Sleeves: Locate openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.
- D. Roof Penetration: Provide roofer with pitch pans, fittings, etc., required for electrical items which penetrate the roof. Roof penetrations are to be waterproofed in such a manner that roofing guarantees are fully in force. Roof penetrations shall be coordinated with other Trades to ensure that roof warranty is not invalidated.

#### 2.8 SLEEVES AND FORMS FOR OPENINGS

- A. Sleeves: Provide sleeves for Raceways penetrating floors, walls, partitions, etc. Locate necessary slots for electrical work and form before concrete is poured. Watertight sleeves shall be line seal type WS. Fire rated partition sleeves shall be mild steel. Sleeves shall be Schedule 40 PVC or galvanized rigid steel unless specifically noted otherwise. Size shall be one standard diameter larger than pipe being installed or of a larger diameter to below 1/4" minimum clearance.

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- B. Forms: Provide boxed out forms for Raceway penetrations only where allowed by the Architect. Fill opening after Raceway installation, with equivalent material.

**2.9 OPERATING AND MAINTENANCE INSTRUCTIONS**

- A. General: Thoroughly instruct the Owner's Representative, to the complete satisfaction of the Architect and Engineer, in the proper operation of all systems and equipment provided. The Contractor shall make all arrangements, via the Architect, as to whom the instructions are to be given in the operation of the systems and the period of time in which they are to be given. The Architect shall be completely satisfied that the Owner's Representative has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by the Contractor to the Owner's Representative, then the Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the Specification has been complied with.
- B. Submittals: Submit to the Architect for approval five (5) typed sets, bound neatly in loose-leaf binders, of instructions for the installation, operation, care and maintenance of equipment and systems, including instructions for the ordering and stocking of spare parts for equipment installed under this contract. The lists shall include part number and suggested suppliers. Each set shall also include an itemized list of component parts that should be kept on hand and where such parts can be purchased.
- C. Information Requirements: Information shall indicate possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section shall be clearly divided from the other sections. A sub index for each section shall also be provided.
- D. Instructions: The instructions shall contain information deemed necessary by the Architect and include but not limited to the following:
1. Introduction:
    - a. Explanation of Manual and its use.
    - b. Summary description of the Electrical Systems.
    - c. Purpose of systems.
  2. System:
    - a. Detailed description of all systems.
    - b. Illustrations, schematics, block diagrams, catalog cuts and other exhibits.
  3. Operations:
    - a. Complete detailed, step by step, sequential description of all phases of operation for all portions of the systems, including start up, shutdown and balancing. Include posted instruction charts.
  4. Maintenance:
    - a. Parts list and part numbers.



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- b. Maintenance and replacement charts and the Manufacturer's recommendations for preventive maintenance.
- c. Trouble shooting charts for systems and components.
- d. Instructions for testing each type of part.
- e. Recommended list of on-hand spare parts.
- f. Complete calibration instructions for all parts and entire systems.
- g. General and miscellaneous maintenance notes.

#### 5. Manufacturer's Literature:

- a. Complete listing for all parts.
- b. Names, addresses and telephone numbers.
- c. Care and operation.
- d. All pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.
- e. Internal wiring diagrams and Engineering data sheets for all items and/or equipment furnished under each Contract.
- f. Guarantee and warranty data.

#### 2.10 SERVICE AND METERING

- A. Company: The utility company serving this project is FPL which will be referred to as the Utility Company herein.
- B. Service: Utility service is existing, 120/240V, 3-phase, high-leg.
- C. Codes: Install a complete system in accordance with the latest edition of the National Electrical Code and the latest regulations of governing local, State, County and other applicable codes, including the Utility Company requirements.

#### 2.11 TEMPORARY LIGHT AND POWER

- A. Capacity: Provide capacity from new temporary service. Make arrangements with the Owner for temporary service and pay all related expenses. Temporary light and power shall be provided constantly during the project dependent upon Owner's safety requirements.
- B. Lighting: Temporary light shall be based on one 200 watt lamp covering each 1,000 square foot of floor area in the building. Each room 100 square foot and over shall have a minimum of one 100-watt lamp with guards. Provide power for motors up to 3/4 horsepower only. Provisions are to be made for electric welders, if required.
- C. Outlets: Provide outlets located at convenient points so that extension cords of not over fifty (50) feet will reach work requiring artificial light or power.
- D. Other Connections: Contractors of other trades shall furnish their own cords and sockets, as may be required for their work and shall also pay for cost of temporary wiring of construction offices and shanties used by them.
- E. New Fixtures: Permanently installed lighting fixtures may be used for temporary lighting at the Contractor's option with the provision that cool white lamps for fluorescent, clear lamps for

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incandescent and marked temporary for other types shall be installed. At job completion, lamps shall be replaced with permanent lamps specified.

- F. Wiring: Temporary electrical work shall be furnished and installed in conformity with the National Electrical Code and in accordance with the requirements of the local ordinances and shall be maintained in a workmanlike manner throughout their entire construction period and shall be removed after installation of the permanent electrical systems. Extension cords shall be GFCI protected or shall be fed from GFCI circuit breakers.
- H. Payment: The Contractor will pay for the cost of energy consumed by all trades. Any temporary wiring of a special nature for light and power required other than mentioned above shall be paid for by the Contractor using same.

### PART 3 - EXECUTION

#### 3.1 WORKMANSHIP

- A. General: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.
- B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function, conforming to applicable standards of building system construction, and exhibiting a high degree of quality and proficiency which is judged by the Architect as equivalent or better than that ordinarily produced by qualified industry tradesmen.
- C. Performance: Personnel shall not be used in the performance of the installation of material and equipment who, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship and not acceptable to the Architect, shall be removed and reinstalled by qualified craftsmen, at no change in the contract price.

#### 3.2 PROTECTION AND CLEAN UP

- A. Protection and Restoration: Suitably protect equipment provided under this Division during construction. Restore damaged surfaces and items to "like new" condition before a request for substantial completion inspection.
- B. Handling: Materials shall be properly protected and Raceway openings shall be temporarily closed by the Contractor to prevent obstruction and damage. Post notice prohibiting the use of systems provided under this Contract, prior to completion of work and acceptance of systems by the Owner's representative. The Contractor shall take precautions to protect his materials from damage and theft.
- C. Safeguards: The Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or systems provided under this contract.
- D. Cleanup: Keep the job site free from debris and rubbish. Remove debris and rubbish from the site and leave premises in clean condition on a daily basis.

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**3.3 SYSTEMS GUARANTEE**

- A. General: Provide a one-year guarantee. This guarantee shall be by the Contractor to the Owner for any defective workmanship or material, which has been provided under this Contract at no cost to the Owner for a period of one year from the date of substantial completion of the System. The guarantee shall include lamps, for ninety days after date of Substantial Completion of the System. Explain the provisions of guarantee to the Owner at the "Demonstration of Completed System".

**3.4 FINAL OBSERVATION**

- A. General: Work shall be completed, and forms and other information shall be submitted for acceptance one week prior to the request for final observation of the installation.

**3.5 SPECIAL CONSIDERATIONS**

- A. Comply with special requirements imposed at site by Owner. This may include badging of employees, prohibition of smoking, special working hours, or special working conditions.

END OF SECTION 260010

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## SECTION 260020 - ACCEPTANCE TESTS AND PERFORMANCE VERIFICATION

### PART 1 - GENERAL

#### 1.1 GENERAL SCOPE

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

- C. The contractor shall engage the services of a recognized independent electrical testing firm to perform short circuit, arc flash and coordination studies as herein specified.
- D. The Contractor shall engage the services of a recognized corporately and financially independent testing firm for the purpose of performing inspections and tests on all new electrical equipment supplied in this contract.
- E. The testing firm shall provide all material, equipment, labor and technical supervision to perform such tests and inspections.
- F. It is the purpose of these tests to assure that all tested electrical equipment, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- G. The tests and inspections shall determine suitability for energization.
- H. An itemized description of equipment to be inspected and tested is as follows:
  - 1. All switchgear/switchboard assemblies.
  - 2. All grounding /ground-fault systems.
  - 3. All motor controls.
  - 4. Uninterruptible power supply and power distribution units.
  - 5. All protective relays.
  - 6. All feeder cables #4 AWG and larger as indicated.
  - 7. All circuit breakers 100 ampere and above as indicated.
  - 8. All dry type transformers 30 KVA and above as indicated.
  - 9. Surge protection devices.

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10. The testing report shall be submitted on 8.5" X 11" paper bound with all field test data in appendix form. The report shall be signed and sealed by a registered professional engineer licensed in the State of Florida.

## 1.2 APPLICABLE CODES, STANDARDS, AND REFERENCES

- A. All inspections and test shall be in accordance with the following codes and standards except as provided otherwise herein:
  1. American Society for Testing and Materials - ASTM
  2. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS
  3. American National Standards Institute - ANSI C2: National Electrical Safety Code.
  4. Insulated Cable Engineers Association - ICEA
  5. Association of Edison Illuminating Companies - AEIC
  6. Occupational Safety and Health Administration - OSHA
  7. National Fire Protection Association - NFPA
    - a. ANSI/NFPA 70B: Electrical Equipment Maintenance
    - b. NFPA 70E: Electrical Safety Requirements for Employee Workplaces

## 1.3 QUALIFICATIONS OF TESTING FIRM

- A. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, supplier, and installers of equipment or systems evaluated by the testing firm.
- B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- C. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the InterNational Electrical Testing Association.
- D. The lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.
- E. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing services.
- F. The testing firm shall submit proof of the above qualifications.
- G. The terms used herein, such as test agency, test contractor, testing laboratory, or contractor test company, shall be construed to mean the testing firm.

## 1.4 DIVISION OF RESPONSIBILITY

- A. The electrical sub-contractor shall perform routine insulation-resistance, continuity, and rotation test for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.
- B. Safety and Precautions

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1. All test shall be performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.

## 1.5 GENERAL

### A. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.
2. Digital multimeters used shall be RMS sensing when the variable being measured contains harmonics or dc offset or any deviation from a pure sine wave.
3. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of 2 percent of the scale used.

### B. Test Instrument Calibration

1. The testing firm shall have a calibrating program which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
3. Field Instruments shall be calibrated at 6 month intervals.
4. Dated calibration labels shall be visible on all test equipment.

### C. Test Report

1. The test report shall include the following:
  - a. Summary of project
  - b. Listing of equipment tested
  - c. Test results
  - d. Arc flash warning labels
2. Furnish copies of the complete report to the engineer as directed.

## 1.6 SHORT-CIRCUIT ANALYSIS, ARC FLASH STUDY AND COORDINATION STUDY

### A. Scope of Services

1. Provide a current and complete short-circuit study, equipment interrupting or withstand evaluation, evaluation to determine potential electric arc flash hazard, and a protective device coordination study for the electrical distribution system.
2. The studies shall include all portions of the electrical distribution system from the normal and emergency sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.

### B. Submittals

1. The studies shall be submitted to the project electrical engineer prior to granting final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture.

### C. Short Circuit Study

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1. The study shall be in accordance with applicable ANSI and IEEE Standards.
2. The study input shall include the utility company's short circuit single and three phase contribution, with the X/R ratio, the resistance and reactance components of each branch impedance, motor contributions, base quantities selected, and all other applicable circuit parameters.
3. Short circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at each switchgear bus, switchboard, motor controls, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.

## D. Equipment Evaluation Study

1. An equipment evaluation study shall be performed to determine the adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the available fault currents. Any problem areas or inadequacies in the equipment shall be documented in the report. The testing company shall coordinate with the supplier of the new switchgear to assure all specifications of the new equipment meet or exceed the ratings required by the study at no additional cost to the owner.

## E. Arc Flash Protection Study

1. An arc flash protection study shall be performed to select and provide markings to warn qualified person of potential electric arc flash hazards, per NEC 110.16
2. The study shall include all electrical equipment, including but not limited to switchgear, switchboards, distribution panels, branch circuit panelboards, enclosed disconnects, motor controllers.
3. The study results shall be utilized to create warning labels for all equipment.

## F. Protective Device Coordination Study

1. A protective device coordination study shall be performed to select or to check the selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and settings.
2. The coordination study shall include all voltage classes of equipment from the utility's incoming line protective device down to and including each motor controller and/or panelboard. The phase and ground overcurrent protection shall be included, as well as settings for all other adjustable protective devices.
3. The time current characteristics of the specified protective devices shall be plotted on appropriate log-log paper. The plots shall include complete titles, representative one-line diagram and legends, associated power company's relays or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves, and fuse curves. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, ANSI transformer magnetizing inrush and withstand curves per ANSI C37.91, cable damage curves, symmetrical and asymmetrical fault currents. All requirements of the current National Electric Code shall be adhered to. Reasonable coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a complete

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system basis. Sufficient curves shall be used to clearly indicate the coordination achieved to each utility main breaker, primary feeder breaker, unit substation primary protective device rated or more. There shall be a maximum of eight protective devices per plot.

4. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. A tabulation of the recommended power fuse selection shall be provided for all fuses in the system. Discrepancies, problem areas, or inadequacies shall be coordinated with the equipment suppliers and resolved within the scope of the project and at no additional cost to the owner.

## G. Study Report

1. The results of the power system study shall be summarized in a final report and made part of the operation and maintenance manuals.
2. The report shall include the following sections;
  - a. Description, purpose, basis, written scope, and a single line diagram of the portion of the power system which is included within the scope of study.
  - b. Tabulations of circuit breaker, fuse and other equipment ratings versus calculated short circuit duties, and commentary regarding same.
  - c. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection and commentary regarding same.
  - d. Fault current tabulations including a definition of terms and a guide for interpretation.
  - e. Arc flash Warning Labels: Warning labels for all electrical equipment, indicating the arc flash boundary and protective clothing requirements.
  - f. Arc flash Evaluation Bus Report, indicating the protective device names, fault kA, trip times, arc flash boundaries, working distances and incident energies.

## H. Implementation

1. The contractors certified testing firm shall be responsible for the inspection, setting, testing, and calibrating the protective relays, circuit breakers, fuses and other applicable devices as recommended in the power systems study report.

## 1.7 INSPECTION AND TEST PROCEDURES

### A. Panelboard Assemblies

1. Visual and Mechanical Inspection
  - a. Inspect all bus connections for high resistance. Use low resistance ohmmeter, or check tightness of bolted bus joints by using a calibrated torque wrench. Refer to manufacturer's instructions for proper torque levels.
  - b. Test all electrical and mechanical interlock systems for proper operation and sequencing. Closure attempt shall be made on locked open devices. Opening attempt shall be made on locked closed devices. Key exchange shall be made with devices operated in off normal positions.
  - c. Inspect insulators for evidence of physical damage or contaminated surfaces.
  - d. Lubrication: Verify appropriate contact lubricant on moving current carrying parts. Verify appropriate lubrication on moving and sliding surfaces.



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- e. Exercise all active components.
  - f. Inspect all mechanical indicating devices for proper operation.
2. Electrical Tests
- a. Perform tests on all instrument transformers.
  - b. Perform ground resistance tests.
  - c. Perform insulation resistance on each bus section, phase-to-phase and phase-to-ground for one (1) minute. Test voltages and minimum resistances shall be in accordance with NETA recommendations.
  - d. Perform insulation-resistance test on control wiring except where connected to solid state components.
  - e. Perform control wiring performance test. Use the elementary diagrams of the switchgear to identify each remote control and protective device. Conduct tests to verify satisfactory performance of each control feature.
3. Test Values: Verify Bolt-torque values, Insulation resistance, overpotential levels in conformance to NETA standards or specified by manufacturer.
- B. Transformers
1. Transformers - Small Dry Type, Air-Cooled, 30 KVA and above. (600 Volt and Below)
- a. Perform insulation-resistance test. Calculate dielectric absorption ratio and polarization index. Make measurements from winding-to-winding and windings-to-ground. Test voltages and minimum resistance shall be to NETA Standards.
  - b. Verify Taps.
  - c. Energize primary winding with system voltage. Measure secondary voltage with the secondary load disconnected. Record results.
- C. Feeder Cables - Low Voltage - 600V Maximum - Test all cables of #4 wire and above.
1. Visual and Mechanical Inspection
- a. Test cable mechanical connections to manufacturer's recommended values or NETA Standards using a calibrated torque wrench.
  - b. Check cable color coding with applicable engineer's specifications and National Electrical Code standards.
2. Electrical Tests
- a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
  - b. Perform continuity test to insure proper cable connection.
  - c. Test Values; Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.
- D. Grounding systems
1. Electrical Tests (Small Systems): Perform ground-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System."

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Instrumentation utilized shall be as Approved by NETA Standards and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten.

2. Electrical Tests (Large Systems): When sufficient spacing of electrodes per above is impractical, perform ground-impedance measurements utilizing either the intersecting curves method or the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81.)
3. Equipment Grounds: Utilize two-point method of IEEE Std. 81. Measure between equipment ground being tested and known low-impedance grounding electrode of system.
4. Test Values: The main ground electrode system impedance-to-ground should be no greater than five (5) ohms. Equipment grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.

## E. Ground-Fault Systems (NEC 230-95)

### 1. Visual and Mechanical Inspection

- a. Inspect neutral main bonding connection to assure:
  - (1) Zero-sequence sensing system is grounded.
  - (2) Ground-strap sensing systems are grounded through sensing device.
  - (3) Ground connection is made ahead of neutral disconnect link on zero-sequence sensing systems.
  - (4) Grounded conductor (neutral) is solidly grounded.
- b. Inspect control power transformer to ensure adequate capacity for system.
- c. Manually operate monitor panels (if present) for: Trip test; No trip test; Nonautomatic reset.
- d. Record proper operation and test sequence.
- e. Set pick-up and time-delay settings in accordance with the settings provided by the manufacturer.

### 2. Electrical Tests

- a. Measure system neutral insulation resistance to ensure no shunt ground paths exist. Remove neutral-ground disconnect link. Measure neutral insulation resistance and replace link.
- b. Determine the relay pickup current by current injection at the sensor and operate the circuit interrupting device.
- c. Test the relay timing by injecting three hundred percent (300%) of pickup current, or as specified by manufacturer.
- d. Test the system operation at fifty-seven percent (57%) rated control voltage, if applicable.
- e. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.
- f. On multiple source, tie breaker, etc., systems, devise a simulation scheme that fully proves correct operation.

### 3. Test Parameters

- a. System neutral insulation shall be a minimum of one hundred (100) ohms, preferable one (1) megohm or greater.

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- b. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves but in no case longer than one (1) second for fault currents equal to or greater than 3,000 amperes.
- c. Relay pickup value shall be within "10% of setting and in no case greater than 1200A.

## F. Motor Control

### 1. Visual and Mechanical Inspection

#### a. Motor-running protection

- (1) Compare overload heater rating with motor full-load current rating to verify proper sizing.
- (2) If motor-running protection is provided by fuses, verify proper rating considering motor characteristics and power-factor correction capacitors if applicable.
- (3) Check tightness of bolted connections using calibrated torque wrench.

### 2. Electrical Tests (Only test for motors 40hp and larger)

#### a. Insulation tests:

- (1) Measure insulation resistance of each bus section phase-to-phase and phase-to-ground for one (1) minute. Test voltage shall be in accordance with NETA Standards.
- (2) Measure insulation resistance of each starter section phase-to-phase and phase-to-ground with the starter contacts closed and the protective device open. Test voltage shall be in accordance with NETA Standards.
- (3) Measure insulation resistance of each control circuit with respect to ground.

- b. Test motor overload units by injecting current through overload unit and monitoring trip time at three hundred percent (300%) of motor full-load current.
- c. Three phase power unbalance: Run motor at full load steady state conditions and take current readings on all three leads. Roll the motor leads maintaining the proper rotation and take motor current readings on all three possible hook-ups. Choose the least unbalance hookup for each motor. The maximum acceptable unbalance is 10 percent at full load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If on the three possible hook ups, the leg of "greatest unbalance" (furthest from the average) stays on the same power lead then most of the unbalance is being caused by the power source. However, if the leg of greatest unbalance moves on each of the hookups with a particular motor lead, the primary source of unbalance is on the motor side of the starter. Check for damaged cable, leaking splices, poor connections, or faulty motor winding.
- d. Test circuit breakers and motor circuit protectors, per NETA Guidelines Section 7.6.
- e. Perform operational tests by initiating control devices.

### 3. Variable Frequency Drives (VFD)

- a. Test all VFD's, furnished by Division 15.
- b. Testing shall be per NETA Standards, Section 7.17.

## G. Circuit Breakers (100 amps and above)

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1. Visual/Mechanical Inspections and electrical tests per NETA 7.6.

## H. Protective Relays

1. Visual/Mechanical Inspections and electrical tests per NETA 7.9.

## I. Uninterruptible Power Supply and Manual Bypass.

1. Per NETA Standards.

## J. Surge Protection Devices

1. Refer to specification section 264313.

## 1.8 SYSTEM FUNCTION TESTS

### A. General

1. Perform system function tests upon completion of equipment tests. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.
2. Implementation
  - a. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.
  - b. Test all interlock devices.
  - c. Record the operation of alarms and indicating devices.

## 1.9 ARC FLASH PROTECTION LABELS

### A. General

1. Place flash protection warning labels on all electrical equipment. Labels shall clearly identify arc flash boundary and protective clothing requirements. Labels shall be machine-printed.
2. Implementation
  - a. Review and place labels during owner's training and demonstration session.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 260020

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## SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Building wires and cables rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related Sections include the following:
  - 1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

#### 1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control test reports.

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## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated. Refer to specification section 260020.
- 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. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, and XHHW.
- C. Multiconductor Cable: For limited use in taps to light fixtures only, per NEC Article 410.

### 2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. Material site/lab testing and inspections performed by CEI firm.

### 3.2 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

### 3.3 CONDUCTOR INSULATION APPLICATIONS AND WIRING METHODS

- A. Feeders: Type THHN-THWN, single conductors in raceway.
- B. Branch Circuit Homeruns and all Branch Circuits Concealed in Inaccessible Ceilings: Type THHN-THWN, single conductors in raceway.

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- C. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- D. Branch Circuits in accessible ceiling spaces, walls, and partitions: Single conductors in raceway. Multiconductor cable for tap to light fixtures only.
- E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

## 3.4 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal raceway in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

## 3.5 CONNECTIONS

- A. 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.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

## 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, perform tests per specification section 260020.
  - 2. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 4 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

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- a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 260519



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## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section includes grounding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.
  - 2. Ground bonding common with lightning protection system.
- B. Related Requirements:
  - 1. Division 27, Grounding for Communication Systems.
  - 2. Division 28, Grounding for Safety and Security Systems.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency and testing agency's field supervisor.
- B. Field quality-control reports.

#### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Refer to specification section 260020.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

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## PART 2 - PRODUCTS

### 2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

### 2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
  - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

### 2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. Material site/lab testing and inspections performed by CEI firm.

### 3.2 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

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1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

### 3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Handholes: Install a driven ground rod through handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall.

### 3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A. Refer to Division 27 and Division 28.
- C. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### 3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
1. No ground rods will be located below the building. Install the grounding electrode system and all other rods outside the building footprint, and provide appropriate bonding conductors for interconnections as specified and required.

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2. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  3. Use exothermic welds for all below-grade connections.
  4. For grounding electrode system, 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, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handholes, as specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
1. Install at least one test well at each driven rod. Set top of test well flush with finished grade.
- E. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
- F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

## 3.6 LABELING

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

## 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections. Refer to specification section 260020.

END OF SECTION 260526

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## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.
- B. Related Requirements:
  - 1. Division 27 Section "Pathways for Communications Systems" for specific requirements for support of communication conduits, wireways, surface pathways, innerduct, boxes, enclosures and cabinets serving communications systems. Provide these support systems as required by these Division 26 and Division 27 requirements.
  - 2. Division 28 Section "Pathways for Electronic Safety and Security" for specific requirements for support of communication conduits, surface pathways, and innerduct, boxes serving electronic safety and security. Provide these support systems as required by these Division 26 and Division 28 requirements.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

#### 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

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## 1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- C. Division 27 and 28: Provide these support systems as required by these Division 27 and Division 28 requirements.

## PART 2 - PRODUCTS

### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 2. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
  - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  - 5. Toggle Bolts: All-steel springhead type.
  - 6. Hanger Rods: Threaded steel.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where Table 1 lists maximum spacing less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

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- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

- 1. Secure raceways and cables to these supports with single-bolt conduit clamps.

## 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To New Concrete: Bolt to concrete inserts.
  - 2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 3. To Light Steel: Sheet metal screws.
  - 4. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

## 3.3 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03.
- C. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

## 3.4 PAINTING

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- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529



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## SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Metal conduits, tubing, and fittings.
  - 2. Metal wireways and auxiliary gutters.
  - 3. Surface raceways.
  - 4. Boxes, enclosures, and cabinets.
  - 5. Handholes and boxes for exterior underground cabling.
- B. Related Requirements:
  - 1. Division 27 Section "Raceways for Technology" for specific requirements of communication conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets and handholes serving communications systems. Provide these raceway systems as required by these Division 26 and Division 27 requirements.

#### 1.3 DEFINITIONS

- A. IMC: Intermediate metal conduit.
- B. GRS: Galvanized rigid steel conduit.
- C. EMT: Electrical metallic tubing.

#### 1.4 Coordination

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- A. Division 27 and 28: Provide these raceway systems as required by these Division 26, for Division 27 and Division 28 requirements. Coordinate all work with the communication and security systems contractors.

## 1.5 SUBMITTALS

- A. For solvent cements and adhesive primers, documentation including printed statement of VOC content.
- B. Laboratory Test Reports: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the South Coast Air Quality Management District (SCAQMD).

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. EMT: Comply with ANSI C80.3 and UL 797.
- C. GRS: Comply with ANSI C80.1 and UL 6.
- D. FMC: Comply with UL 1; zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: Setscrew.
  - 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions, where installed, and including flexible external bonding jumper.

### 2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
  - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

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- C. Wireway Covers: Screw-cover type unless otherwise indicated.
- D. Finish: Manufacturer's standard enamel finish.

## 2.3 NONMETALLIC CONDUITS AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. RNC: Type EPC-40-PVC, and EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Solvent cements and adhesive primers used on the interior of the building shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Solvent cements and adhesive primers shall comply with the testing and product requirements of SCAQMD.

## 2.4 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

## 2.5 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Metal Floor Boxes:
  - 1. Material: Cast metal.
  - 2. Exposed, Subject to physical damage:
  - 3. Type: Fully adjustable.
  - 4. Shape: Rectangular.
  - 5. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb . Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

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- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep, for typical device applications.
- H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

## 2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
  - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
  - 1. Standard: Comply with SCTE 77.
  - 2. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
  - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 5. Cover Legend: Molded lettering, "ELECTRIC" or "COMMUNICATION", as required.

## 2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Concealed Conduit, Aboveground: RNC, Type EPC-80-PVC.
  - 2. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
  - 3. Underground Conduit, Elbow Transition to Above Ground: GRS elbow.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Feeders: All feeders shall be GRS.
  - 2. Concealed in Ceilings and Interior Walls and Partitions: EMT.

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3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  4. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10
  2. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
  3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install surface raceways only where indicated on Drawings.
- 3.2 INSTALLATION
- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of hot-water pipes. Install horizontal raceway runs above water piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Division 26 Section "Identification for Electrical Systems" for required tags and labels.
- E. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.
- F. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- G. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- H. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- I. Support conduit within 12 inches of enclosures to which attached.
- J. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
  2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

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- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Surface Raceways:
  - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
  - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of conditioned spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

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## W. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.
2. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

## X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

## Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

## Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

## AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

## BB. Locate boxes so that cover or plate will not span different building finishes.

## CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

## DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

## EE. Set metal floor boxes level and flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

#### A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31, for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

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4. Install manufactured rigid steel conduit long-radius elbows for stub-ups at poles and equipment and at building entrances through floor, and for conductor pulls longer than 200 feet.
  - a. Couple steel conduits to ducts with adapters designed for this purpose.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground Warning Tape: Comply with requirements in Division 26 Section "Identification for Electrical Systems."

## 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

## 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

## 3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

## 3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533



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## SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
  - 2. Grout.
  - 3. Silicone sealants.
- B. Related Requirements:
  - 1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
  - 2. Division 27 Section "Pathways for Communications Systems" for specific requirements of communication conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets and handholes serving communications systems. Provide these systems as required by these Division 26 and Division 27 requirements.
  - 3. Division 28 Section "Pathways for Electronic Safety and Security" for specific requirements for communication conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security. Provide these systems as required by these Division 26 and Division 28 requirements

### PART 2 - PRODUCTS

#### 2.1 SLEEVES

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## A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

## B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

## C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
  - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
  - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

## 2.2 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.3 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
  2. Sealant shall have low VOC content according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.

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- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

END OF SECTION 260544

# LEHIGH ACRES LEE TRAN PARK AND RIDE LEHIGH ACRES, FLORIDA

## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Identification for raceways.
  - 2. Identification of power and control cables.
  - 3. Identification for conductors.
  - 4. Underground-line warning tape.
  - 5. Warning labels and signs.
  - 6. Instruction signs.
  - 7. Equipment identification labels.
  - 8. Miscellaneous identification products.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

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## 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
  - 3. **High-Leg: Clearly designate orange high-leg conductor, for 4-wire delta service, per NEC Article 110.**
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Provide tag at each end of all conduits, identifying source location of opposite end.

### 2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

### 2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

### 2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape:

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1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

## B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

## C. Conductive Tapes:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

## 2.5 WARNING LABELS AND SIGNS

### A. Comply with NFPA 70 and 29 CFR 1910.145.

### B. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

### C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. ARC Flash Rating signs for all switchgear and panelboards.

### D. High-Leg Identification.

1. **Permanently label to designate high-leg, 4-wire delta service on all new and existing panelboards, per NEC Article 408**

## 2.6 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

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1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.7 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

## 2.8 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black except where used for color-coding.

## 2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
  1. Outdoors: UV-stabilized nylon.
  2. In Spaces Handling Environmental Air: Plenum rated.

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- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

## 3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. **UPS.**
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
    - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
    - b. Colors for 120/240-V Circuits:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) **Phase C: Orange (high-leg).**
    - c. **High-Leg Designation: Per NEC Article 110.**
    - d. Field-Applied, Color-Coding Conductor Tape (for conductor sizes larger than No. 8 AWG): Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and for complete length where visible in boxes. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  - 2. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.



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- F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
  - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
  - 1. Comply with 29 CFR 1910.145.
  - 2. Identify system voltage with black letters on an orange background.
  - 3. Apply to exterior of door, cover, or other access.
  - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.
    - b. Controls with external control power connections.
- H. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- I. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer, load shedding, and generator paralleling gear.
- J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
  - 1. Labeling Instructions:
    - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
    - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    - d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
  - 2. Equipment to Be Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
    - b. **High-Leg label: Per NEC Article 408, for 4-wire delta-connected services.**
    - c. Enclosures and electrical cabinets.

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- d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- e. Emergency system boxes and enclosures.
- f. Enclosed switches.
- g. Enclosed circuit breakers.
- h. Enclosed controllers.
- i. Variable-speed controllers.
- j. Push-button stations.
- k. Contactors.
- l. Remote-controlled switches, dimmer modules, and control devices.
- m. Monitoring and control equipment.
- n. UPS equipment.

END OF SECTION 260553

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## SECTION 260923 - LIGHTING CONTROL DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Photoelectric switches.
  - 2. Indoor occupancy sensors.
  - 3. Indoor daylight harvesting sensors.
  - 4. Lighting contactors.
- B. Related Requirements:
  - 1. Division 26 Section "Wiring Devices".
  - 2. Division 23 Section "Instrumentation and Control for HVAC", for building automation/DDC systems, and interface with lighting control system/devices.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

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## PART 2 - PRODUCTS

### 2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. NSi Industries LLC; TORK Products.
4. Tyco Electronics; ALR Brand.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc , with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

### 2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper Industries, Inc.
2. Leviton Mfg. Company Inc.
3. Sensor Switch, Inc.
4. Watt Stopper.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
  - a. Sensor: Suitable for mounting in any position on a standard outlet box.

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- b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
  - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
- 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
- 7. Bypass Switch: Override the "on" function in case of sensor failure.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
  - 1. Sensitivity Adjustment: Separate for each sensing technology.
  - 2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. , and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s .
  - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

## 2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Cooper Industries, Inc.
  - 2. Leviton Mfg. Company Inc.
  - 3. Sensor Switch, Inc.
  - 4. Watt Stopper.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F .
  - 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor:
  - 1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft..
  - 2. Sensing Technology: Dual technology - PIR and ultrasonic.
  - 3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
  - 4. Voltage: Match the circuit voltage.
  - 5. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
  - 6. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

## 2.4 DAYLIGHT-HARVESTING SENSORS

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- A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels.
- B. Provide combination occupancy and daylight sensors.
- C. Refer to drawing details.

## 2.5 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

### 3.2 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

### 3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

### 3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.

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2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

- B. Label time switches and contactors with a unique designation.

## 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## 3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
  1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
  2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
  3. Align high-ceiling occupancy sensors using manufacturer's laser aiming tool.

END OF SECTION 260923

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## SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
  - 1. Distribution transformers.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Source quality-control test reports.
- B. Field quality-control test reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Refer to specification section 260020.



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- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- C. 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.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

## 1.8 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Products.
  - 2. General Electric Company.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; Schneider Electric.

### 2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
  - 1. Internal Coil Connections: Brazed or pressure type.
  - 2. Coil Material: Copper.

### 2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

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- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
  - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- G. K-Factor Rating: Transformers shall be K-factor rated and shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor. K-factor rating shall be minimum K-30.
  - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
  - 2. Indicate value of K-factor on transformer nameplate.
- H. Wall Brackets: Manufacturer's standard brackets.

## 2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

## 2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. Material site/lab testing and inspections performed by CEI firm.

### 3.2 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

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- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.3 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.

## 3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Refer to specification section 260020.
- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Refer to specification section 260020.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Infrared Scanning: After Substantial Completion, perform an infrared scan of transformer connections.
  - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  - 2. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

## 3.6 CLEANING

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- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

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## SECTION 262416 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Lighting and appliance branch-circuit panelboards.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 6. Include wiring diagrams for power, signal, and control wiring.
  - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit electronically on disk; include selectable ranges for each type of overcurrent protective device.

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- C. **Electrical Coordination Study:** Coordination and short circuit study shall be submitted for all switchgear, panelboard and circuit breakers prior to approval of shop drawings. Any discrepancies or conflicts in specified equipment shall be corrected prior to final approval. Refer to spec section 260020 for study requirements.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Reports:
1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- B. Panelboard Schedules: For installation in panelboards.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

## 1.6 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Keys: Two spares for each type of panelboard cabinet lock.
  2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares, each 20 amp, single-pole.
  3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

## 1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Refer to specification section 260020.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum areas for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated layouts.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; if stored in area subjected to weather, install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

## 1.9 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## 1.10 COORDINATION

A. 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, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush or surface-mounted cabinets, as indicated.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Front Cover: Secured to box with concealed trim clamps, and with standard door within trim cover.

3. Finishes:

a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Galvanized steel.

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- 4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Main and Neutral Lugs: Compression type.
  - 3. Ground Lugs and Bus-Configured Terminators: Compression type.
  - 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  - 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  - 6. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only, as indicated.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

## 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES



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- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with fully rated interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments.
    - d. Ground-fault pickup level, time delay, and  $I^2t$  response.
  - 3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
    - c. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position. (Provide for circuit to fire alarm system).

## 2.4 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. Material site/lab testing and inspections performed by CEI firm.

### 3.2 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

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- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.3 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03.
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
  - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to panelboards.
  - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. Comply with NECA 1.

## 3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

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- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

## 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Refer to specification section 260020.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.6 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Testing agency shall set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Acceptance Tests and Performance Verification."

END OF SECTION 262416

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## SECTION 262726 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. USB receptacles
  - 3. Twist-locking receptacles.
  - 4. Weather-resistant receptacles.
  - 5. Snap switches and wall-box dimmers.
  - 6. Pendant cord-connector devices.
  - 7. Cord and plug sets.
  - 8. Floor service outlets
  - 9. Multi-outlet assemblies.

#### 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

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## A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
  1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
  2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  3. Leviton Mfg. Company Inc. (Leviton).
  4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

### 2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

### 2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; 5351 (single), CR5362 (duplex).

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- b. Hubbell; HBL5351 (single), HBL5352 (duplex).
- c. Leviton; 5891 (single), 5352 (duplex).
- d. Pass & Seymour; 5361 (single), 5362 (duplex).

## 2.4 USB RECEPTACLES

### A. USB Charging Receptacles - Combination USB and 125V Straight-Blade

- 1. Description: Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
- 2. USB Receptacle: Dual, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
- 3. 125V Receptacle, 20A duplex.
- 4. Common faceplate.

### B. Standards: Comply with UL 1310 and USB 3.0 device

## 2.5 GFCI RECEPTACLES

### A. General Description:

- 1. Straight blade, non-feed-through type.
- 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
- 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

### B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Cooper; VGF20.
  - b. Hubbell; GFR5352L.
  - c. Pass & Seymour; 2095.
  - d. Leviton; 7590.

## 2.6 TWIST-LOCKING RECEPTACLES

### A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Cooper; CWL520R.
  - b. Hubbell; HBL2310.
  - c. Leviton; 2310.
  - d. Pass & Seymour; L520-R.

## 2.7 PENDANT CORD-CONNECTOR DEVICES

### A. Description:

- 1. Matching, locking-type plug and receptacle body connector.

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2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

#### 2.8 CORD AND PLUG SETS

##### A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

#### 2.9 TOGGLE SWITCHES

##### A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

##### B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Single Pole (Similar for 2, 3 and 4-way):
    - 1) Cooper; AH1221.
    - 2) Hubbell; HBL1221.
    - 3) Leviton; 1221-2.
    - 4) Pass & Seymour; CSB20AC1.

##### C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Cooper; AH1221PL for 120 and 277 V.
  - b. Hubbell; HBL1201PL for 120 and 277 V.
  - c. Leviton; 1221-LH1.
  - d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

##### D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Cooper; AH1221L.
  - b. Hubbell; HBL1221L.

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- c. Leviton; 1221-2L.
  - d. Pass & Seymour; PS20AC1-L.
- 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; 1995.
    - b. Hubbell; HBL1557.
    - c. Leviton; 1257.
    - d. Pass & Seymour; 1251.

## 2.10 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider with on/off toggle switch; with single-pole or three-way switching. Comply with UL 1472.
  - 1. 2000 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off."
- C. LED Lamp Dimmer Switches: Modular; compatible with LED drivers; trim potentiometer to adjust low-end dimming; dimmer-driver combination capable of consistent dimming with low end not greater than 10 percent of full brightness.

## 2.11 OCCUPANCY SENSORS

- A. Long-Range Wall-Switch Sensors:
  - 1. Products: Subject to compliance with requirements, provide as indicated on the drawings, one of the following:
    - a. Hubbell; ATD1600WRP.
    - b. Leviton; ODW12-MRW.
    - c. Watt Stopper (The); DT-200.
  - 2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.

## 2.12 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: Smooth, high-impact thermoplastic.



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3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Thermoplastic with cover, and listed and labeled for use in wet and damp locations, while in use.

- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with cover. Listed as weatherproof while in-use.

## 2.13 FLOOR SERVICE FITTINGS

- A. Type: As indicated on electrical details, Modular, flush-type, three-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice, video/sound, and data communication cabling.
- C. Service Plate: Rectangular, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Division 27 Section "Communications Horizontal Cabling."

## 2.14 PREFABRICATED MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Hubbell Incorporated; Wiring Device-Kellems.
  2. Wiremold/Legrand.
- B. Description:
  1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
  2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Multioutlet Harness:
  1. Receptacles: 20-A, 125-V, NEMA WD 6 Configuration 5-20R duplex receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
  2. Receptacle Spacing: 12 inches.
  3. Wiring: No. 12 AWG solid, Type THHN copper, single circuit.

## 2.15 FINISHES

- A. Device Color:

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1. Wiring Devices Connected to Normal Power System: White or as selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
  2. Wiring Devices Connected to Uninterruptible Power System (UPS): Orange dot on face.
- B. Wall Plate Color: For plastic covers, white or as selected by Architect.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. Material site/lab testing and inspections performed by CEI firm.

### 3.2 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
- D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

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5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
  6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
  7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
  8. Tighten unused terminal screws on the device.
  9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- F. Dimmers:
1. Install dimmers within terms of their listing.
  2. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

### 3.3 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles. Protection of downstream receptacles is not acceptable.

### 3.4 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

### 3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Test Instruments: Use instruments that comply with UL 1436.
  2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
  2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
  3. Ground Impedance: Values of up to 2 ohms are acceptable.

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4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  5. Using the test plug, verify that the device and its outlet box are securely mounted.
  6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 262726

# LEHIGH ACRES LEE TRAN PARK AND RIDE LEHIGH ACRES, FLORIDA

## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Molded-case circuit breakers (MCCBs).
  - 4. Enclosures.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.

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3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Refer to specification section 260020.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

## 1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## PART 2 - PRODUCTS

### 2.1 FUSIBLE AND NON-FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.

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2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.2 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Features and Accessories:
  1. Standard frame sizes, trip ratings, and number of poles.
  2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

## 2.3 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  2. Outdoor Locations: NEMA 250, Type 3R.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. Material site/lab testing and inspections performed by CEI firm.

### 3.2 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.3 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

## 3.4 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

## 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections. Refer to specification section 260020.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.



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- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

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## SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements:  
<https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes Transient Voltage Surge Suppressors (TVSS) or Surge Protection Devices (SPD) for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
  - 1. Division 26 Section "Wiring Devices" transient voltage surge suppressors.
  - 2. Division 26 Section "Panelboards"

#### 1.3 SUBMITTALS

- A. Must have *ten day* prior approval to bid on project. Request for submittal must be in writing and attached with independent documentation of the following items.
- B. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, mounting provisions, connection notes, wire size and wiring diagram.
- C. Equipment Manual: The manufacturer shall furnish an installation manual with installation notes, start-up and operating instructions for the specified system. Installation instructions shall clearly state whether the system requires an external overcurrent device to maintain the system's UL 1449 listing. SPD requiring external overcurrent devices are not acceptable.
- D. Verification that all SPD are UL tested and labeled with 20kA (In) nominal discharge rating for compliance to UL96A Lightning Protection Master Label and NFPA 780. Manufacturer shall

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provide UL 4<sup>th</sup> Edition documentation as part of submittal. Products submitted will be listed on UL's website under category code VZCA. Products not listed on UL's website will not be accepted.

- E. VPR (clamping voltage) rating under UL 1449 4<sup>th</sup> edition 6kV x 3000A testing will be a maximum of the following:

- 1. 120Vsystem 600V (L-N)

#### 1.4 STANDARDS

- A. Underwriters Laboratories 1449 - (UL 1449 4<sup>th</sup> edition or current safety standard for surge protection devices)
- B. NEC article 285. National Electrical Code and NFPA 780 Standard for the installation of lightning protection systems. SPD shall be labeled with a minimum 100kAIC rating.
- C. UL96A - Lightning Protection Master Label
- D. IEEE (Institute of Electrical and Electronic Engineering Inc.) C62.41.1 and C62.41.2 – 2002  
IEEE C62.45 – 2002  
IEEE C62.33 & C62.35
- E. All manufacturers must comply with above listed standards and any additions current revisions of industry standards. All products that do not comply with current industry standards will not be accepted.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

#### 1.6 PROJECT CONDITIONS

- A. Placing into Service: Do not energize or connect service entrance equipment, panelboards, control terminals, or data terminals to their sources until the surge protective devices are installed and connected.
- B. Protection modes: The SPD shall provide Line to Neutral (L-N) (Wye), Line to Ground (L-G) (Wye or Delta), Line to Line (L-L) (Delta) and Neutral to Ground (N-G) (Wye) protection.
- C. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
  - 1. Maximum Continuous Operating Voltage (MCOV): Not less than 115 percent of nominal system operating voltage per UL 1449 3<sup>rd</sup>.
  - 2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
  - 3. Humidity: 0 to 85 percent, non-condensing.

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4. Altitude: Less than 20,000 feet (6000 m) above sea level.

**1.7 COORDINATION**

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

**1.8 WARRANTY**

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer shall provide a product warranty for a period of not less than ten (10) years from date of installation. Warranty shall cover unlimited replacement of TVSS modules during the warranty period. Those firms responding to this specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of TVSS for not less than five (5) years.

**PART 2 - PRODUCTS**

**2.1 ACCEPTABLE MANUFACTURERS**

- A. PQ Protection/Power Logics
- B. LEA International
- C. Advanced Protection Technologies (APT)
- D. Surge Suppression Incorporated (SSI)
- E. Square D
- F. Current Technologies

**2.2 SERVICE ENTRANCE SUPPRESSORS**

- A. Required surge current ratings per phase:

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	$\geq 3,000$ Amps	2500-1600Amps	1200-800A	600A	400-100A
Service Entrance	400kA/Modular	300kA/modular	200kA/modular		
200kA/Modular	200kA/Modular				
Distribution	-	-	200kA	200kA	200kA

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Branch Panels		-		-		-		100kA		100kA
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- B. Equipment shall be a multi-stage parallel protector. All voltages must be verified by location on drawings, online diagrams and equipment scheduled. The equipment's minimum surge current capacity shall be as shown above depending upon panel amperage.
- C. SPD shall be modular design with field replaceable modules per phase and per mode. Redundant status indicators shall be mounted on the front of the door that monitors the system protection circuitry.
- D. SPD shall contain a technology that utilizes multiple thermally protected metal oxide varistors (MOV) per mode.
- E. SPD shall be labeled as minimum with Type 1 if installed ahead of the service entrance disconnect or Type 2 if installed downstream of the service entrance disconnect (verifiable at UL.com). Every component of every mode, including N-G, shall be protected by internal thermal protection. SPDs relying upon external or supplementary installed safety overcurrent protection do not meet the intent of this specification. Units must have an In (nominal discharge) of 20kA.
- F. SPD shall provide the following monitoring features and options: dry contacts, surge counter and audible alarm. Equipment shall utilize a NEMA 4 enclosure.
- G. SPD shall be designed and equipped with integral disconnecting means, for SPD at main service entrance switchboard.

## 2.3 DISTRIBUTION PANELS

- A. Device shall meet all specification requirements in section 2.1 except as follows:

Equipment shall be a multi-stage parallel protector. All voltage must be verified by location on drawings, one-line diagrams and equipment scheduled. The equipment's minimum surge current capacity shall be 200kA per phase (L-N plus L-G) and 100kA per mode (L-N, L-G, L-L and N-G).

1. The system protection shall contain metal oxide varistors (MOV). Each MOV will be individually coordinated to pass UL 1449. The unit shall be non-modular or modular type.
2. Equipment shall provide the following monitoring features: dry contacts and audible alarm. Equipment shall utilize a NEMA 4 enclosure.

## 2.4 BRANCH PANEL SUPPRESSORS & AUXILIARY PANEL SUPPRESSORS

- A. Device shall meet all specification requirements in section 2.1 except as follows:

Equipment shall be a multi-stage parallel protector. All voltage must be verified by location on drawings, one-line diagrams and equipment scheduled. The equipment's minimum surge current capacity shall be 100kA per phase (L-N plus L-G) and 50kA per mode (L-N, L-G, L-L and N-G).

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1. The system protection shall contain metal oxide varistors (MOV). Each MOV will be individually coordinated to pass UL 1449. The unit shall be non-modular or modular type.
2. Equipment shall provide the following monitoring features: dry contacts and audible alarm. Equipment shall utilize a NEMA 4 enclosure

#### PART 3 - EXECUTION

##### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

##### 3.2 INSTALLATION OF SURGE PROTECTIVE DEVICES

- A. Review all installation information in owners manual. Verify all voltage before connections to avoid injury and damage to equipment. The specified unit shall be installed external to switchboard, distribution and panelboard as stand alone. Internal products will not be accepted.
- B. The specified service entrance/switchboard/switchgear system shall be installed with the shortest lead length possible from the power conductor(s) it is protecting, must have a grounding of 25 Ohms (NEC Article 250.53) or less and shall avoid any unnecessary or sharp bends. Utilize product as described under 2.2.G with integral disconnect means.
- C. The specified distribution and branch panelboard system shall be installed with the shortest lead length possible from the power conductor(s) it is protecting, must have a grounding of 25 Ohms (NEC Article 250.53) or less and shall avoid any unnecessary or sharp bends. Utilize a 30 amp breaker for connection means. See manufacturer's installation manual. For service entrance devices, utilize product as described under 2.2.G with integral disconnect means.

##### 3.3 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
  1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.
  2. Complete startup checks according to manufacturer's written instructions.
- B. Manufacturers Field Service:
  1. Engage a factory authorized service representative to inspect equipment installation. Report results in writing
  2. Verify that electrical wiring installation complies with manufacturer's installation requirements.

END OF SECTION 264313

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## SECTION 265100 - INTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Interior lighting fixtures, lamps, and ballasts.
  - 2. Emergency lighting units.
  - 3. Exit signs.
  - 4. Lighting fixture supports.
- B. Related Sections:
  - 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
  - 2. Division 26 Section "Wiring Devices" for manual wall-box dimmers.
  - 3. Division 26 Section "Exterior Lighting".

#### 1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. Lumen: Measured output of lamp and luminaire, or both.



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E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. LED: Light Emitting Diode

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast, including BF.
4. Energy-efficiency data.
5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

- a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Installation instructions.

## 1.5 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

## 1.7 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

## 1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

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## 1.9 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

## 1.10 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

### 2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. Diffusers and Globes:
  - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
    - b. UV stabilized.
  - 2. Glass: Annealed crystal glass unless otherwise indicated.
- F. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

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1. Label shall include the following lamp and ballast characteristics:

- a. "USE ONLY" and include specific lamp type.
- b. CCT and CRI for all luminaires.

## 2.3 LIGHT EMITTING DIODE (LED) FIXTURES

- A. LED Lumen Maintenance: All LED sources provided, including LED packages/arrays/modules, shall be tested in accordance with IESNA Standard LM-80.
- B. LED Fixture Photometric Performance: All LED fixtures provided shall be tested in accordance with IESNA Standard LM-79.

## 2.4 DRIVERS FOR LED FIXTURES

- A. Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:
  - 1. Rated for 50,000 hours of life, unless otherwise noted.
  - 2. Sound Rating: Class A.
  - 3. Total harmonic Distortion Rating: 15 percent or less.
  - 4. Current Crest Factor: 1.5 or less.
  - 5. 0-10V Dimming Standard (Step Dimming does not comply)

## 2.5 LED FIXTURES

- A. Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
- B. Include the following features unless otherwise indicated:
  - 1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
  - 2. Each luminaire shall be rated for a minimum operational life of 50,000 hours utilizing a minimum ambient temperature of (25°C).
  - 3. Light Emitting Diodes tested under LM-80 Standards for a minimum of 12,000 hours.
  - 4. Color Rendering Index (CRI) of 82 at a minimum.
  - 5. Color temperature [3500] <Insert value> K, unless otherwise indicated.
  - 6. Rated lumen maintenance at 70% lumen output for 50,000 hours, unless otherwise indicated.
  - 7. Fixture efficacy of 60 Lumens/Watt, minimum.
  - 8. 5 year luminaire warranty, minimum.
  - 9. Photometry must comply with IESNA LM-79.
  - 10. The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.
- C. Technical Requirements
  - 1. Luminaire shall have a minimum efficacy of 60 lumens per watt. The luminaire shall not consume power in the off state.

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2. Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
3. Power Factor: The luminaire shall have a power factor of 0.9 or greater.
4. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 15 percent.
5. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

## D. Thermal Management

1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
2. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
3. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
4. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.

## 2.6 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
  1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

## 2.7 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
  1. Battery: Sealed, maintenance-free, lead-acid type.
  2. Charger: Fully automatic, solid-state type with sealed transfer relay.
  3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.8 LIGHTING FIXTURE SUPPORT COMPONENTS

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- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

### 3.2 INSTALLATION

- A. Lighting fixtures:
  - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
  - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
  - 1. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  - 2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- D. Suspended Lighting Fixture Support:
  - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
  - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
  - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
  - 5. In finished spaces, use aircraft cable.
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 IDENTIFICATION

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- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.5 ADJUSTING

- A. Occupancy Adjustments: Prior to Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
  - 1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265100

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## SECTION 265600 - EXTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Exterior luminaires with lamps and ballasts.
  - 2. Poles mounting hardware and accessories.
- B. Related Sections:
  - 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LER: Luminaire efficacy rating.
- D. Luminaire: Complete lighting fixture, including ballast housing if provided.
- E. Standard: Same definition as "Pole" above.
- F. LED: Light Emitting Diode.

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## 1.4 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  - 2. Details of attaching luminaires and accessories.
  - 3. Details of installation and construction.
  - 4. Luminaire materials.
  - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
    - a. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  - 6. Photoelectric relays.
  - 7. LED Drivers, including energy-efficiency data.
  - 8. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
  - 9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
  - 3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
  - 4. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
- D. Field quality-control reports.
- E. Warranty: Sample of special warranty.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

## 1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

LED Drivers: One for every 100 of each type and rating installed. Furnish at least one of each type.



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## 1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
  - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
  - 2. Warranty Period for Metal Corrosion: Ten years from date of Substantial Completion.
  - 3. Warranty Period for Color Retention: Ten years from date of Substantial Completion.
  - 4. Warranty Period for Lamps and Fuses: Replace lamps and fuses that fail within, 12 months from date of Substantial Completion.
  - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products for each fixture type indicated on Drawings.

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## 2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- N. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

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## 2.3 LED FIXTURES

### A. LED fixtures shall comply with the following;

1. Photometry shall be provided by the fixture manufacturer to comply with "IESNA LM-79-08" and formatted to comply with "IESNA LM-63-02"
2. Fixtures shall be capable of operating in a temperature range of 0 deg.c. to 35 deg.c. however, lumen depreciation shall be based on an ambient temperature of 25 deg.c. lumen depreciation at the end of 50,000 hours of operation shall not exceed 20% of the initial lumen output for drivers rated at 350ma and 25% for drivers rated at 525ma. Depreciation data shall be derived from "temperature measurements testing" under ul 1598 environments and shall be directly correlated by the fixture manufacture under "IESNA LM-80-08" data.
3. Site lighting fixtures shall be provided with low copper/aluminum housings having high performance heat sinks. Active cooling involving fans or such shall not be required. The fixtures shall be configured to allow for modular upgrading and/or field repair of all electrical components.
4. The drivers for each fixture shall be of the electronic type (90% p. F.) With an operating voltage as indicated in the fixture schedule (plus or minus 10%) at 60hz. In addition, the drivers shall be provided with overheating protection (self-limited short circuit & overload) with a case temperature up to 80 deg.c.
5. The fixture manufacturer shall provide a warranty of five years for LED's & driver's.

## 2.4 HIGH PERFORMANCE LED LAMPS

### A. Description: Electronic solid state type.

1. Ten-year operational life while operating at maximum case temperature and 90 percent non-condensing relative humidity. .
2. Composed of 42 high performance white LEDs, 65w lamp wattage. Color temperature of 4000 Kelvin nominal, 70 CRI. Operating lifespan based on TM 21 extrapolation to get results after which 50% of LEDs still emits over 70% (L70) of its original lumen output. Use of metal core board insures greater heat transfer and longer lifespan of the light engine.
3. Designed and tested to withstand electrostatic discharges up to 15,000
4. Electrolytic capacitors shall operate at least 20 degrees C below the capacitor's maximum temperature rating when the driver is under fully-loaded conditions and under maximum case temperature.
5. Maximum inrush current of 2 amperes for 120V and 277V drivers.
6. Withstand up to a 4,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
7. The electronic components sensitive to electrostatic discharge (ESD) such as light emitting diodes (LEDs) are assembled in compliance with IEC61340 5 1 and ANSI/ESD S20.20 standards so as to eliminate ESD events that could decrease the useful life of the product.
8. Inaudible in a 27 dBA ambient.
9. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
10. Total Harmonic Distortion less than 20 percent and meet ANSI C82.11 maximum allowable THD requirements.
11. Drivers shall track evenly across multiple fixtures and all light levels.

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12. Constant current drivers shall provide models shall support from 200mA to 2.1Amps (in 10mA steps) to ensure a compatible driver exists and support LED arrays up to 40W.
13. Constant voltage drivers shall provide models to support from 10Volts to 40Volts (in 0.5V steps) to ensure a compatible driver exists and support LED arrays up to 40W.
14. Configuration tool shall be available to optimize light level, efficacy, and thermal performance for LED fixtures.

## 2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
  1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
  2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  1. Materials: Shall not cause galvanic action at contact points.
  2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
  3. Anchor-Bolt Template: Plywood or steel.
- D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

### 3.2 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

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## 3.3 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

## 3.4 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole.
  - 2. Install grounding conductor and conductor protector.
  - 3. Ground metallic components of pole accessories and foundations.

## 3.5 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
  - 1. Verify operation of photoelectric controls.
- C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265600

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## SECTION 270010 – TECHNOLOGY GENERAL PROVISIONS

### PART 1 - GENERAL

#### 1.1 GENERAL CONDITIONS AND DEFINITIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.
- C. Scope: This specification section applies to all Division 27 specification sections and all Division 28 specification sections with the exception of Fire Alarm. All systems under the specifications indicated above are referenced also in this contract documents as "technology systems".
- D. Drawings and specifications: The words "drawings" and "specifications" used on this section refer to all contract drawings and specifications describing the scope of work of the technology system.
- E. Installer and Contractor: The word "installer" where used on the drawings or specifications without any further description shall reference the installer of the system under reference. The word "contractor" where used on the drawings or specifications without any further description shall reference to the General Contractor (or Construction Manager) holding the prime agreement with the owner for the construction of this project.
- F. Provide and Install: The word, "provide" where used on the drawings or specifications shall mean, "furnish, install, mount, connect, test, complete, document and make ready for operation". The word "install" where used on the drawings or specifications shall mean, "mount, connect, test, complete, and make ready for operation".
- G. The word Engineer (also referenced as A&E) where used on the drawings or specification refers to the design engineer of the project working for the project architect or the owner. It does not refer to an engineer working for the General contractor, Construction Manager or any of the installers in the project.
- H. Complete systems: All technology systems are intended to be complete systems, including all materials, labor and programming to make it an operation system. Refer to drawings for the "Responsibility Matrix" outlining the responsibility of each trade on each technology system.

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- I. Active equipment: Active equipment is defined as equipment composed of electronic component and electric materials, design to work with power applied to it. Cables are not considered active equipment.

#### 1.2 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. Objective: The intent of the design drawings and specifications is to provide the installer of a technology system a scope of work for bidding purposes and to make sure different bids received by the entity holding the bidding for the technology system are at the same level of scope for comparison purposes. The drawings and specifications are not intended to show every single element of the project to produce a buyout list for the installer. In general, for all technology systems, all active components are specifically called out but small wires and small installation materials (such as nut, bolts, washers, termination blocks, clamps, ties, etc) are not indicated in the documents. Guidelines for installation of those systems are provided in the specification to allow the installer to produce the complete buyout list of materials.
- B. Accuracy: The Drawings are diagrammatic and are not intended to show exact locations of conduit runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment, appliances, fixtures, conduits, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the Architect or Engineer during construction. Obtain in the field all information relevant to the placing of technology systems work and in case of interference with other work, proceed as directed by the Architect or Engineer.
- C. Distances: Although most drawings have a scale referenced on each sheet, the drawings are a two dimensional representation of the system, so design drawings do not indicate changes in elevation that cause additional lengths and quantities of materials. It is the responsibility of the installer of each technology system to field verify all distances before bidding to properly estimate all cable distances and materials.
- D. Discrepancies: Notify the A&E of any discrepancies found during construction of the project and do not proceed with that portion of the project, until a written definitive statement is received providing clear direction. If a conflict exists between the contract documents and any applicable code or standard, the most stringent requirement shall be included for this project. The Engineer shall make the decision regarding questionable areas of conflict.
- E. Existing Conditions: All existing conditions might not be indicated in the design drawings. The installer of each system shall check site and existing conditions thoroughly before bidding and advise the Engineer of discrepancies prior to bid.
- F. Coordination: Although design technology drawings were intended to be coordinated with other trades, the fact that installer for other non-technology system might have changes to their design drawings, requires the Contractor to produce coordination drawings for a specific space, including all elements of all trades for space planning and coordination purposes.

#### 1.3 ABBREVIATIONS

- A. Abbreviations: The following abbreviations or initials may be used:
  - 1. ABV CLG - Above Ceiling
  - 2. AC - Alternating Current
  - 3. ADA - American Disabilities Act

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4. AFF - Above Finished Floor
5. AFG - Above Finished Grade
6. AMP - Ampere
7. ANSI - American National Standards Institute
8. AWG - American Wire Gauge
9. BC - Bare Copper
10. CCTV - Closed Circuit Television
11. CATV - Community antenna television
12. CLG - Ceiling
13. COAX - Coaxial Cable
14. CPU - Central Processing Unit
15. DC - Direct Current
16. DEG - Degree
17. EMT – Electrical Metallic Tubing
18. GND - Ground
19. IDF - Intermediate Distribution Frame (Telecom Room)
20. IMC - Intermediate Metallic Conduit
21. IN - Inches
22. IP - Internet Protocol
23. JB - Junction Box
24. KVA - Kilo-Volt-Amps
25. KW - Kilowatts
26. LBS - Pounds
27. LED - Light Emitting Diode
28. MAX - Maximum
29. MDF - Main Distribution Frame (Main Telecom Room)
30. MIC - Microphone
31. MIN - Minimum
32. MTD - Mounted
33. MTG - Mounting
34. NEC - National Electrical Code
35. NECA - National Electrical Contractors Association
36. NEMA - National Electrical Manufacturers Association
37. NFPA - National Fire Protection Association
38. NIC - Not in Contract
39. OFE - Owner furnished equipment
40. OSHA - Occupational Safety and Health Administration
41. PB - Pullbox
42. PWR - Power
43. PVC - Polyvinylchloride
44. EF - Telecommunications Entrance Facility
45. TR - Telecommunications Room
46. TTB - Telephone Terminal Board
47. V - Volt
48. WP - Weatherproof

## 1.4 CODES AND STANDARDS

- A. Application: The codes, standards and practices listed herein generally apply to the entire project and all technology systems. Other codes, standards or practices that are more specific will be referenced within a particular specification.



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- B. Requirements: All articles, products, materials, fixtures, forms or types of construction covered in the specifications will be required to meet or exceed all applicable standards of manufacturer, testing, performance, capabilities, procedures and installation according to the requirements of ANSI, NEMA, IEEE, NEC, BICSI and TIA referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents which exceed but are not contrary to governing codes shall be followed.
- C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed technology system installation shall be inspected and certified by all applicable agencies that it is in compliance with all codes.
- D. Applicability: The codes and standards and practices listed herein, and their respective dates are furnished as the minimum latest requirements. List of applicable codes:
  - 1. State Code: Florida Administrative Code
  - 2. Building Code: Florida Building Code, current version
  - 3. Manuals: Accessibility Requirements Manual - Florida Department of Community Affairs.
- E. UL Labels: All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. No equipment shall be installed if there is no labeling or listing service is available for such equipment.

#### 1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. Definitions:
  - 1. Basis of design: A product or group of products from an identified manufacturer that was used as the basis of systems layouts and installation details, part of the contract documents.
  - 2. Prototype: Is a product or a group of products that are not yet ready for commercial use because they are in the testing phase (Beta testing) of the product development.
  - 3. Alternates: Products or manufacturers listed in the contract documents as acceptable compare to the basis of design. Use of alternates shall follow the same system architecture as the basis of design.
  - 4. Obsolete: A product that has been discontinued by the manufacturer or declared in end of life, and it is no longer being manufactured.
  - 5. Substitution: A product not listed in the contract documents but capable of similar characteristics as the basis of design operating as a direct replacement in the system in reference. The installers can propose a substitution if all requirements are met as indicated in this specification.
  - 6. Substitutions that create a change in system architecture are products that create a very different system configuration impacting other trades (i.e. change in power/cooling requirements, changes in raceways layout or sizes, changes in equipment space requirements, changes in low voltage wiring layouts, types and quantities, etc) but providing a similar end result as the system/products basis of design.
- B. Use of Prototype. Prototypes are not allowed in any technology system.
- C. Use of alternates. Alternates are allowed and installer shall follow these requirements:

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1. Where several brand names make or manufacturers are listed as acceptable alternates each shall be regarded as equally acceptable, based on the design selection. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance. Where three or more manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance.
  2. The use of alternate products does not allow the change of system architecture with such products.
- D. Use of substitutions. Substitutions are only allowed when they meet all the requirements below:
1. Substitutions are only allowed when a particular specification section for a technology system, allows the use of substitutions for that particular system.
  2. The performance of all substitutions components must meet or exceed those of the basis of design. Should an installer wish to submit a substitution product or a product set stated in the construction documents as 'acceptable', it shall be the responsibility of the installer to submit to the Engineer an item-for-item CROSS REFERENCE for all specifications of the product, all related specifications and product data sheets, for the proposed substitution. Use the substitution request form indicated in Addendum 1 of this specification.
  3. The Engineer has the authority to reject a substitution without cause and the installer shall provide the basis of design and no additional compensation.
  4. Substitutions of unnamed manufacturers will not be acceptable.
  5. Certification of substitutions: When a basis of design is specified to be in accordance with a trade association or government standard requested by the Engineer, installer shall provide a certificate that the substitution complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.
  6. Substitutions that create a change in system architecture are not allowed.

#### 1.6 SHOP DRAWINGS AND SUBMITTALS

- A. General: Shop drawings shall be submitted for equipment and material as indicated in the individual specification sections for each system. .
- B. Quantity of shop drawings submittals: Follow Division 1 requirements for quantity of shop drawings and submitting requirements. If the project does not have a Division 1 specification, shop drawings shall be submitted in quantity of one (1) for electronic format submittal and quantity of four (4) for hardcopies.
- C. Electronic submittals. Submittals in electronic format (PDF) are accepted.
- D. When cut sheets of products are submitted and the manufacturer cut sheets indicate several model numbers or variations of the same product, the cut sheet shall be highlighted by the installer to indicate the specific product that will be provided for this project. Submittals received with cut sheets indicating multiple parts numbers and not highlighted will be rejected and not reviewed.
- E. Equipment and material quantities are not reviewed by the A&E as part of this submittal process. Equipment quantities are to be provided by the installer as indicated in contract documents. Approved shop drawings indicating any changes in equipment quantities or overall scope of work different from contract documents does not constitute approval by the A&E of

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those changes. The contract documents and any changes issued by the A&E in the form of Supplemental Information during the construction process are always to be followed for equipment quantities and scope of work.

- F. All electronic equipment prone to obsolescence and with lead times less than 3 months shall be submitted for approval no sooner than 12 month before the date set for substantial completion of the project. Electronic equipment prone to obsolescence includes devices like flat panel displays, transceivers, servers, players, workstation and routers
- G. Equipment and materials installed not in accordance with the approved shop drawings shall be replaced at installer's expense.
- H. Multiple stages of shop drawings shall be required as indicated in each specification section. For final completion and testing the installer shall provide a submittal with the following information:
  - 1. Detailed course syllabus for each type of training required in the specifications
  - 2. A proposed schedule of training sessions in compliance with the specification sections and indicating place where the training will take place.
  - 3. A copy of all training material to be used during each session.
  - 4. Test result sheets for all testing done by the installer prior to the system acceptance test.

## PART 2 - PRODUCTS

### 2.1 IDENTIFICATION AND LABELING TAGS

- A. All conduit, cabinets, cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified with pre-printed labels or tags.
- B. The only approved types of labels for inside premise environments for any technology systems are:
  - 1. Non-laminated thermal transfer labels, printed with a high quality thermal transfer printer.
  - 2. Laminated thermal transfer labels printed with a high quality thermal transfer printer.
  - 3. Thermal transfer polyolefin tape printed with a high quality thermal transfer printer.
  - 4. Self laminated dot-matrix labels, printed with a high quality dot matrix printer.
  - 5. Non-laminated dot-matrix labels, printed with a high quality dot matrix printer.
- C. For labeling of cables or equipment in outdoor environments use only marker plates attached to cable or equipment with cable ties. Do not use any labels with adhesive materials. Use different color plates for different cable types. Use only waterproof ink for writing on marker plates.
- D. Any type of write-on labels (except for outdoor marker plates), hand writing on cable jackets or directly on equipment, labels made with masking tape or any other type of tape not listed in previous paragraph are not acceptable and shall be corrected with approved labeling methods at no additional cost to the owner.
- E. Approved manufacturer:
  - 1. Rhino,
  - 2. Brady,

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3. Panduit or
4. approved equal

## 2.2 TECHNOLOGY EQUIPMENT AND MATERIALS

- A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacture of the type and size of equipment, shall be suitable for the environment in which it is to be installed, shall be approved for its purpose, environment, and application, and shall bear a label as indicated in paragraph 1.4.E. of this section.
- B. Installation Requirements: Each item of equipment or material shall be installed in accordance with instructions and recommendations of the manufacturer and the contract documents.
- C. Required Accessories: All equipment specified in the technology systems shall be provided with all required accessories for proper operation and mounting. Typically these accessories are not specifically indicated in the design drawings but shall be provided per this specification section. Such accessories include items such as power supplies, power cords, rack ears, rack rails, bolts, lugs, faceplates, etc.

## PART 3 - EXECUTION

### 3.1 INSTALLATION PRACTICES

- A. WORKMANSHIP: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.
- B. STANDARD OF QUALITY: To define good workmanship, all installation practices described in BICSI standards shall be followed.
- C. PROTECTION OF EQUIPMENT: Equipment for Technology systems shall at all times during construction be adequately protected against mechanical/chemical damage by the elements or work performed by other trades. Equipment shall be stored in dry permanent shelters. If equipment or materials has been damaged, such equipment shall be replaced at no additional cost or time extension to the Contract. Damaged equipment and materials include the following conditions:
  1. Equipment that has visible scratches, cracks or equipment that has paint or finished surface peeled off.
  2. Equipment with visible indication of rust or water intrusion.
  3. Equipment that has dents on the metal enclosures and are clearly visible to the end user.
  4. Equipment that has been sprayed with paint, fire proofing materials, or other type of chemicals, when the equipment was not intended to have this type of materials applied to it, per contract documents.
  5. Equipment that has been burnt by controlled fires, power surges, power sags or by lightning.
  6. Equipment that has a known damage to any parts, electronic board or component, even if such component or board has no specific use in the project.

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7. Cables that have visible damages to the jackets even if cables are not broken and still provide electrical continuity.
  8. Cables sprayed with paints that affect the warranty of the cable as defined by the cable manufacturer.
  9. Equipment with screws with stripped heads.
- D. **CLEAN EQUIPMENT:** All equipment installed in spaces accessible to the building occupants like in racks, cabinets, wall mounted panels, credenzas, etc. shall be free of dust at the time the space part of the project gets the final Certificate of Occupancy and at the time of the acceptance test by the A&E. A clean equipment is defined as an equipment that if wiped with a finger, in any surface, does not leave visible debris and dust in the finger, also equipment with no visible signs of dust inside the equipment, like in ventilation fans..
- E. **IDENTIFICATION AND TAGGING:** All technology systems items shall be labeled and identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system which it serves or controls. Refer to Identification Section of the specifications for additional information. All labels of equipment and wiring shall match the labeling used in the shop drawings for the system.

### 3.2 COORDINATION

- A. **General:** The installer shall compare shop drawings with those of other trades and report any conflicts between them to the A&E. Obtain from the A&E written instructions to make the necessary changes in any of the affected work. All work shall be installed in cooperation with other Trades installing interrelated work.
- B. **Adjustments:** Locations of conduit and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of all systems prior to fabrication or installation.
- C. **Replacement:** All work shall be installed in a way to permit removal (without damage to other parts) of all other system components provided under this Contract requiring periodic replacement or maintenance. All conduits shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.

### 3.3 REQUEST OF IP ADDRESSES

- A. **General:** When contract document require the installer of any of the technology systems to use IP addresses for the configuration of such system, inside the owner's controlled IP network, the installer shall request the owner to provide such IP addresses. The installer shall request such information no less than one (1) month in advance from the moment the installer will be programming the system and by using the form named "Network Connections Programming Plan" indicated in Attachment 2 of this specification. An electronic copy of this form is available upon request from TLC Engineering.
- B. **Completing the form.** The Network Connections Programming plan shall be completed in separate by each trade that requires IP addresses. This form has two parts. The first part indicates all the different device types for a system (i.e. cameras, workstation, servers, controllers, VoIP phones, etc). The second part is a list of all devices required classified by their type and properly indicating location where the device will be used.

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- C. Request that do not follow this process, or have incomplete information will be ignored and will not be processed.
- D. Reprogramming cost of any technology systems due to un-approved addresses used by the installer shall be at the installer's expense

**3.4 TELECOM ROOM/EQUIPMENT ROOM READINESS**

- A. In any projects where the technology systems require the use of network equipment (switches, routers, firewalls, etc) provided by the owner, the Contractor shall complete all telecom rooms to a point where they are suitable for the owner to deploy such equipment in those rooms. At a minimum the following conditions shall be met at all rooms in order for the owner to install the equipment:
  - 1. All power outlets in the telecom rooms shall be fed from the permanent source of power. Temporary power shall not be provided.
  - 2. Backup power (generator and/or UPS) shall be already operation, tested and connected to the final power distribution system.
  - 3. The mechanical equipment providing the cooling for the telecom rooms shall be fully operational. Temporary cooling shall not be accepted.
  - 4. Fire suppression system (sprinkler or gas based system) protecting the telecom rooms shall be fully operational and tested.
  - 5. All light fixtures in the telecom rooms shall be fully operational.
  - 6. All walls to the telecom rooms shall be completed and including the last coat of paint.
  - 7. The ceiling and flooring of the telecom rooms shall be finished.
  - 8. All horizontal and backbone cabling system part of the structured cabling system (SCS) shall be installed, terminated and tested.
  - 9. The final and permanent doors to the telecom rooms shall be installed with a key core different from all other construction cores in the site.
  - 10. Telecom rooms shall be cleared of any materials being stored inside the room.
  - 11. Telecom rooms shall be clean. Clean will be measured as not having any debris left in the room and not having dust in rack, cabinets, or wall mounted panels. If wiping a finger in any of the surfaces of such equipment leaves visible dust residue in the finger, the room will not be considered clean.
  - 12. Hallways and rooms leading into the telecom rooms shall have no more sanding to be done in the walls and the floor shall be completed to avoid dust from these spaces moving into the telecom rooms.
  - 13. Prior to the owner deploying the equipment in these rooms, the Contractor shall provide disposable sticky mats at the entrance of each telecom room to capture dust and/or dirt from people's shoes or boots coming into the room. The sticky mats shall be selected as to cover the width of the door opening. Sticky mats shall contain no less than 60 sheets in each unit. Used sheets of the mats shall be replaced no less than on a daily basis or if worn out before the end of the day. Sticky mats shall be provided until the project receives the final Certificate of Occupancy.
- B. In projects where the network equipment is part of the contract documents, the contractor is required to provide all equipment functioning and clean at the end of the project. The contractor is responsible to determine at what point this delicate equipment can be installed in the telecom room. The contractor shall make sure the recommended manufacturer guidelines are applied to the installation of the equipment when it comes to cleanliness. It is highly recommended that all steps indicated above are followed even for this type of project.

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#### 3.5 SYSTEMS WARRANTY AND SERVICE

- A. General: At a minimum all technology system shall include a warranty from the manufacturer and installer of the system for no less than one (1) year with the following exceptions:
1. Structured Cabling system shall have a warranty longer than one year as indicated in that specification section.
  2. When specific equipment or software manufacturers include a warranty longer than one year, the manufacturer's warranty shall be transferred to the owner in the same terms as indicated by the manufacturer.
- B. Warranty coverage. The warranty for the technology system shall cover the following elements:
1. All equipment parts, cabling and materials.
  2. Any software updates/patches issued during the warranty period by the manufacturer.
  3. The labor to replace those parts and programming time to re-configure equipment.
  4. Shipping and freight charges to send equipment back and forth from the manufacturer and/or site.
  5. Tool rentals such as scaffold or lifts to access equipment.
  6. The troubleshooting time to detect the faults in the system.
  7. All travel time and expenses associated with the service.
- C. Start of warranty. The warranty period for the technology systems starts the day the project gets the Certificate of Occupancy (CO), for new construction projects. For retrofit jobs of a particular system, the warranty starts when the project is accepted by A&E. For most equipment/software manufacturer's the warranty period starts when the equipment is shipped from the factory, so it is the responsibility of the installer of each system to provide additional warranty coverage from the manufacturer to cover the additional time of warranty up to the CO date plus one year.
- D. Service calls. During the warranty period the installer shall support the system when called by owner/contractor for service. All equipment/software service shall be done by personnel with the same qualifications as the personnel who installed the system and as indicated in each technology system specification section. Service calls shall be taken during business hours (same time zone as the project) for normal service and twenty (24) hours three hundred and sixty five (365) days in the year for emergency service. Emergency Service shall be defined as the loss or failure of any critical component necessary to maintain the overall integrity and operation of the system. Normal service shall be defined as the loss or failure of a system component that does not compromise the complete operation of the system and allows the owner to operate the system at a minimum of 90% of its capacity. See individual specification sections for delineation on critical components and normal service.
- E. Response time for service. The maximum allowed response time after a service call for emergency service shall be four (4) hours and for normal service twenty four (24) hours.
- F. Equipment registration. All equipment/software part of the technology system shall be registered to the owner with the manufacturer of the equipment/software for warranty and support. Equipment/software registered with the manufacturer to the name of the Contractor or installer shall be removed from the project and replaced with equal equipment registered to the owner at no additional cost to the owner.

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- G. Periodic preventive maintenance visits. During the warranty period the installer of the system shall provide no less than two (2) preventive maintenance services. These services shall be provided at 6 months from start of the warranty period and a few weeks before the end of the warranty period. The installer of the system shall coordinate with the owner the precise dates for this type of service. During these visits the following task shall be perform:
1. Clean up of any active equipment that shows visible accumulation of dirt, dust of debris of any kind.
  2. Replacement of any consumable parts in the system that require replacement per manufacturer's instructions during the warranty period, such as filters.
  3. Oiling/greasing of any mechanical parts that require period maintenance as per manufacturer's instructions during the warranty period.
  4. Run manufacturer's recommended test for each piece of equipment installed. The installer shall provide at the end of the service a report of such test.
  5. Visual observation of all devices in the system to spot any anomalies.
  6. Review of error logs from any system components and analysis of such logs with explanation to owner on the cause of those errors.
- H. Extended service agreement. Prior to final acceptance testing, and within thirty 30-days of project completion, the installer of each technology system shall submit to the Owner an option to purchase extended service coverage. This proposal shall provide for the purchase option of 1, 3, or 5, year coverage. Coverage shall include, at a minimum, the same provisions as during the warranty period.

#### 3.6 ENGINEER'S FINAL ACCEPTANCE TEST

- A. The technology systems shall be tested during installation by the installer as frequently as required to solve any installation issues and non compliance of system specifications. Technology systems will not be considered delivered to the owner until final acceptance test is passed. The final acceptance test shall be done in presence of the A&E and/or the owner. The installer shall request in writing with 2 weeks in advance the presence of the A&E and/or owner for the final acceptance test.
- B. In order for the installer of the system to request final acceptance the following task shall be completed:
1. All components shall be inspected to ensure they have been properly installed by the installer, securely attached, and remain clean and unmarred
  2. All equipment shall be properly adjusted, clearly labeled, and fully operational.
  3. The installer shall have tested the system previously to ensure the final acceptance test will be successful. Detailed proof of test shall be sent to the A&E with the request for final acceptance
  4. All permanent and final labels as requested in the identification and tagging section of this specification are completed.
  5. No temporary conditions shall be present in the system.
  6. All batteries on all system components shall be connected.
  7. All system programming shall be completed as indicated in the specification for each technology system.
- C. All test equipment required for the Final acceptance shall be provided by the installer of the system unless specifically indicated by the A&E.



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- D. The A&E shall define the scope of the testing but the installer shall be prepared for testing every single component of the system. During the day of the test the A&E will indicate the testing process and procedures for each system. Test could include operation of the system during power outages. The installer of the system shall be available during the complete testing process to answer questions from the Engineer and to demonstrate specific parts of the system. If personnel from the installer or test equipment is not available, the test will be considered and marked as a failure.
- E. A punch list of the items to be corrected will be prepared by the A&E during the final acceptance test. The installer shall correct all items and request a second day for verification of all punch-list items by the A&E and Owner. During the second test, no additional punch list items shall be expected, and only the items in the punch list will be tested.
- F. If during the testing process the A&E and/or Owner consider that the rate of failure of the test is too high (more than 5 failures or non-compliance with specifications in one hour of test), the test will be cancelled unilaterally by the A&E and/or owner. The installer shall correct all items and re-schedule the final acceptance test again. The new test will start over from the beginning and nothing previously tested will be accepted. The installer shall not be entitled to additional compensation for the additional effort to test the system during this condition. To the contrary, the Contractor/Installer shall reimburse the owner of the project with the cost of the additional hours of testing required to be spent by the A&E and owner's team. The rate to be used for this reimbursement will be \$150 per hour per person required by the A&E and Owner to complete the test.
- G. Upon successful completion of the final acceptance test the installer of the system will receive a written notice by the A&E and/or Owner acknowledging the acceptance of the test
- H. See individual specification sections for system specific requirements for testing.

#### 3.7 TRAINING AND INSTRUCTION

- A. Training for each technology system shall be provided as indicated in this specification and in the individual specification section for each system.
- B. The following training guidelines shall be followed for all technology system.
  - 1. Training shall not be scheduled in a way that no attendee or presenter shall be required to attend more than 6 hours of training per day.
  - 2. Prior to starting all training, the training submittal shall be approved. See section one of this specification for details on the training submittal
  - 3. No training shall be scheduled prior to the system being completed and accepted by the A&E.
  - 4. Training shall be conducted during normal business hours of the client, at a date and time of mutual convenience to the Owner and installer. All training sessions need to be scheduled by the installer at least 2 weeks in advance. The Owner shall be notified in writing by the installer on when are the possible dates for each session.
  - 5. All different types of training shall be videotaped and delivered to the owner as part of the close out information in digital copy. All tapes shall be recorded in hi-quality MPEG2 or HD recorders, and the media turned to the owner shall be in electronic format viewable through QuickTime or Windows Media Player.
  - 6. The installer is responsible for completing list of attendants for each session of training. All these sheets shall be submitted as part of the close out information.

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#### 3.8 AS BUILT DOCUMENTS

- A. Production: During the course of this project the contractor shall maintain record "as-built drawings". One set shall be maintained at the site and at all times and it shall be accurate, clear, and complete, showing the actual location of all equipment as installed. The "As-Built" drawings shall show all technology systems work installed complete to the present stage of progress. These drawings shall be available for review by the A&E's field representatives at all times.
- B. Completion: At the completion of the Work, transfer onto the second set of drawings all changes marked in colored and submit to the A&E.
- C. Final: Upon installer's completion of the Engineer's final punch list, transfer all "As-Built" conditions and all requirements by the Engineer to a reproducible set of drawings. Submit full size drawings and one (1) set of CAD/Autodesk Revit© disks for review and acceptance.
- D. Additional documents. At project completion, the installer of the technology system shall provide, as part of the as-built documents, updated tables, equipment schedules, configuration worksheets and labeling system used. See individual system specification section for more details on these documents.
- E. See individual specification sections for each system for additional requirements for As-Built documents.

#### 3.9 CLOSE OUT DOCUMENTS

- A. Closeout information shall be provided to the owner in electronic format at the end of the project. The file shall be organized by each system and shall follow this organization:
  - 1. PART 1 – OPERATION AND MAINTENANCE MANUALS. Operation and Maintenance manuals as issued by the manufacturer of each system's component. Such manuals shall include all maintenance procedures required to be done by the owner. Also, when required by each individual specification section, a short form operation guide, prepared by installer) for the system.
  - 2. PART 2 – INVENTORY OF EQUIPMENT INSTALLED. A detailed list of all relevant active equipment (equipment with electronic components with a market value over \$200) installed in the project including the following information and presented in electronic format (Microsoft Excel):
    - a. Make
    - b. Model
    - c. Serial number
    - d. Room location
    - e. Warranty period, including manufacturer's extended warranties.
  - 3. PART 3 – PROOF OWNERSHIP, DELIVERY AND ACCEPTANCE. The following letters/documents shall be attached in this part:
    - a. Acceptance letter signed by A&E for each of the technology systems installed.
    - b. Proof of training by submitting sign in sheets for each training session done
    - c. Signed transmittal for all training videos and training material.

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- d. Signed transmittal for all spare parts and consumables delivered to the owner.
  - e. A list of all the user names and passwords for all the different software programs used by the technology systems and any equipment with password codes. All levels of passwords shall be provided, from the lowest hierarchy to the highest.
  - f. At least four (4) copies of all physical keys to different devices part of the technology systems. Each key shall be individually tagged in a key ring. All keys shall be included and organized inside a key ring management enclosure.
  - g. A list of all software modules and licenses delivered to the owner. The list shall include part numbers, serial numbers, license certificate of authenticity, hardware key (dongles) numbers and software version. This list shall have a clear signature, name and date on person that received this software by the Owner.
  - h. A copy of all official equipment and software registrations with manufacturer.
4. PART 4 – AS BUILT DOCUMENTS. All as-built documents as indicated in this specification section

END OF SECTION 270010

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**ATTACHMENT 1 – SUBSTITUTION REQUEST FORM**

Substitution Request Number: \_\_\_\_\_

PROJECT: \_\_\_\_\_ DATE: \_\_\_\_\_

SPECIFICATION SECTION: \_\_\_\_\_ ITEM(S): \_\_\_\_\_

SPECIFIED MANUFACTURER: \_\_\_\_\_

SPECIFIED MODEL NO: \_\_\_\_\_

PROPOSED MANUFACTURER: \_\_\_\_\_

PROPOSED MODEL NO: \_\_\_\_\_

REASON(S) FOR NOT PROVIDING SPECIFIED ITEM: \_\_\_\_\_

Attach product description, drawings, photographs, performance and test data, samples and other information necessary for side-by-side evaluation. Fill in all blanks.

A. Provide substantiated reason for requested substitution.

B. Does the requested substitution affect dimensions, locations or configurations?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (attach drawings if necessary): \_\_\_\_\_

\_\_\_\_\_

C. What are the differences between the specified item and the requested item:

\_\_\_\_\_

\_\_\_\_\_

D. Will the Contractor pay for any changes to the building design, including engineering and detailing costs caused by the approval?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (if no, and describe modifications required to install or accommodate the requested change): \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

E. Will approval affect the work of other trades, including the Construction schedule?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (if yes): \_\_\_\_\_

\_\_\_\_\_

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F. Manufacturer's guarantees of the proposed and specified items are:

Same: \_\_\_\_\_ Different: \_\_\_\_\_

Explain (if different): \_\_\_\_\_

G. Does the proposed item meet all applicable codes, ordinances and regulations for this specific application?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (if no): \_\_\_\_\_

H. Has proposed item been used locally in similar applications?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (give nearest location): \_\_\_\_\_

I. Will maintenance and service parts be locally available for the requested item?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (if no, give nearest location): \_\_\_\_\_

J. Will the requested item require waiving of any qualifications or other requirements?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (if yes): \_\_\_\_\_

K. Are there any license fees or royalties associated with the requested substitution?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (if yes): \_\_\_\_\_

L. If approved, will the Owner receive a credit for the proposed alternate material?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (if no): \_\_\_\_\_

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M. Does the proposed alternate material meet the same applicable standards (ASTM, ANSI, UL, FS) as the specified item?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (if no, attach drawings if necessary): \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

N. Identify the recycled materials or components or features that lead to the claims to being "Green": \_

\_\_\_\_\_

\_\_\_\_\_

O. Has the required line-by-line comparison been included?

No: \_\_\_\_\_ Yes: \_\_\_\_\_

Explain (if no): \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

The undersigned agrees to pay for the Designer's review time and for changes to the building design, including review, re-design, engineering, drawings and other costs caused by the requested substitution.

\_\_\_\_\_

Signature

\_\_\_\_\_

Print

The following Purchase Order or billing number is to be used for billing the Contractor for costs incurred in evaluating and if applicable accommodating the requested substitution.

\_\_\_\_\_

The Engineer will not be required to approve any product that is not equal or suitable for the specific application and functionality of this project.

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## ATTACHMENT 2 – NETWORK CONNECTIONS PROGRAMMING PLAN

### TLC ENGINEERING SOLUTIONS NETWORK CONNECTIONS PROGRAMMING PLAN

<b>PROJECT NAME</b>	
<b>DATE</b>	

<b>SUBCONTRACTOR</b>	
<b>TRADE</b>	

TYPE OF DEVICES FORM (Fill one column per device type provided)						
DEVICES CHARACTERISTICS	DEVICE NAME		DEVICE NAME		DEVICE NAME	
	DEVICE CODE	A	DEVICE CODE	B	DEVICE CODE	C
Manufacturer						
Part Number						
Firmware version						
Is a fixed address required or can device work with a dynamic address (DHCP)?						
Does device require an address from a DNS server?						
Does device support Layer 3 traffic (IP)?						
Does device needs access to the internet?						
Number of physical network ports per device?						
Does device require IPv6 to work or IPv4?						
Does device support SNMP?						
Does device need specific TCP ports open? Please list						
Is this device connecting to existing network devices (Yes/no) Server/client application						
If yes to above, please describe to what device, located where.						

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**TLC ENGINEERING SOLUTIONS**

PROJECT NAME	
DATE	
SUBCONTRACTOR	
TRADE	

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## SECTION 270526 – GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.
- C. General: For grounding electrode system and equipment grounding system for Telecommunications refer to specification section 260526. In all cases the applicable electrical codes for grounding and bonding for telecommunications shall be met.
- D. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
  - 1. 270010 Technology General Provisions
  - 2. 270528 Raceways for Technology
  - 3. 271000 Structured Cabling System
  - 4. 260526 Grounding and Bonding for Electrical Systems
- E. General. For a bonding diagram for telecommunications refer to T Drawings.
- F. General. The bonding approach required herein is intended to work in concert with the cabling topology as specified in Specification section 271000 and installed in accordance with specification section 270528.
- G. Reference Standards:
  - 1. TIA-607-C
  - 2. TIA-568.0-D
  - 3. TIA-606-C
  - 4. UL 1863 Communication Circuit Accessories
  - 5. UL-50 & UL-514
  - 6. NFPA 70 – NATIONAL ELECTRIC CODE

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7. IEEE Std. 1100-1992, Powering and Grounding Sensitive Electronic Equipment.
8. BICSI TDDMM, Telecommunications Distribution Method Manual.
9. UL 1449

## 1.2 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 270010 are followed.

## 1.3 SHOP DRAWINGS AND SUBMITTALS

- A. See additional requirements for shop drawings and submittals in specification section 270010.
- B. The installer of the Telecommunications Grounding systems shall provide the following information in the shop drawings phase of the project:
  1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
  2. A spreadsheet indicating telecommunications ground bar information selection for each telecommunications room indicated in the design drawings, including the following information:
    - a. Room Name or number
    - b. Quantity of ground bars
    - c. Height of each ground bar
    - d. Length of each ground bar
    - e. Number of holes in each ground bar
    - f. Label for each ground bar
  3. A drawing indicating the following information:
    - a. Location of all telecommunications ground bars and routing of all telecommunications grounding backbones.
    - b. Wire size charts for all telecommunications grounding backbones in the project.
    - c. All labels to be used in telecommunications backbone cables, bonding conductors and telecommunications ground bars.

## 1.4 ABBREVIATIONS

- A. General: The following abbreviations are used in this specification section:
  1. TBB - Telecommunications Bonding Backbone
  2. BC - Bonding Conductor
  3. EMT - Electrical Metallic Tubing
  4. RMC - Rigid Metal Conduit

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## PART 2 - PRODUCTS

### 2.1 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- A. The TMGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB shall be located and provided in the Main Telecommunication Room in each building. The TMGB must also be listed by a nationally recognized testing laboratory (NRTL).
- B. The TMGB shall have the following specifications:
  - 1. Material: Copper with a thin plated finish.
  - 2. Thickness: ¼" thick
  - 3. Width: No less than 4"
  - 4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 14" long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
    - a. Two holes required for each TBB termination.
    - b. Two holes for each cabinet or rack row in the room
    - c. Two holes for each protector block in the room
    - d. Two holes for each layer of ladder tray above the rack.
    - e. Two holes for each set of conduit sleeves entering the room
    - f. 20% of spare capacity shall be available after all terminations are done.
    - g. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.
  - 5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16"
  - 6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.
- C. The TMGB shall be installed in the wall with stand offs and isolators. Isolators shall be rated at 600V.
- D. Approved manufacturers:
  - 1. Panduit,
  - 2. Erico or
  - 3. approved equal.

### 2.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR INTERIOR USE

- A. The TGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TGB shall be located and provided in each telecommunication room (except the main telecommunication room) in each building and any other additional locations as indicated in the drawings. The TGB must also be listed by a nationally recognized testing laboratory (NRTL).
- B. The TMGB shall have the following specifications:

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1. Material: Copper with a thin platted finish.
2. Thickness: ¼" thick
3. Width: No less than 4"
4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 12" long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
  - a. Two holes required for each TBB termination.
  - b. Two holes for each cabinet or rack row in the room
  - c. Two holes for each protector block in the room
  - d. Two holes for each layer of ladder tray above the rack.
  - e. Two holes for each set of conduit sleeves entering the room
  - f. 20% of spare capacity shall be available after all terminations are done.
  - g. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.
5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16"
6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.

C. The TMGB shall be installed in the wall with stand offs and isolators. Isolators shall be rated at 600V.

D. Approved manufacturers:

1. Panduit,
2. Erico or
3. approved equal.

## 2.3 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR OUTDOOR USE

A. When TGB are located outdoors, all specs for indoor used TGB shall be followed with the exception of the construction material. The TGB for outdoor use shall be made of galvanized steel.

## 2.4 FLEX CONDUCTOR, ONE-HOLE, LONG BARREL WITH WINDOW LUG

A. All BCs (different from TBB) shall be terminated in a flex conductor, one hole, long barrel with window lug when a two hole connector is not possible to be used because receiving equipment does not support the two holes. All lugs shall be selected to match the size of the conductor being used. Other types of terminations such as screw type connectors are not accepted

B. The flex conductor, one hole, long barrel with window lug shall have the following specification:

1. Finish: Thin platted
2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
3. Stud hole size: ¼"

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4. Barrel type: Long barrel > 1"
5. Termination type: crimp type
6. Angle: straight or angled if installation space is limited.
7. Listing: UL listed and tested to 35 KV and 90°C

C. Approved manufacturers: Panduit, Thomas & Betts or approved equal.

## 2.5 FLEX CONDUCTOR, TWO HOLE, LONG BARREL WITH WINDOW LUG

A. Flex conductors, two hole, long barrel with window shall be used with TBB and BCs to provide a good bond. All lugs shall be selected to match the size of the conductor being used. Other types of termination are not accepted.

B. The flex conductor, two hole, long barrel with window lug shall have the following specification:

1. Finish: Thin platted
2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
3. Stud hole size: 1/4"
4. Hole spacing: to match spacing of pre-drilled holes in ground bar or equipment.
5. Barrel length: long barrel > 1"
6. Termination type: crimp type
7. Angle: straight or angled if installation space is limited.
8. Listing: UL listed and tested to 35 KV and 90°C

C. Flex conductors, two hole, long barrel with window shall be used with BCs in the following cases:

1. Bonding two sections of pathways such as sections of tubular runways or cable trays.
2. Bonding a BC or a TBB to a TGB or TMGB
3. Bonding to equipment that requires two holes for bonding.

D. Approved manufacturers:

1. Panduit,
2. Thomas & Betts or
3. approved equal.

## 2.6 HTAP CONNECTOR

A. When a BC is required to be bonded to another BC of same or different size the only approved method of bonding is with HTAP style crimp connectors. Screw type connectors, wire nuts or any other method are not acceptable. The specifications of the HTAP connectors are:

1. Finish: Thin platted
2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
3. Tap grooves: installer to select HTAP connector based on size of BCs and quantity of BCs to be bonded.

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4. Slots: The HTAP connector shall have a lot to support the unit to the bonding conductors with nylon cable ties for initial support before crimping.
5. Termination type: crimp type
6. Listing: UL listed and tested to 600V

B. Approved manufacturers:

1. Panduit,
2. Thomas & Betts or
3. approved equal.

## 2.7 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- A. Telecommunications bonding backbones shall be provided as indicated in the design documents. TBBs shall be insulated copper stranded conductors with a wire gauge dictated by the length of the cable. The TBB shall be sized at 2 kcmil per linear foot of conductor length up to a maximum of 3/0 AWG. The following table shall be used to estimate the size of the TBBs:

TBB length linear m (FT)	TBB Size (awg)
Less than 4 (13)	6
5- 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8– 10 (27 – 33)	2
10– 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
Greater than 20 (66)	3/0

- B. Once a TBB has been sized with a particular gauge, any extensions of such backbone shall not be done with a wire gauge smaller than the previous run regardless of distance.

## 2.8 BONDING CONDUCTOR (BC)

- A. Bonding conductors shall be used to bond equipment and raceways to the telecommunications grounding infrastructure. The specifications of the BC are:
1. Conductor Size: use the chart above for TBB to estimate the size of the bonding conductor. BC shall be no smaller than an AWG-6
  2. Material: copper stranded conductors.
  3. Insulation: Use non-insulated conductors only under raised floor spaces. Insulation color shall be green with a yellow stripe.

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- B. Pre-fabricated BCs or field made BCs are acceptable.
- C. Both ends of a BC shall be terminated in long barrel lugs.

## 2.9 LABELS FOR TELECOMMUNICATIONS GROUNDING INFRASTRUCTURE

- A. Installer shall follow labeling materials indicated in specification section 270010.

## PART 3 - EXECUTION

### 3.1 INSTALLATION PRACTICES

- A. General: Specification section 260526 applies to work of this section. Installation requirements specified herein takes precedence over specification section 260526.
- B. General: All installation requirements indicated in specification section 270010 shall be followed.
- C. PROTECTION. The TBBs and BCs shall be installed and protected from physical and mechanical damage.
- D. GALVANIC CONTINUITY. The TBBs and BCs shall be continuous and routed in the shortest possible straight line path.
- E. CRIMPING. All lugs shall be crimped with the proper die for the size of lug being used.
- F. PAINT REMOVAL. Paint shall be removed before attaching any BC to an equipment with paint in the surface, such as ladder trays and racks, if no ground lug is available in the equipment.
- G. SPLICING. The TBBs and BCs shall be installed without splices. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located within telecommunications spaces. Joined segments of a TBB or BC shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage.
- H. BONDING TO ELECTRICAL PANELS. The TGB or TMGB shall be as close to the electrical power panel as is practicable and shall be installed to maintain clearances required by applicable electrical codes. The electrical power panel bus or the panel enclosure feeding telecommunications equipment racks/cabinets shall be bonded to the TGB or TMGB.
- I. BONDING TO BUILDING STEEL. All connectors used for bonding to the metal frame of a building shall be listed for the intended purpose.
- J. LUG SCREWS. All connections from lugs to ground bars or grounding equipment shall be done with metal screws with nuts and compression washers. Connections made with metal self tapping screws will not be allowed.
- K. BONDING PROTECTOR BLOCKS. All primary or secondary building entrance protectors

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blocks shall be bonded to the nearest TMGB or TGB with a BC. A minimum of 300 mm (1 ft) separation shall be maintained between this insulated conductor and any dc power cables, switchboard cable, or high frequency cables, even when placed in rigid metal conduit or EMT.

- L. BONDING OUTSIDE PLANT CABLES. When the outside plant cables in the Telecommunications Entrance Facility room incorporate a cable metallic shield (armor) isolation gap, the cable metallic shield on the building side of the gap shall be bonded to the TMGB or TGB or the rack/cabinet or the rack's vertical ground bar (if available).
- M. BONDING BACKBONE CABLES. Where backbone cables (fiber or copper) incorporate a shield (armor) or metallic member, this shield or metallic member shall be bonded to the TMGB or TGB or rack/cabinet or the rack's vertical ground bar (if available).
- N. BONDING HORIZONTAL CABLES. When shielded horizontal cable is used and terminated in patch panels, each patch panel needs to be bonded to the telecommunications grounding systems. A BC shall be used between each patch panel and the rack rails of the rack/cabinet or the rack's vertical ground bar (if available).
- O. INTENDED USE OF TBB OR BC. The TBB or BC is not intended to serve as the only conductor providing a ground fault current return path. The intended function of the TBB or BC is to equalize potential differences between telecommunications systems.
- P. INSTALLATION OF TBBs INSIDE TELECOMMUNICATIONS SPACES. When TBBs are run inside telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs inside telecommunications spaces can be made of PVC and shall be sized and supported as required by NEC.
- Q. INSTALLATION OF TBBs OUTSIDE TELECOMMUNICATIONS SPACES. When TBBs are run outside of telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs outside telecommunications spaces shall be EMT or RMC. To avoid an electromagnetic choke effect in this conductor, each end of the conduit used to protect the TBB shall be bonded to the TMGB or TGB at each end. Conduit used for protection of TBBs shall be sized and supported as required by NEC.
- R. RACK/CABINET BONDING. All racks/cabinets in the project shall be bonded to the nearest TMGB or TGB inside the room. All rows of rack/cabinets shall be bonded together by a single AWG-2 conductor coming from the nearest TMGB or TGB inside the room. This bonding conductor shall be insulated and run above the racks in the side of the cable tray system, going above the racks, supported by a hanger external to the cable tray. At each rack a bonding jumper (AWG-6) shall be provided and terminated to the rack manufacturer's recommended lug for bonding the rack/cabinet. The bonding jumper shall be connected to the AWG-2 conductor by means of an HTAP connector, protected with heat shrink material. This ground bar shall be the termination point for the bonding jumper for each rack and shall also bond the manufacturer's approved grounding lug in the rack/cabinet to the ground bar.
- S. RACK/CABINET BONDING OUTSIDE OF TELECOM ROOMS. Racks/cabinets outside of telecom rooms shall be bonded to the nearest electrical ground with a BC.
- T. LABELING: All labeling systems for telecommunications grounding infrastructure shall be in compliance with the ANSI/TIA/EIA-606-C standard. At a minimum, the following elements



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shall be labeled in the telecommunications grounding system:

1. All TMGB or TGB, with a unique identifier located in the wall near the unit, not on the ground bar.
  2. All TBBs in the project with a unique identifier at each termination point of each TBB. The label in one side of the cable shall indicate the termination location of the other side of the cable.
  3. BC for rows of racks with a unique identifier at both ends of the cable
  4. BC for surge protectors with a unique identifier at both ends of the cable
- U. ADDITIONAL LABELING. All BCs bonding rows of racks/cabinets and TBBs shall have additional to the identification marker a yellow printed wrap around tag installed close to the bonding point strap to the cable jacket with a flame retardant cable tie. This tag shall have the following wording in green letters: "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER".
- 3.2 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION
- A. See specification section 270010 for these requirements.

END OF SECTION 270526

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## SECTION 270528 – RACEWAYS FOR TECHNOLOGY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.
- C. Section 260533 - Raceway Systems, apply to work of this Section. Specifications described herein take precedence over Section 260533.
- D. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
  - 1. 270010 Technology General Provisions
  - 2. 270526 Grounding and Bonding for Telecommunications Systems

#### 1.2 DESCRIPTION

- A. General: Furnish and install complete with all accessories a Pathways and Spaces infrastructure for supporting of Structured Cabling System (SCS) and housing of technology equipment. The goal of the project is to provide a reliable architecture of the building that shall serve as a support for transport of data, voice telephony, security and audio/visual cabling throughout the building from designated demarcation points to places located at various wall, floor, ceiling, column, room and other locations as indicated on the contract drawings and described herein.
- B. General: For pathways the system shall utilize a combination of conduit, cable tray and supports for vertical and horizontal cabling support. Pathways shall be provided and located as shown and in the quantities indicated on the drawings. Pathways shall terminate in rooms or closets using approved fasteners and termination hardware and bushings and shall be reamed to eliminate sharp edges. All Pathways shall be identified at all locations.
- C. All installers should anticipate that all products and installation procedures shall comply with the ANSI/TIA-569-D requirements at a minimum.

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- D. General: Installation of the raceways for communications shall be a complete system including all supports and hangers as required per contract documents and manufacturer's installation guidelines.
- E. Support: All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters' Laboratories. Wire shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling suspension wires or to ceiling channels. Do not install any devices supported by ceiling tiles.
- F. Installation: The Installer shall layout and provide his work in advance of the laying of floors or walls, and shall provide all sleeves that may be required for openings through floors, walls, etc. Where plans call for conduit to be run exposed, provide all inserts and clamps for the supporting of conduit.
- G. Pull Strings: Provide pull strings in all raceways. Pull strings shall be nylon and shall be impervious to moisture. Pull strings installed in one (1) inch and smaller conduits shall have a tensile strength of not less than 30 lbs. Pull strings installed in conduits larger than one (1) inch shall have a tensile strength not less than 200 lbs.

## 1.3 INSTALLER QUALIFICATIONS

- A. General: The installer selected for the Project must be BICSI certified installer and certified by the manufacturer for the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning the Project.
- B. General: The Installer directly responsible for this work shall be a " Pathways and Spaces for Structured Cabling System Installer (PS-SCS) " who is, and who has been, regularly engaged in the providing and installation of commercial and industrial pathways and spaces for telecommunications wiring systems of this type and size for at least the immediate past five years. Any sub-Installer who will assist the PS-SCS installer in performance of this work, shall have the same training and certification as the PS-SCS installer.
- C. Certification: The installer's Project Manager shall possess a current and in good standing BICSI Registered Communications Distribution Designer (RCDD) certificate. All shop drawings submitted by the installer shall bear the RCDD's seal.
- D. Experience: The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and have personnel who are adequately trained in the use of such tools and equipment.

## 1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 270010 are followed.

## 1.5 SHOP DRAWINGS AND SUBMITTALS

- A. See additional requirements for shop drawings and submittals in specification section 270010.

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- B. General: The PS-SCS installer shall provide no later than 30 days after contract award the following information:
1. Proof of Installer's qualifications per paragraph 1.03.
  2. Cut sheets of all products to be used for the project, highlighting in particular the precise product to be used in each case, when multiple devices are indicated in the cut sheet. At a minimum the following devices shall be submitted with this specification section:
    - a. Supporting devices (j-hooks) if allowed in the project. See part 3 of this specification.
    - b. Cable tray system with accessories
    - c. Runway cable tray system with accessories.
    - d. Plywood
    - e. Through wall/floor firestop system
    - f. Innerduct
    - g. Detectable tape
    - h. Conduit waterfalls
    - i. Fire stop system (for small penetrations)
  3. Drawings indicating precise location and type of all support for cable tray or ladder tray systems in all areas where they will be used.
  4. For all communication vaults, drawings shall be prepared indicating conduit penetrations on each side of each vault. Vaults shall be labeled to indicate their correct location in the site plan.
  5. Pre-cast communications vaults shall be submitted with load calculations signed and sealed by a professional engineer.
  6. For any directional boring runs, the installer shall provide a drawing indicating all underground locate surveys and the proposed routing of the conduit as well as proposed depth.

## 1.6 WORK EXTERNAL TO THE BUILDING

- A. General: Any work external to the confines of this building as shown on the drawings shall be governed by provisions of this specification.

## PART 2 - PRODUCTS

### 2.1 CONDUIT

- A. All conduits as indicated in Section 26

### 2.2 TELECOMMUNICATIONS OUTLET BOX

- A. Telecommunication outlet electrical boxes shall be used to make terminations to limited energy systems described in Division 27 and Division 28 specifications. Telecommunications outlet boxes shall have the following specifications:
1. Material: Steel, 0.6858mm. thickness (minimum) with galvanized zinc coating, 0.013mm. (minimum) thickness on both sides of bracket

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2. Construction: Cleanly punched knockouts, welded at 8 points (minimum) with softened edges (no sharp edges).
3. Size (HXW): 4-11/16" X 4-11/16"
4. Depth: 2-1/8"
5. Knock outs: At least one of this dimension: 1"
6. Listing: UL or ETL

- B. Telecommunications outlet electrical boxes shall be provided with the appropriate 1 gang or 2 gang rings selected for the proper thickness of the drywall in all areas. Standard telecommunications outlets shall use 1 gang ring, but design documents might indicate the use of 2 gang rings in selected areas.
- C. Knockouts in telecommunications outlet boxes shall not be field punched.
- D. Basis of design: Raco, Steel City, Randal Industries Inc,

## 2.3 WIREWAYS

- A. General: Wireway shall be sized as shown on drawings, NEMA 1, lay-in type. Wireway sides and bottom shall contain no knock-outs unless shown otherwise on the drawings. The Installer shall punch holes required. The cover shall be hinge type with quarter turn fasteners to hold cover shut. Covers and bodies shall be 16 gauge steel. Wireway shall be as manufactured by Hoffman Engineering Company, Square "D" or Steel City.

## 2.4 SUPPORTING DEVICES

- A. Hangers: Hangers shall be made of durable materials suitable for the application involved. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected after fabrication by galvanizing, or approved suitable preservative methods.
- B. Non-continuous cable supports (j-hooks) shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed.
- C. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
- D. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
- E. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
- F. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.
- G. Anchoring: Insert anchors shall be installed on concrete or brick construction, with hex head machine screws. Recessed head screws shall be used in wood construction. An electric or hand drill shall be used for drilling holes for all inserts in concrete or similar construction. Installed inserts, brick, shall be near center of brick, not near edge or in joint. Drilled and tapped, and round head machine screws shall be used where steel members occur. All screws, bolts, washers, etc.,

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used for supporting conduit or outlets shall be fabricated from rust-resisting metal, or accepted substitution. Gunpowder or lead set anchors are not permitted.

- H. Accessories: Non-continuous support systems shall be provided with the adequate mounting accessories depending on the location where the support will be installed, like beam clips, flange clips, C and Z purlin clips.
- I. Accepted manufactures; Erico or Panduit.

## 2.5 TUBULAR RUNWAY CABLE TRAY AND FITTINGS

- A. Materials: ASIM A36 steel bar.
- B. Finish: Baked Powder painted surface treatment using Polyester coating.
- C. Finish color: to match equipment cabinet finish color. See specification section 271000.
- D. Cable management tray width: as shown on the drawings.
- E. Fittings: Cable management fittings and hardware recommended by Manufacturer. Provide drop-off, 90° and tees as required for the equipment served and support of the cable. Provide at least one large radius drop off for each rack/cabinet in the project.
- F. Installation: Cable management system to be installed using support components as recommended by the Manufacturer.
- G. Loading: Cable management system to be installed and supported per Manufacturer's suggested span load criteria.
- H. Approved Manufacturers: B-line, GS Metals, Chatsworth.

## 2.6 PLYWOOD BOARDS IN TELECOMMUNICATION ROOMS

- A. Plywood Backboard: Backboards shall be installed in each TR and the MTR on walls to a height of 8' AFF or as shown on the drawings. Rooms shall have walls covered as shown on the drawings
- B. Acceptable options for plywood boards are:
  - 1. ¾" AC Grade fire rated plywood painted with two coats of fire retardant paint in both sides and on the edges.
  - 2. Pre-manufactured plywood system for telecommunications such as ReadySpec by Pathways and Spaces Inc.
- C. Other specifications:
  - 1. All imperfections and voids shall be filled, sealed and sanded prior to being primed and painted.
  - 2. Fire retardant coating shall be tested to UL723, "Test for surface burning characteristics of building materials."

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3. Paint color shall be grey, white or blue.
4. Fire retardant plywood shall be clearly labeled with the name of the Backboard Manufacturer, UL Classification of the Fire Retardant Coating, NFPA 255 Coating Flame Spread Index Class and the APA Grade of the plywood.
5. Plywood shall be installed with best side out.

**2.7 THROUGH WALL/FLOOR FITTING FIRE STOP SYSTEM**

- A. General. These devices covered under this specification are firestop devices for use in through-penetration firestop systems, which are used to maintain the fire rating of the wall or floor, as well as to route and protect power and/or communications cable distribution for commercial, educational, healthcare, government, institutional, industrial and utility needs.
- B. Classification and use: The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of 3.3 cfm. The device shall be classified for use in one-, two-, and three-hour rated concrete floors having a minimum 4 1/2" (114mm) thick reinforced lightweight or normal weight (100-150 pcf) (1600-2400 kg/m<sup>3</sup>). The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.
- C. Materials:
  1. Box: The fire stop device box shall be constructed of 16 gage G90 steel.
  2. Intumescent block: The fire stop device intumescent block shall be constructed of a graphite base material with expansion starting at 375° F and an unrestrained expansion between 6 to 12 times. The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.
  3. Adjustable doors: the fire stop device shall have doors or other system which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16 gage G90 steel with no. 10-32 screws use to adjust opening size.
  4. Heat shield: For retrofit applications where an existing in-wall conduit extends out from the wall more than 7/8" [22mm], a UL listed Heat Shield must be used in order to maintain UL Fire Classification. The firestop device is then installed onto the heat shield
  5. Split conduit and wall plate: For retrofit applications where no conduit is installed in the wall to protect existing cables, a split conduit assembly should be used to protect cables. After installing the split conduit within the wall, a wall plate should be installed to cover any irregularly shaped hole cut in the wall. The firestop device is then installed onto the conduit.
- D. Sizes: the fire stop device shall be available for two (2) inch and four (4) inch trade size emt conduit.
- E. Finish: the fire stop device shall be available in safety yellow or orange powder coat, custom colors and an unpainted galvanized finish.
- F. Design selection: Wiremold FlameStopper, STI EZpath or approved equal

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## 2.8 INNERDUCT (REGULAR)

- A. Flexible raceway system also referenced in the design documents as regular innerduct or innerduct shall be provided in locations indicated in design drawings. The innerduct type shall be selected according to the environment where it will be installed, use HDPE innerduct only outdoors, use plenum or riser rated innerduct indoors. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.
- B. For plenum rated applications, the specifications of the innerduct shall be:
  - 1. Material: White or orange Kynar PVDF Resin, a fluoropolymer compound.
  - 2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed in the product.
  - 3. Marking: Footage shall be sequentially marked.
  - 4. Configuration: corrugated type.
  - 5. Pull line: built in 900 lb rated tape.
  - 6. Size: Shall be available in ¾" through 2" diameters.
- C. For riser rated applications, the specifications of the innerduct shall be:
  - 1. Material: Orange polyvinyl chloride (PVC).
  - 2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed in the product.
  - 3. Marking: Footage shall be sequentially marked.
  - 4. Configuration: corrugated type.
  - 5. Pull line: built in 900 lb rated tape.
  - 6. Size: Shall be available in ¾" through 2" diameters.
- D. For outdoor applications, the specifications of the innerduct shall be:
  - 1. Material: High Density Polyethylene (HDPE).
  - 2. Listing: None.
  - 3. Marking: Footage shall be sequentially marked.
  - 4. Configuration: corrugated type.
  - 5. Pull line: built in 1,800 lb rated tape.
  - 6. Size: Shall be available in ¾" through 2" diameters.
- E. All inner ducts shall be provided with couplings and accessories suitable for the environment where they will be installed.
- F. Design selection: products by Carlon or approved equal.

## 2.9 DETECTABLE TAPE

- A. A detectable tape shall be installed above all underground conduit at a minimum depth of 18" or as shown on the drawings. The detectable warning tapes shall be constructed with a solid aluminum foil core with a minimum thickness of 5 mils and 3" wide. The detectable warning shall have printed diagonal warning stripes conform to APWA color recommendations and bold, black legends identify what type of utility line is buried below. All detectable tapes used for this shall be labeled "fiber optics buried below".



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- B. Design selection: Detectable tape from Carlon, Stranco, Ind., Terra Tape or approved equal.

## 2.10 CONDUIT WATERFALLS

- A. All 4" EMT terminations with communication cable entering/exiting the conduit from a cable tray (or tubular runway) system and the vertical separation between raceways is larger than 7" shall be fitted with a device to control the bend radius of the communication cable to a minimum of a 4" radius. The device to control the bend radius shall be called a conduit waterfall and must comply with all National Electrical Code requirements and TIA/EIA Standards. In addition, the product must be RoHS compliant to meet environmental requirements, be UL 94V-0 approved to reduce the spread of flame, and be approved by UL for use in air handling spaces. The device to provide bend radius control must support a static load of 40 lbs. (177.9 N) and have a fastening device that allows for incremental adjustments to conform to variances in conduit diameters.
- B. Device quantities are not indicated in the drawings but the PS-SCS shall use all 4" conduits and sleeves indicated in the drawings to estimate the quantities of waterfalls to be used in the project.
- C. Basis of design: Panduit CWF 400 or approved equal.

## 2.11 FIRE STOP SYSTEMS (FOR SMALL PENETRATIONS)

- A. General: Fire stop system shall be selected by the PS-SCS installer as to comply with the following requirements:
  - 1. Selected system shall be UL listed for the condition on which it will be installed. These conditions include: wall/slab type (masonry, drywall, etc), hour rating, and accessibility type.
- B. Acceptable systems: caulk based products or firestop grommets by STI or equal.

## 2.12 EXPANSION FITTINGS

- A. Installation: Provide expansion fittings in each conduit run wherever it crosses an expansion joint. Install the fitting on one side of the joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints.
- B. Location: Provide expansion fittings in each conduit run which is mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.
- C. Length: Provide expansion fittings in straight conduit runs above ground which are more than one hundred (100) feet long.

## PART 3 - EXECUTION

### 3.1 INSTALLATION PRACTICES

- A. See additional requirements indicated in part 3 of specification section 270010.

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## 3.2 INDOOR CONDUITS BELOW GRADE AND ABOVE GRADE

- A. BEND RADIUS. Conduits shall utilize long radius sweeps at all 90 degree transitions. The inside radius of a bend in conduit shall be at least six (6) times the internal diameter. When the conduit size is greater than two (2) inches, the inside radius shall be at least ten (10) times the internal diameter of the conduit. For fiber optic cable, the inside radius of a bend shall always be at least ten (10) times the internal diameter of the conduit
- B. MAXIMUM DISTANCE BETWEEN JBOXES. For indoor installation no section of conduit shall be longer than one hundred (100) ft or contain more than two (2) 90 degree bends between pull points or pull boxes are required. For outdoor installation no section of conduit shall be longer than six hundred (600) ft. or contain more than two 90 degree bends between pull points or pull boxes are required.
- C. LABELING. All indoor conduits 2" or larger shall be labeled at both ends when these conduit runs are continuous between two rooms and going through multiple walls or slabs. Labeling materials shall be as indicated in specification section 270010. Conduit sleeves 2" or larger penetrating just one wall is not required to be labeled.
- D. PULL STRINGS; All conduits for technology systems shall be installed with pull strings.

## 3.3 UNDERGROUND TELECOMMUNICATIONS DUCT LINES

- A. Description: Underground duct lines shall be of individual conduits. Conduits shall be encased in concrete where indicated on the plan drawings and duct bank sections. The conduit shall be of plastic, PVC Schedule 40, unless indicated or specified otherwise. The conduit used shall not be smaller than four (4) inches in diameter, inside, unless otherwise noted on the drawings.
- B. Duct lines shall have a continuous slope downward toward communication vaults and away from buildings with a pitch of not less than 0.125 inches per foot. Changes in direction of runs exceeding a total of ten (10) degrees either vertical or horizontal shall be accomplished by long sweep bends having a minimum radius of curvature of twenty five (25) feet, except that manufactured bends may be made up on one or more curved or straightened sections or combinations thereof. Manufactured bends shall have a minimum radius of forty eight (48) inches.
- C. Conduits. Conduits shall terminate in end-bells where duct lines enter manholes or communications vaults. Provide four (4) to six (6) inch reducers as required. Separators shall be of pre-cast concrete, high impact polystyrene, steel or any combination of these. The joints of the conduits shall be staggered by rows so as to provide a duct line having the maximum strength. During construction partially complete duct lines shall be protected from the entrance of debris, such as mud, sand and dirt by means of suitable conduit plugs. As the duct line is completed, a testing mandrel not less than 13 inches long with a diameter 1/4 inch less than the size of the stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand or gravel; conduit plug shall then be immediately installed.
- D. Conduit. Plastic conduit, fittings and joints shall not have been stored in the sun or weather, in any excessively heated space, or unevenly supported during storage. Use and installation shall be in accordance with the National Electrical Code requirements for the installation of non-metallic rigid conduit. Plastic conduit shall be protected against the direct rays of the sun prior to installation.

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Conduit shall be Carlon Type EB, Queen City Plastics, or accepted substitution. Conduit shall be U.L. listed and conform to NEMA Standard TC6 1972.

- E. Trench: Trenches for duct banks shall be completely dry before setting conduits or pouring concrete. Well pointing as required shall be provided if necessary to keep trench dry.
- F. Excavation: Backfilling shall be in layers not more than eight (8) inches deep, and shall be thoroughly tamped. The first layer shall be earth or sand, free from particles that would be retained on a 1/4 inch sieve. The succeeding layers shall be excavated material having stones no larger than would pass through a four (4) inch ring. The backfill shall be level with adjacent surface, except that in sodded or paved areas, a space equal to the thickness of the sod or paving shall be left.
- G. Finish: The surface disturbed during the installation of duct shall be restored to its original elevation and condition if not refinished in connection with site work.
- H. Plugging: All unused conduit openings shall be plugged or capped with a suitable device designed for the purpose; caulking compound shall not be used for plugging conduit openings.
- I. Stubs: Spare conduit stubs shall be capped and marked in the field and accurately dimensioned on the as-built drawings.
- J. Spacers: All conduit run underground, or stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose, or shall be strapped to Kindorf channel supported by conduit driven into ground or tied to steel.
- K. Minimum burial depth: All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300.5 of the NEC except that the minimum cover for any conduit or duct bank shall be two (2) feet, unless otherwise indicated.
- L. Directional boring. For all applications requiring directional boring the following installation practices shall be followed.
  - 1. The installer shall select the directional boring equipment based on the length of the pulls, soil conditions, pipe size and pipe quantities.
  - 2. When multiple pipes are run, each pipe shall be a different color.
  - 3. Any pipe run less than 1,500 ft, shall be run as a single pull without splices.
  - 4. Any splices done to HDPE pipes shall be done with manufacturer's approved methods.

## 3.4 INSTALLATION OF COMMUNICATIONS VAULTS

- A. Excavating and backfilling for vaults. Perform earthwork as specified in Division 2. Provide 6-inch minimum thickness 3/4-inch crushed rock over the full width of the vault base and extend 12 inches beyond the edges of the vault. After repairing the waterproofing, backfill and compact around the vault with structural backfill material. Excavated material may be used for structural backfill provided it conforms to the Standard Specifications for structural backfill material.
- B. Installing vaults and risers. Set each concrete vault section or riser plumb on a double layer bed of sealant at least 1/2-inch thick to make a watertight joint with the preceding unit. Point the inside joint and wipe off the excess sealant.

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- C. Waterproofing. Waterproofing shall be factory applied to all exterior surfaces of vaults and risers. This includes the bottom of the vault to be coated as an exterior surface. Apply two coats at a rate of 65 square feet per gallon per coat. Prior to backfilling, field apply waterproofing material on joints and damaged surfaces. Protect coating from damage during backfilling and compacting.

## 3.5 CUTTING AND PATCHING

- A. Core Drilling: The installer shall be responsible for all core drilling as required for work under this section, but in no case shall the installer cut into or weld onto any structural element of the project without the written approval of the A&E. Any post tension slabs or slabs with embedded electrical raceways shall be X-rayed prior to coring by the installer.
- B. Cutting and Patching: All cutting, rough patching and finish patching shall be provided as specified in the contract documents. All cutting and patching shall be performed in a neat and workmanlike manner.
- C. Openings and Sleeves: Locate all openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.
- D. Roof Penetration: All roof penetrations for raceways part of technology systems shall be approved by A&E prior to executing this work. All roof penetrations shall be as accepted by the roof manufacturer.

## 3.6 IDENTIFICATION OF BOXES

- A. Tags: During installation of pull strings all pull strings shall be marked with waterproof vinyl tags indicating where the opposite end may be found.

## 3.7 BLANK PLATES

- A. Plates: Unless otherwise noted all unused outlet boxes shall receive blank plates matching the finish of plates for electrical devices in the same room.

## 3.8 RACEWAY INSTALLATION

- A. SUPPORT. All raceways shall be run in a neat and workmanlike manner and shall be properly supported and in accordance with the latest edition of the NEC code and BICSI guidelines. Supporting conduit and boxes with wire is not acceptable. Exposed raceways where allowed, shall be supported with clamp fasteners with toggle bolt on hollow walls, and with no lead expansion shields on masonry. All conduits shall be securely fastened in place with at least one support per eight foot section. Support within one foot of changes in direction. All required hangers, supports and fastenings shall be provided at each elbow and at no more than one foot from the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits shall not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

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- B. **HANGER INSTALLATION.** Where two (2) or more conduits one (1) inch or larger run parallel, trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or Unistrut cross members. These conduits shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.
- C. **NON-CONTINUOUS CABLE SUPPORTS INSTALLATION.** When j-hooks are allowed in the project by this specification (See USE OF CONDUIT FOR DIFFERENT SYSTEMS) non-continuous cable supports (j-hooks) shall be installed only as recommended by manufacturer not exceeding the load ratings of the devices. Install non-continuous cable supports in spans no longer than 4'. Whenever there are changes in elevation additional supports shall be required to avoid having stress on cable or sharp bends.
- D. **FIRE STOPPING:** For 4" sleeves, the PS-SCS installer shall provide through wall/floor fittings firestop system and for other smaller sleeves or wall penetrations through fire rated partitions the PS-SCS installer can use the same type of firestop system or a fire stop system for small penetrations in compliance with products described in part 2 of this specification.
- E. **PENETRATIONS IN FIRE RATED PARTITIONS.** Installation of electrical boxes or equipment backboxes in fire rated walls and smoke barriers shall follow the following requirements:
1. Electrical boxes and or technology system backboxes can be installed in 1 or 2 hour rated walls as long as all requirements indicated in the proper Building Code, National Electrical Code and nationally recognized testing laboratories are met for this type of installation.
  2. As a summary, some of the requirements indicated by the codes listed above are:
    - a. Boxes shall be metallic or listed for that purpose
    - b. The area of the boxes shall not exceed 16 square inches, provided the aggregate area of the openings through the membrane does not exceed 100 square inches in any 100 square feet of wall area.
    - c. The spacing between the wall membrane and the box shall not exceed 1/8 of an inch.
    - d. Boxes on opposite sides of the walls shall be separated by no less than 24 inches, or boxes shall be covered by listed putty pads, or a listed material and method used.
  3. Electrical boxes or technology systems backboxes shall not be installed in a 3 or 4 hour fire rated walls.
- F. **ROUTING:** Conduits shall be run parallel to building walls wherever possible, exposed or concealed as specified, and shall be grouped in workmanlike fashion. Crisscrossing of conduits shall be minimized.
- G. **PROTECTION DURING CONSTRUCTION.** All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction until wires are pulled in and covers are in place. No conductors shall be pulled into raceways until the raceway system is clean and complete.

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- H. PROTECTIVE BUSHINGS: All un-terminated conduits shall have an insulated protective bushing to avoid cable damage at the edge of the conduit.
- I. AVOIDING EMI: To avoid EMI for Telecommunications cabling and/or conduit containing cabling, all raceways shall provide clearances of at least four (4) feet (1.2 meters) from motors or transformers; one (1) foot (0.3 meter) from conduit and cables used for electrical-power distribution; and five (5) inches (12 centimeters) from fluorescent lighting. Raceways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The Installer shall not place any raceway alongside power lines
- J. COORDINATION. All raceways shall be kept clear of mechanical equipment and plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.
- K. MASONARY INSTALLATION. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.
- L. USE OF CONDUIT IN DIFFERENT AREAS. When low voltage cables (any technology system) have to be run above ground in a space with no type of accessible ceiling (interior or exterior), all cable runs shall be in conduit completely, continuing the raceways all the way to the nearest accessible ceiling (in the direction of the telecom closet) or grouping the raceways into a single larger diameter conduit with the same or larger cross sectional area than the sum of all the conduits coming into it. The use of j-hooks to support low voltage cables in areas with no ceiling or hard ceiling shall not be allowed. This type of condition is usually not indicated in the drawings because design drawings don't show conduits smaller than 2", nevertheless it shall be provided as indicated herein.
- M. USE OF CONDUIT FOR DIFFERENT SYSTEMS: The following paragraphs indicate the design intent for raceways system for all technology systems.
  - 1. For all systems under division 27: Conduit stub up from the outlet to the nearest accessible ceiling, non-continuous support system to the telecom room
  - 2. For all systems under division 28 with the exception of Fire Alarm or Security Voice communications systems: Conduit stub up from the outlet to the nearest accessible ceiling, non-continuous support system to the telecom room.
  - 3. Non-continuous support systems (J-hooks) are allowed in this project as a horizontal support system for cables above ceilings.

## 3.9 CABLE TRAY INSTALLATION

- A. Inspection: Examine area for clearances, to allow proper installation of the tray according to the routing indicated on the drawings. Check existing building steel and other supporting structures to establish the type of tray hangers to be used and at the proper spans.
- B. Installation Criteria: Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines

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- C. Support: Cable tray support shall be by means of welded angle brackets to structural components, brackets shall be as manufactured by the Cable tray manufacturer. Complete straight section of cable tray shall have at least 1 support at a  $\frac{1}{4}$  of the length of the section. Additional supports are required at tray ends, offsets, bends and changes of elevation.
- D. Grounding: All conduits terminating within 12 inches of a cable tray shall be bonded with a grounded in accordance with the National Electric Code.
- E. Coordination: Wherever possible, install horizontal cable trays above water and steam piping. Coordinate installation of tray with other trades for clearances, to avoid conflicts. A minimum of 300 mm (12 in) access headroom shall be provided and maintained above the cable tray system or cable runway. A minimum of 150 mm (6 in) access headroom shall be provided and maintained at both sides (one side if tray is supported at the wall. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, structural elements) do not restrict access. The cable tray must be installed with at least 75mm (3 in) of clear vertical space above the ceiling tiles and support channels (T-bars) to ensure accessibility. When crossing other building components with the cable tray or runway the above specified clearances shall be maintained.

## 3.10 RUNWAY CABLE TRAY SYSTEM INSTALLATION

- A. General. Runway cable tray system shall be installed following manufacturer's recommendations for installation.
- B. Support locations: supports shall be provided as recommended by the manufacturer, but as a minimum supports shall be located as follows:
  - 1. Before each 90 deg turn.
  - 2. No continuous section shall have more than 3ft of span without a support..
  - 3. At each 2-post rack or 4-post rack
  - 4. At each change in elevation
- C. Support type. When runway cable tray is to be installed against the wall, the only support type to be used is a wall bracket supporting from the bottom of the tray. For sections of runway cable tray to be installed over racks, the preferred support system is to the racks themselves. Trapeze style support brackets shall only be used when no other method of support is possible. Center hung support systems shall never be used.
- D. Vertical runways. Runway cable tray system shall be installed continuously vertically in all telecommunications rooms in the project from sleeves coming from the ground (or floor below) to the sleeves going to the floor above, whether or not indicated in the drawings. The runway installed shall have the same width as the total width of the sleeves coming into the telecommunications room, although multiple sections installed together are acceptable. If the sleeves from the floor below to the floor above don't line up in a straight line, two vertical sections are accepted, one to the horizontal runway cable tray and one from the horizontal runway cable tray to the sleeves above. Runway cable trays installed vertically shall have supports to the floor, wall and slab above.
- E. Cable dropout. At each rack or cabinet that has runway cable tray system running on top of it, a cable dropout shall be installed to protect the bend radii of the cable. This dropout accessory shall have a bend radius of no less than 4".

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- F. Bonding. Any two continuous sections of runway cable tray system shall be bonded together with a #1 bonding jumper (600A) 15" long. All bonding jumpers shall be made of steel with yellow, zinc-dichromate finish. All fasteners shall be made of steel with zinc-plated finish
- G. Protective end caps. All end sections of runway cable tray sections shall be protected with plastic protective end caps.

3.11 INSTALLATION OF INNERDUCT

- A. Protect products from the effects of moisture, UV exposure, corrosion and physical damage during construction.
- B. When inner duct is laid on a cable tray, it shall be strapped to cable tray with nylon ty-wraps at periodic intervals of no less than 4 ft.
- C. When multiple inner duct are in a single conduit, and innerduct are of the same size, they shall be different colors for identification or have different color electrical taped wrapped on the ends to identify them at the end of each conduit.

3.12 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

- A. See specification section 270010 for as built documents and close out information these requirements.

END OF SECTION 270528



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## SECTION 271000 – STRUCTURED CABLING SYSTEM

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.
- C. General: Telecommunications Drawings apply to work of this section. The overall and detailed Structured Cabling System (SCS) design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.
- D. General: Furnish, install, test and certify complete with all accessories an ANSI/TIA 568C SCS with a minimum 25 year performance warranty for the entire system from the manufacturers and a minimum of 3 years warranty for materials and labor from the SCS installer for all components not covered under the manufacturer's 25 year warranty. The goal of the project is to provide an enhanced SCS that shall serve as a vehicle for the transport of voice telephony, data, audio, video, security and low voltage devices for building controls and management, throughout the building and from building to building from designated demarcation points to outlets located at various desk, workstation and other locations as indicated in the contract drawings.
- E. Coordination with other trades: It is the responsibility of the installer of the SCS to verify and advise the installer of the raceway infrastructure (conduit, boxes, cable tray, in ground boxes, etc) for this system on raceway routing to minimize the wiring distances to the telecommunication room. When J-hooks are acceptable for the use in structured cabling system, all J-hooks and supports for these devices shall be in the scope of work of the SCS installer.
- F. All patching and cross connect to owner provided equipment shall be included under the scope of work of this project.
- G. During the execution of the work, all required relocation, demolition, temporary connections, rerouting, etc., of existing cabling, equipment and systems in the existing building areas where

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the work is required, shall be performed by the SCS installer, as indicated on the drawings, or as required by job conditions and as determined by the Architect in the field, to facilitate the installation of the new systems. The Owner shall require continuous operation of the existing systems, while demolition, relocation work or new tie-ins are performed.

- H. **SHIELDED/UNSHIELDED SOLUTIONS.** This project has two different structured cabling solutions for horizontal cabling. F/UTP and U/UTP. All security cameras and wireless access points shall also be F/UTP. The F/UTP cable has a screen around all four pairs but it does not have a foil or mesh around each pair. All other horizontal cabling shall be regular unshielded twisted pair (U/UTP). This specification applies to both these solutions. The shielded solution shall include a complete installation of shielded components such as jacks, patch panels and patch cords. If shielded F/UTP cabling is used for the horizontal cabling, then S/FTP shall be used for the patch cords.
- I. **RESPONSIBILITY MATRIX.** The scope of work for the SCS installer as defined in the responsibility matrix indicated in the drawings shall include providing installation labor and small parts (cable ties, anchors, screws, support material, etc.), for the complete installation of the equipment.

## 1.2 RELATED DOCUMENTS

- A. **General:** Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section
- B. **Supplemental:** Refer to the specification sections identified below for additional requirements, which are supplemented by this section:

Section	Title
270010	TECHNOLOGY GENERAL PROVISIONS
270528	RACEWAYS FOR TECHNOLOGY
270526	GROUNDING & BONDING FOR TELECOMMUNICATIONS SYSTEMS

- C. **Owner standards:** Comply with the document "Requirements for all Communication Cabling at Clients name" prepared by the Clients applicable office.
- D. **Standards:** All work related to the SCS shall be in compliance with the following industry codes and standards latest edition:
  - 1. ANSI/TIA-568.0-D "Generic Telecommunications Cabling for Customer Premises" with addendums and errata.
  - 2. ANSI/TIA-568.1-D, "Commercial Building Telecommunications Cabling Standard" with addendums and errata.
  - 3. ANSI/TIA-568-C.2, "Balanced Twisted- Pair Cabling Components Standard" with addendums and errata.
  - 4. ANSI/TIA-568.3-D, "Optical Fiber Cabling Component Standard" with addendums and errata.
  - 5. ANSI/TIA-569-D, "Telecommunications Pathways and Spaces" with addendums and errata.

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6. ANSI/TIA-606-C, "Administration Standard for Telecommunications Infrastructure" with addendum and errata.
7. ANSI/TIA-607-C, "Generic Telecommunications Bonding and Grounding (earthing) for Customer Premises" with addendum and errata.
8. ANSI/NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.
9. ANSI/TIA 758-B, "Customer-Owned Outside Plant Telecommunications Infrastructure Standard" with addendum and errata
10. ANSI/TIA 862-B, "Structured Cabling Infrastructure Standard for Intelligent Building Systems" with addendum and errata.
11. ANSI/TIA-1152-A, "Requirements for Field Test Instruments and Measurement for Balanced Twisted Pair Cabling" with addendum and errata.
12. ANSI/TIA-526-7-A, "Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant".
13. ANSI/TIA-526-14-C, "Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant".
14. TIA-598-C, Optical Fiber Cable color coding. .
15. IEC/TR3 61000-5-2 - Ed. 1.0 and amendments. "Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling"
16. ANSI/TIA-942-B , "Telecommunications Infrastructure Standard for Data Centers" with addendum and errata
17. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
18. ANSI/NFPA 70 "National Electrical Code", CSA C22.1.
19. BICSI Telecommunications Distribution Methods Manual (TDMM)
20. BICSI Telecommunications Cabling Installation Manual (TCIM)
21. BICSI Customer Owned Outside Plant Manual (COOPM)
22. Local County/City Codes, Ordinances and Regulations.
23. Underwriters Laboratories (UL)
24. FCC -Federal Communications Commission
25. ADA Requirements
26. Occupational Safety and Health Regulations (OSHA)
27. National Fire Protection Association (NFPA)
28. ANSI/TIA-1179, Healthcare Facility Telecommunications Infrastructure Standards
29. Florida Statutes and Administrative Rules
30. Manufacturers Product Cabling Catalogs
31. Manufacturers Training Manuals (Design and Installation).

- E. General: Installation practices for SCS as describe herein take precedence over any other section in the construction documents set.

## 1.3 STRUCTURED CABLING SYSTEM INSTALLER QUALIFICATIONS

- A. General: The installer selected for the project must be certified by the manufacturers of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturers components and distribution channels in provisioning the Project.
- B. General: The installer directly responsible for this work shall be a Structured Cabling System (SCS) Installer who is, and who has been, regularly engaged in the providing and installation of commercial and industrial telecommunications wiring systems of this type and size for at least

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the immediate past five years. Any other company working for the SCS installer of this system shall have the same training and certification as the SCS installer.

- C. Certification: The SCS installer's Project Manager shall possess a current and in Good Standings BICSI Registered Communications Distribution Designer (RCDD®) certificate. All shop drawings submitted by the SCS Installer shall bear the RCDD's stamp.
- D. The SCS Installer shall have a (BICSI) RCDD on Staff. Third party RCDD's shall not be acceptable.
- E. The Installer team leader assigned for the project shall be BICSI registered Level II installer or proven and qualified equal.
- F. Experience: The SCS Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The SCS Installer shall own and maintain tools and equipment necessary for successful installation and testing of SCS and have personnel who are adequately trained in the use of such tools and equipment. The Owner or engineer may elect to request submittal of additional financial, operational and administrative information of the SCS installer to demonstrate the required experience.
- G. The SCS Installer shall possess a State of Florida Low Voltage License.
- H. The SCS Installer shall maintain a permanent office within 50 miles of the project site with the capability to provide emergency service 7 days a week, 24 hours a day.

## 1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. SCS Installer shall follow all requirements for materials alternates and substitutions indicated in specification section 270010.
- B. Basis of design for copper connectivity shall be Siemon. Other acceptable manufactures include Berk-tek, Panduit, Belden, Commscope, Hubbell.
- C. Basis of design for fiber optics connectivity manufacturer shall be Corning.

## 1.5 SHOP DRAWINGS AND SUBMITTALS

- A. See additional requirements for shop drawings and submittals in specification section 270010.
- B. Proposal Submittals: The SCS Installer shall submit the following information with the proposal to execute the work:
  - 1. A list of five (5) recently completed projects of similar type and size with contact names and telephone numbers for each.
  - 2. A list of test equipment proposed for use in verifying the integrity of the installed SCS. Test equipment list shall include manufacturer part number, serial numbers and a copy of the last calibration report done by the manufacturer of the equipment of the unit, indicating the date when the calibration was done. Calibrations shall not be older than one year. Test equipment includes, cable certifiers, OTDRs, fiber splicers, etc.

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3. A technical resume of experience for the installer's engineer/RCDD and on-site foreman who will be assigned to the project, including RCDD license number.
  4. Similar documentation for any company working for the SCS Installers who will assist in the performance of this work.
  5. A copy of a current and valid Low voltage License for the State of Florida.
  6. Location of office from which installation and warranty work will be performed.
- C. Construction submittals: Once all proposal submittals have been received and approved by the Architect and Engineer (A&E) of the project, the SCS Installer shall provide all construction submittals. Construction submittals are composed of the following items.
1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the cut sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
  2. Faceplate color selection.
  3. Detail explanation of the labeling scheme to be used for all components of the system. This explanation shall include examples of all types of labels to be used, like labels for cables, patch panels, outlet jacks, etc.
  4. Autocad® or Revit drawings in sheets matching the size of the design documents with the following information:
    - a. Floor plans with all outlets in the project. All outlets shall have the label to be used during identification and tagging process described in this specification section.
    - b. Enlarged telecommunication rooms with all equipment components and rack layouts for each room. All racks shall have the label to be used during identification and tagging process described in this specification section.
    - c. Drawings indicating rack elevations for all cabinets or racks in the project, identifying the precise quantity of patch panels, fiber distribution centers and wire managers and accurate RU heights based on equipment selection. All equipment shall have the label to be used during the identification and tagging process described in this specification section.
    - d. A spreadsheet indicating all patch cords (fiber and copper) to be provided in the project. The spreadsheet shall indicate the quantity, color of the jacket, cable type, length and connector termination on each side.
- D. Construction submittals received before proposal submittals are received or approved will be rejected.

## 1.6 ABBREVIATIONS

- A. General: The following abbreviations are used in this specification section:
1. A&E - Architect and Engineer. The Architect is the legal entity that holds a contract for the design the project. The Engineer is the consulting engineer firm or engineer of record for the project who prepared this specification.
  2. APC - Angle physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
  3. Array connector - a multi-strand fiber connector user for high density applications, such as the MPO connector

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4. BICSI - Building Industry Consultant Services International
5. CCTV - Close circuit television system (surveillance video system)
6. FCC - Federal Communications Commission.
7. FTP - Foiled Twisted pair. One foiled screen around each cable pair.
8. IDC - Insulation Displacement Connector
9. NEC - National Electrical Code.®
10. NEMA - National Electrical Manufacturers Association.
11. OM1 - ISO 11801 designation for multimode 62.5/125µm glass fiber optics.
12. OM2 - ISO 11801 designation for multimode 50/125µm glass fiber optics.
13. OM3 - ISO 11801 designation for multimode laser optimized 50/125µm glass fiber optics.
14. OM4 - TIA designation for multimode laser optimized 50/125µm glass fiber optics in compliance with TIA-492-AAAD.
15. OS1 - ISO 11801 designation for single mode 9/125µm glass fiber optics.
16. OS2 - ISO 11801 designation for single mode 9/125µm glass fiber optic with performance criteria identical to ITU-T G652.
17. OTDR - Optical Time Domain Reflectometer.
18. RU - Rack units. Height dimension for rack mounted equipment. 1 RU equivalent to 1.75”.
19. SCS - Structured Cabling System
20. ScTP - Screened twisted pair. One foiled screen around all cable pairs
21. TIA - Telecommunications Industry Association.
22. TR - Telecommunications Room.
23. UPC - Ultra physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
24. UTP - Unshielded twisted Pair
25. UV - Ultra violet
26. VAC - Volts alternating current.

## PART 2 - PRODUCTS

### 2.1 MODULAR SCS JACKS

- A. Structured cabling system outlets indicated in design drawings are composed of modular SCS jacks, mounted in a faceplate on an electrical box. Modular SCS jacks shall be 8-pin modules (RJ-45) that meet or exceed the following electrical and mechanical specifications:
  1. Electrical Specifications:
    - a. Insulation resistance: 500 MΩ minimum.
    - b. Dielectric withstand voltage 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
    - c. Contact resistance: 20 M Ω maximum.
    - d. Current rating: 1.5 A at 68 ° F (20 ° C) per IEC publication 512-3, Test 5b
    - e. ISO 9001 Certified Manufacturer
    - f. UL verified for EIA/TIA electrical performance
    - g. Comply with FCC Part 68
    - h. Cable termination: IDC type universal T568A or T568B.

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## 2. Mechanical Performance:

- a. Plug Insertion Life: 750 insertions
- b. Contact Force: 3.5 oz (99.2 g) minimum using FCC-Approved modular plug.
- c. Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack.
- d. Temperature Range: -40° to 150°F (-40 ° to 66 ° C)

## B. Design selection: modular SCS jacks shall be selected according to the following criteria:

- 1. Performance requirement: CAT6 & CAT6A (For WAPS only)
- 2. Style: Rear loading
- 3. Mounting orientation: straight mounting
- 4. Color: Orange
- 5. Dust cover required: No
- 6. Shielding: use shielded modular jacks only with ScTP cable.

## C. Approved manufacturer: See paragraph 1.4.

## 2.2 FIELD TERMINATABLE 8 POSITION MODULAR PLUG

### A. When indicated in the design drawings to use Direct Attach connection for any field devices, field terminatable 8 positions modular plugs shall be used. This devices shall be 8-pin modules (RJ-45) plugs that meet or exceed the following electrical and mechanical specifications:

#### 1. General Specifications:

- a. Shall include an IDC type of termination for the cable. Crimp type terminations not acceptable.
- b. Shall support cable gauges from 22 to 26 AWG
- c. Shall include a rubber boot

#### 2. Electrical Specifications:

- a. ISO 9001 Certified Manufacturer
- b. UL verified for EIA/TIA electrical performance
- c. Comply with FCC Part 68
- d. Cable termination: IDC type universal T568A or T568B.

## B. Design selection: modular SCS jacks shall be selected according to the following criteria:

- 1. Performance requirement: Match performance of Modular SCS jacks

## C. Approved manufacturer: Match selection for modular SCS jacks.

## 2.3 OTHER MODULAR JACKS

### A. Whenever indicated in the design drawings SCS outlets could have terminations for other media types like fiber optic cables, coaxial cables or audio cables. Whenever those type of media are identified in the drawings, the following specifications shall be meet for modular jacks mounted in SCS outlets:

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1. Style, mounting orientation and color: match design selection for modular SCS jacks.
2. Broadband distribution system connector: Use modular jack with F connector bulkhead rated at 75Ω.
3. Fiber optic connectors: use modular jack with adapter plate for SC.
4. For line level audio signals: use modular jack with RCA connector bulkhead. Use different color coded insulators for different audio channels.

B. Approved manufacturer: Match selection for modular SCS jacks.

## 2.4 FACEPLATES

A. Faceplates shall be used for all flush mounted telecommunication outlets to house modular jacks. Faceplates shall have the following specifications:

1. Construction material: High impact thermo Plastic.
2. Size: use single gang faceplates only unless specifically noted in the design drawings.
3. Capacity of modular jacks per faceplate: faceplate shall be selected as to accommodate the amount of cables in each telecommunication outlet. No more than one unused opening shall be present on each faceplate.
4. Color: submit color to A&E for approval.
5. Labels: faceplate shall have two (2) recesses for labels, top and bottom, and shall have transparent label snap-on covers.
6. Faceplate style: Direct modular plug rear loading style.

B. All faceplates shall have a tamper resistant cover to access the modular jacks

C. Approved manufacturer: Match selection for modular SCS jacks.

## 2.5 FACEPLATES WITH SUPPORT STUDS

A. Telecommunication outlets indicated in the design drawings as to be wall mounted telephone outlets shall be composed of one modular SCS jack and one faceplate with support studs mounted on an electric box. Faceplates with support studs shall have the following specifications:

1. Construction material: Stainless Steel.
2. Size: use single gang faceplate with two support studs.
3. Capacity of modular jacks per faceplate: One.
4. Faceplate style: Direct modular plug rear loading style.

B. Approved manufacturer: Match selection for modular SCS jacks.

## 2.6 SURFACE MOUNTED BOXES

A. Telecommunication outlets indicated in the design drawings as to be surface mounted outlets shall be composed of modular jacks mounted in a surface mounted box inside an electrical enclosure. Surface mounted boxes shall have the following specifications:

1. Construction material: High impact thermo Plastic.



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2. Capacity of modular jacks per surface mounted box: size of surface mounted box shall be selected as to accommodate the amount of cables in the surface mounted telecommunication outlet. No more than one unused opening shall be present on each box.
3. Color: White.
4. Labels: surface mounted boxes shall have at least one (1) recess for labels, and shall have transparent label snap-on covers

B. Approved manufacturer: Match selection for modular SCS jacks.

## 2.7 MOUNTING FRAMES

- A. All telecommunication outlets shall be properly mounted in the electrical raceway system provided for the outlet. The SCS installer shall select the proper mounting frame and/or bezel to mount the modular plugs in the raceway system. Raceway systems include furniture systems, floor boxes, poke-thrus, power poles, surface raceways system, etc.
- B. Whenever design drawings indicate a telecommunication outlet to be mounted in a furniture system the SCS Installer shall select the proper mounting frame to hold the modular jacks in the furniture system selected by the owner. Color of the mounting frames shall match the color of the furniture system.
- C. If owner provided furniture system does not have a raceway system for telecommunication, and design drawings indicate outlet to be mounted in the furniture system, SCS installer shall provide a plastic surface mounted box that allows the mounting of the modular plugs in a standard telecommunication faceplate.
- D. SCS installer shall provide all mounting frames and bezels to mount modular jacks inside floor boxes or poke-thrus.
- E. All un-used ports in mounting frames shall be covered with blank inserts.
- F. Approved manufacturer: Match selection for modular SCS jacks.

## 2.8 HORIZONTAL 4-PAIR CABLE

- A. General: Horizontal 4-pair cables shall be extended between the telecommunications outlet location and its associated equipment inside the TR. The cable shall consist of 4 pair cable solid copper conductors, certified to the specified performance standard. All horizontal 4-pair cables shall be terminated in modular jacks and patch panels with IDC type connectors and shall have the following specifications:
  1. Cable Gauge: minimum 23 AWG for CAT6 and CAT6A
  2. Performance standard: TIA/EIA CAT6 and CAT6A
  3. Cable type: UTP
  4. Performance characterized to: Minimum 500 MHz
  5. Time delay skew: Maximum 45 ns/100m
  6. Input impedance (1-100MHz): 100Ω
  7. Cable diameter: ≤ 0.295 inch

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- B. Cable jacket colors for 4-pair horizontal cables shall be selected according to the following criteria:
  - 1. All cables shall be Blue
- C. Performance verification: All performance of horizontal 4-pair cable shall be verified by a Nationally Recognized Testing Laboratory (NRTL) for EIA/TIA electrical performance and comply with FCC Part 68.
- D. Jacket: Cable jacket for inside premise cables shall comply with Article 800 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated.
- E. OSP Jackets: All horizontal 4-pair cables run in conduits below the floor slab shall have a water resistant flooding compound and a jacket made of UV resistant polyethylene. Cables with PVC jackets are not acceptable for this application.
- F. Jacket marking: All horizontal 4-pair cables shall have at least two types of markings imprinted in the jacket, transmission performance marking and NEC rating for environment to be used.
- G. Approved manufacturer: See paragraph 1.4

## 2.9 PATCH PANELS FOR HORIZONTAL CABLING

- A. All 4-pair horizontal cables shall be terminated in rack mounted patch panel located in the telecommunication rooms rack. These patch panels shall have the following specifications.
  - 1. Connector type: 8-position modular plug (RJ-45)
  - 2. Cable termination: IDC type universal T568A or T568B.
  - 3. Performance requirement: CAT6 and CAT6A
  - 4. Maximum connectors per patch panel allowed: 48
  - 5. Patch panel type: factory preloaded panels.
  - 6. Patch panel shape: straight (flat)
  - 7. Permanent marking: All connectors shall be labeled in sequential numbers
  - 8. Field labels: patch panels shall have a space for field labels covered with transparent protectors.
  - 9. Shielding: use shielded patch panels only with ScTP cable.
- B. Approved manufacturers. Match selection for modular SCS jacks

## 2.10 HORIZONTAL WIRE MANAGERS

- A. Horizontal wire managers shall be mounted in racks to route cables from patch panels to vertical wire managers and to equipment. Horizontal wire managers shall have the following specification:
  - 1. Style: Finger duct style with hinged cover
  - 2. Sides: front of rack

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3. Minimum height: two RU

B. Approved manufacturers. Match selection for modular SCS jacks

## 2.11 FOUR (4) PAIR PATCH CORDS

A. Four (4) pair patch cords are required at the work area side and at the patch panel side to complete the connectivity path to the equipment. All 4-pair patch cords shall be factory tested and shall have molded boots to the cable jacket. Field made patch cords are not acceptable. Four pair patch cords shall have the following specifications:

1. Connectors: 8-pin modular plugs at both ends
2. Conductors: 4-pair stranded conductors.
3. Wire gauge: Wire gauge: 23 AWG for patch cords in the field side. 28 AWG for patch cords in the telecom room side with exception of WAPs and VOIP phones which shall use 23 AWG.
4. Wiring map: See section 3 of this specification
5. Performance requirement: To match horizontal 4-pair cable performance
6. Cable type: UTP

B. Approved manufacturers. Match selection for modular SCS jacks

## 2.12 SINGLE STRAND FIBER OPTICS CONNECTORS

A. All fiber optic cables (horizontal or backbone cables) shall be terminated on fiber optic connectors at both ends of the cable with either single strand fiber optic connectors or array connectors. Single strand fiber optic connector shall be compliant with industry standard ANSI/TIA-568-C.3 and the applicable TIA/EIA Fiber Optic Connector Intermateability Standard (FOCIS) document, TIA/EIA 604 series. Single strand fiber optic connectors shall have the following specification:

1. Physical contact type: use UPC type connector for all application with the exception of applications of Broadband TV distribution systems or DAS systems. For those applications use APC type connectors.
2. Connector type: LC
3. Security level: non-keyed connector
4. Pairing style: simplex
5. Acceptable connector attachment types:
  - a. Epoxy type connectors, field polished
  - b. Splice on connectors. Fusion spliced connectors with factory polished finish.
  - c. Fusion spliced pig tail with factory polished connector. Mechanical splices for pig tails are not acceptable.
6. Fiber type: SCS installer shall select the connector according to the fiber type where connector will be installed. As an example use OM1 connectors only in OM1 fiber optic cables.
7. Fusion spliced pig tails. When using fusion spliced pig tails the SCS installer shall make sure the fiber type of the pig tail and the actual cable have the same optical characteristics, such as back scatter, core diameter, etc.

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8. Ferrule construction: use ceramic ferrule connectors only, plastic ferrules are not acceptable.
- B. All single strand fiber optic connectors shall include boots to protect the fiber optic cable. The SCS installer shall select the boot according to the fiber optic type selected. As an example use 900µm boots in 900µm coated fiber, use 250µm boots on 250µm coated fiber and use 2mm boots on 2mm jacketed fiber. All boots shall be color coded to identify the type of fiber connector used. Boots shall be beige for OM1 fiber, black for OM2, aqua for OM3 and OM4 or green.
- C. Single strand multimode fiber optic connectors shall have the following performance requirements:
1. The maximum insertion loss shall be 0.75 dB (maximum) when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
  2. Connector reflectance shall be less than or equal to -26 dB when installed in accordance with the manufacturer's recommended procedure.
  3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.
  4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90° angle, with a maximum 0.5dB increase in attenuation for both tests when tested in accordance with ANSI/EIA/TIA-455-6B.
- D. Single strand single mode fiber optic connectors shall have the following performance requirements:
1. Maximum insertion loss shall be 0.75 dB per each mated connector pair when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
  2. Connector reflectance shall be less than or equal to -40 dB (UPC) when installed in accordance with the manufacturer's recommended procedure.
  3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.
  4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90° angle, with a maximum 0.5 dB increase in attenuation for both tests when tested in accordance with ANSI/EIA/TIA-455-6B.
  5. Connectors shall meet the following performance criteria:
- | Test            | Procedure | Maximum Attenuation Change (dB) |
|-----------------|-----------|---------------------------------|
| Cable Retention | FOTP-6    | 0.2 dB                          |
| Durability      | FOTP-21   | 0.2 dB                          |
| Impact          | FOTP-2    | 0.2 dB                          |
| Thermal Shock   | FOTP-3    | 0.2 dB                          |
| Humidity        | FOTP-5    | 0.2 dB                          |
- E. Approved manufacturers. See paragraph 1.4

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**2.13 FIBER OPTICS SPLICES**

- A. When fiber splicing is required in the project because of the use of pigtails or field splicing, only fusion splicing will be acceptable. Mechanical splices shall not be used unless specifically indicated in the contract documents.
- B. All fiber splices shall be terminated with heat shrink sleeves and organized in splice trays. Splice trays sizes shall be selected to match the quantity of fiber strands in the cable bundles. Splice trays shall be organized in Fiber Optics Distribution Centers when inside a telecom room or in outdoor rated splice closures when done outdoors.
- C. Fusion splice equipment to be used in this project shall have the following specifications:
  - 1. Alignment system: Automatic Core Detection system (ACD). V-groove splicers are not allowed.
  - 2. Typical splice loss for single mode fibers: 0.02 dB
  - 3. Splice loss result: Estimated (ACD)
  - 4. Unit shall have a fast heat shrink oven, maintenance free electrodes, built in cleaver and graphical user interface to display alignment condition.
  - 5. Cleaver blade type: diamond.

**2.14 OUTSIDE PLANT FIBER OPTICS BACKBONE CABLES**

- A. Whenever design drawings indicate fiber optics backbone cables to be run between building or outside premises, the following specification shall be followed for those cables:
  - 1. Strand Count: As indicated in design drawings
  - 2. Fiber type: As indicated in design drawings
  - 3. Fiber coating: 250µm coating protected with break-out kits with color coded 900µm buffers at both ends of the cable when cables are terminated in conditioned spaces. When fibers are terminated in outdoor non-conditioned spaces, break-out kits shall be used with 3 mm tubes with aramid yarn for each fiber. Unprotected 900µm fibers in non-conditioned spaces are not allowed.
  - 4. Rodent protection requirement: not required
  - 5. Buffer type: Loose tube.
  - 6. Center strength member material: a dielectric material
- B. Jacket: All outside plant fiber optics backbone cables shall have UV resistant cable sheathing and a water-blocking material to prevent water intrusion. All outside plant fiber optics backbone cables shall be tested and in compliance with the following standards:
  - 1. ANSI/TIA-568-C
  - 2. Telcordia GR-20
  - 3. ANSI/ICEA S-87-640
- C. Approved manufacturers. Match selection for horizontal 4-pair cable.

**2.15 FIBER OPTIC DISTRIBUTION CENTERS**

- A. All fiber optic cables shall be terminated in fiber optic distribution centers. Inside premises horizontal fiber optic cables shall be terminated in one side (telecommunication room side) in a

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fiber optics distribution center (FODC). Backbone fiber optic distribution centers shall be terminated at both ends in a FODC. FODC are composed of an enclosure and snap on adapters. These are the specifications of the enclosures for the FODC:

1. Mounting: Use rack mounted FODC enclosures in all rooms where racks are available or any type of rack rails. Use wall mounted FODC enclosures only when racks are not available like in outdoor enclosures, or other spaces different than telecom rooms.
2. Size: SCS Installer shall size the FODC based on the amount of fiber strands to be terminated in the FODC.
3. Front locking doors are required.
4. Locking door shall be transparent doors and shall have labeling cards.
5. Whenever fiber splices are indicated in the design drawings next to an FODC, enclosures shall be selected by the SCS installer as to have spaces to hold splice trays. FODCs under these conditions shall be able to hold the amount of splice trays required for the fiber count indicated in the drawings.

B. These are the specifications of the snap on adapters for the FODC:

1. Style: plate style
2. Connector type: LC
3. Maximum fiber strands allowed per adapter: 24
4. Security level: non-keyed connector keyed connector
5. Pairing style: duplex

C. Approved manufacturers. Match selection for fiber optic connectors

## 2.16 FIBER OPTICS PATCH CORDS

A. Fiber optic patch cords shall be required for connections from active equipment to FODCs and/or to telecommunication outlets. Fiber optic patch cords shall be required at both ends of fiber optics backbone cables or horizontal fiber optic cables. Direct connection of backbone cables or horizontal fiber optic cables to active equipment shall not be allowed.

B. Fiber optic patch cords shall be all factory tested. Field made fiber optic patch cords are not acceptable. The specifications of the fiber optic patch cords shall be:

1. Strand Count: 2 strands
2. Fiber type: Match fiber type of backbone cable or horizontal cable.
3. Fiber connector in FODC or outlet side: LC
4. Fiber connector in active equipment side: LC
5. Fiber protection: aramid yarn
6. Jacket type: 2.9mm flame-retardant PVC jacket zip-cord type.
7. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.

C. Approved manufacturers. Match selection for fiber optic connectors

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## 2.17 TWO POST RACKS (CHANNEL RACKS)

- A. Whenever indicated in the design drawings two post racks shall be provided as shown. Two post racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Two post racks shall have the following specifications:
1. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
  2. Channel depth: 6.5"
  3. Rack rails type: standards EIA 19" located in the front and back of rack. Rack rails shall have RU marked and labeled.
  4. Rack screw type: #12-24 threaded rack rails. Screws shall be provided for all openings in rack rails and shall be made of steel.
  5. Weight capacity: UL listed for 1000 lb or more.
- B. Two post racks shall be provided with the following accessories:
1. Cable runway mounting brackets to support cable runway installed above racks
  2. Isolation pads
  3. Grounding kit.
  4. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threaded holes 1032 mounted to the cabinet using nylon insulation washers
  5. End panels to support vertical wire managers at both ends of each rack row.
- C. Front vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
1. Style: Metal cage with dual hinged door cover
  2. Sides: single sided wire manager.
  3. Capacity: Usable cross sectional area shall be minimum of: 48 sq-in.
  4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- D. Rear vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
1. Style: D-rings
  2. Sides: single sided wire manager (rear only) or if dual side wire front managers are included, no need for rear vertical wire managers.
  3. Capacity: Usable cross sectional area shall be minimum of: 16 sq-in.
  4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- E. Basis of design: Ortronics Mighty Mo 6E

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## 2.18 CABLE TIES

- A. Cable ties shall be used at different locations of the project but with the same goal of producing a neat and organized installation. Cable ties shall be used to support cables to j-hooks (when j-hooks are allowed in the project) to organize cables in ladder trays, D-rings and cable trays, to support cables to wire managers including managers behind patch panels, to bundle cables, organize patch cords, etc.
- B. To support and organize all horizontal cabling and inside premise backbone cables, only the following types of cable ties shall be used:
  - 1. Hook and loop style, re-usable with Velcro no smaller than 0.5" width.
  - 2. Pre-perforated rolls of re-usable ties with Velcro no smaller than 0.5" width
  - 3. Straps of other soft materials with cinch rings that allow for re-use of the cable ties in widths no smaller than 0.85".
- C. Nylon based cable ties (re-usable or not) can only be used to support and organize the following types of cables:
  - 1. Outside plant fiber and copper backbone cables.
  - 2. Inside premise fiber optic backbone cables with interlock armors.
  - 3. Grounding conductors
- D. Nylon based cable ties shall never be used to support or organize any type of horizontal cables or inside premise fiber optic backbone cable without armor.
- E. All cable ties to be used in outdoor environments shall be made of weather resistant Acetal. Outdoor cable ties used for aerial cable lacing shall be in compliance with Telcordia TR-TSY-000789 standard.
- F. All cable ties shall be selected in lengths as to properly secure the bundle of cable being supported.
- G. All cable ties to be used in air handling spaces, such as above ceiling and under raised floor areas, shall be UL listed for the use in those environments.
- H. Approved manufactures: Ortronics, Panduit or approved equal

## 2.19 IDENTIFICATION AND LABELING TAGS

- A. SCS installer shall follow labeling materials indicated in specification section 270010.

## PART 3 - EXECUTION

### 3.1 INSTALLATION PRACTICES

- A. GENERAL. All installation requirements indicated in specification section 270010 shall be followed.



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- B. **WORKMANSHIP.** All work shall be completed by the SCS installer in a neat and workmanlike manner. The use of all BICSI standards and recommendations for installation shall be followed as the benchmark for workmanship.
- C. **CABLE LENGTHS.** It is the SCS installer's responsibility to plan the cable routing in the cable tray and other raceways as to minimize all cable runs to be able to stay under the 90 meter (295 ft) length limitation for Horizontal Cabling. All cable runs exceeding the wiring distance, due to raceways run in not the most efficient way to minimize distance, shall be re-run with horizontal fiber optic cables and with media converters, at no extra cost to the owner.
- D. **WIRE MAPPING.** All terminations of 4-pair horizontal cabling in this project and terminations of all 4-pair patch cords shall be per T568B standard.
- E. **FIBER OPTICS TERMINATION POLARITY.** All fiber optic cables (horizontal or backbone) terminated in duplex style adapter panels shall be connected in a cross-over polarity configuration. As an example, if fibers 1 and 2 are terminated in one end in positions A and B respectively in one side of the cable, the same strands shall be terminated in B and A positions in the other side of the cable.
- F. **CABLE BUNDLES.** In suspended ceiling and raised floor areas if duct, cable trays or conduits are shown on the contract drawings, the SCS installer shall bundle, in bundles of 40 or less, horizontal wiring with cable ties snug, but not deforming the cable geometry. The cable bundling shall be supported via "CLIC" fasteners in TR's and non-plenum areas and J-hooks in ceiling spaces. The SCS installer shall adhere to the manufacturers' requirements for bending radius and pulling tension of all cables.
- G. **CLIC FASTENERS:** Horizontal cables shall be suspended by "CLIC" fasteners with cable inserts in TR's on the plywood area where ladder tray or rack management is not available per the design documents. Listings: "CLIC" fasteners shall be in accordance with NEC and BICSI standards. Above the plywood area J-hooks or D-rings should be used.
- H. **FIRE STOP PROTECTION:** Sealing of openings between floors, through rated fire and smoke walls, existing or created by the SCS installer for cable pass through shall be the responsibility of the SCS installer. Sealing material and application of this material shall be accomplished in such a manner, which is acceptable to the local fire and building authorities having jurisdiction over this work. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the SCS Installer's work. Any openings created by or for the SCS installer and left unused shall also be sealed as part of this work. Penetration rating shall equal structure rating.
- I. **NEW MATERIALS:** All components, wiring and materials to be used for the installation of the SCS shall be new and free of defects. Used components, wiring and materials shall only be used when specifically indicated in the design drawings.
- J. **DAMAGE:** The SCS Installer shall be responsible for any damage to any surfaces or work disrupted as a result of his work. Repair of surfaces including painting and ceiling tile replacement shall be included as part of this contract.
- K. **AVODING EMI:** To avoid EMI, all pathways shall provide clearances of at least 4 feet (1.2 meters) from motors or transformers; 1 foot (0.3 meter) from conduit and cables used for

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electrical-power distribution; and 5 inches (12 centimeters) from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The SCS installer shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

- L. **WORK EXTERNAL TO THE BUILDING:** Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification.
- M. **DEMOLITION.** Any task part of the installation of the SCS requiring relocation, rerouting and/or demolition shall be done according to the following requirements:
  - 1. **Coordination:** Prior to any deactivation and relocation or demolition work, arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused or to remain in operation and be integrated with the new systems.
  - 2. **Provisions:** All deactivation, relocation, and temporary tie-ins shall be provided by the SCS installer. All demolition, removal and the legal disposal of demolished materials of system designated to be demolished shall be provided by the SCS installer.
  - 3. All Existing Voice/Data cables and connecting hardware not to be used after the new installation is complete and within the areas where work is required as part of this project shall be removed by the SCS installer. All existing cables to be left for future use if indicated by the owner shall be tagged for that purpose.
  - 4. **Owners Salvage:** The Owner reserves the right to inspect the material scheduled for removal and salvage any items he deems usable as spare parts.
  - 5. **Phasing:** The SCS installer shall perform all work in phases as directed by the Architect to suit the project progress schedule, as well as the completion date of the project.
- N. **ICONS.** Faceplates, jacks or patch panels with inserts for icons shall be filled with icons when unit capable of accepting icons. Icons in the work area side (outlet) shall match the color of the faceplate. Icons for path panels shall match the color of the horizontal cabling.
- O. **BLANK INSERTS AND PANELS.** All telecommunications outlets with faceplates or mounting frames with unused terminations shall be plugged with blank inserts or panels. Blank inserts shall match the color of the faceplate or mounting frame. No more than one blank module shall be required for each faceplate. All unused ports in the FODC enclosures for adapter panels shall be filled with blank adapter panels.
- P. **PATCH PANEL AND FODC SEPARATION:** Horizontal cables shall be terminated in separate patch panels according to the use of the cable. Each series of patch panels or FODC for a specific use shall have at least 20% spare capacity of ports. Patch panels of the same use shall be mounted consecutive in the equipment cabinets or racks. The following separation for patch panels and FODCs shall be provided:
  - 1. Cables for Wireless Access Points (WAPS) shall be separated from cables for any other purpose.
  - 2. Cables for surveillance cameras, card access and SCADA systems shall be separated from cables for any other purpose.
  - 3. Single mode fiber optic backbone cables shall be terminated in separate FODC from multimode fiber optic backbone cables.

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- Q. SUPPORTS FOR REAR OF PATCH PANELS. All patch panels for horizontal cables shall be provided with a rear support bar to hold the cable and to provide strain relief. At a minimum one rear support bars shall be provided for each two rows of 24 connectors.
- R. HORIZONTAL WIRE MANAGERS. Horizontal wire managers shall be provided following this criteria:
1. At least one above and below each straight (flat) patch panel.
  2. At least one above and below any network switches.
- S. PATCH CORD QUANTITY, COLOR AND LENGTHS. Copper and fiber optics patch cords shall be provided per following chart. All percentage calculations shall be rounded off to the nearest integer number.

TYPE	QTY	COLOR JACKET	LENGTH
4-pair at work area outlet	One for 90% of all 4-pair horizontal cables in the project	Blue for controls, Orange for County network  Green for phones.	30% 8', 50% 10' and 20% 15'
4-pair at WAP location	One for 100% of all 4-pair horizontal cables for WAPS in the project + 10% spare	Orange	The SCS installer shall field verify all lengths to match location of WAPS selected by owner or wireless survey. For pricing purposes use 12'
4-pair at Surveillance camera	One for 100% of all 4-pair horizontal cables for cameras in the project +10%	Purple	The SCS installer shall field verify all lengths to match location of cameras. For pricing purposes use 12'
4-pair at patch panel side (excluding surveillance cameras and WAPS)	One for 90% of all 4-pair horizontal cables in the project	Blue for controls, Orange for County network  Green for phones	For pricing purposes use: 40% 6', 40% 8', 20% 12'. SCS installer shall field verify these percentages to provide more accuracy.
4-pair at patch panel side (surveillance cameras and WAPS)	One for 100% of all 4-pair horizontal cables in the project +10%	Orange for WAPs, Purple for cameras  .	For pricing purposes use: 40% 6', 40% 8', 20% 12'. SCS installer shall field verify these percentages to provide more accuracy.
One or two pair for copper backbone cross connects	One for 90% of all backbone copper pairs installed in the project.	Gray	For pricing purposes use: 80% 8', 20% 10'. SCS installer shall field verify these percentages to provide more accuracy.

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- T. CABLE SLACK. Cable slack shall be provided for all cables in the project following this guideline:
1. At each work area outlets, all horizontal cables shall have 12" of slack.
  2. At the telecom room side all horizontal cables shall have at least 6' neatly organized on the wall using a figure 8 configuration or a non-loop shaped arrangement with Velcro straps.
  3. Backbone cables at termination points shall have at least 15' of slack neatly organized on the wall using a standard loop and Velcro straps.
  4. Outside plant backbone cables run through in-ground pull boxes greater than 24"X24" shall include one service loop inside the box.
- U. BEND RADIUS. Installation of Fiber Optic Cables shall be in accordance with ANSI/TIA-568C guidelines and cable manufacturer specifications. Bend radius parameters shall be followed for load and no load conditions. Cable installation and terminations that do not comply shall be replaced by the SCS installer. If no recommendation is specified by cable manufacturer, at least the following criteria shall be met:
1. The bend radius for intrabuilding 2 and 4-fiber horizontal optical fiber cable shall not be less than 25 mm (1 in) under no-load conditions. When under a maximum tensile load of 222 N (50lbf), the bend radius shall not be less than 50 mm (2 in).
  2. The bend radius for intrabuilding optical fiber backbone with fiber counts above 4 shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 15 times the cable outside diameter when the cable is under tensile load.
  3. The bend radius for interbuilding optical fiber backbone shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 20 times the cable outside diameter when the cable is under tensile load up to the rating of the cable, usually 2670 N (600lbf).
- V. INNERDUCT. Innerduct shall be provided from end to end of a raceway system under the following conditions:
1. Inside underground conduits as indicated in design drawings.
  2. For horizontal fiber optic cable or inside premise fiber optics backbone cables without interlocking armor when routed through cable trays, ladder trays or vertical conduit sleeves. This requirement is usually not indicated in the drawings but indicated only in this specification.
  3. For backbone fiber optic cable in vertical risers
- W. SCS PROTECTION DURING CONSTRUCTION. The SCS installer shall protect all SCS materials from damage during construction. Racks shall be covered with fabric or plastic after mounting to prevent dust, debris and other foreign materials having contact with SCS devices. The SCS installer shall protect at all times all fiber optic and copper cables from damage during installation. All cables shall maintain the physical integrity as manufactured for testing and delivery to the owner. All damaged cables shall be replaced at no additional cost to the owner.
- X. CABLE BONDING. Shielded cables or cables with metal strength or protection members (like interlocking armor) shall be bonded to the telecommunications grounding system as indicated in specification section 270526.

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- Y. RACK INSTALATION. All racks shall be installed leveled and plumbed. Four post racks and two post racks shall be anchored to the floor and shall be installed with isolation pads. Equipment cabinets shall be leveled using the leveling feet unless design drawings specifically indicate to leave them on the casters.
- Z. RACK BONDING. All equipment cabinets and racks shall be bonded to the telecommunication grounding system as indicated in specification section 270526

## 3.2 IDENTIFICATION AND TAGGING

- A. General: Identification and tagging of SCS components shall be executed by the SCS installer. At a minimum identification and tagging shall be provided for the following components of the system:
  - 1. All horizontal and backbone cables at both ends of the cable in the cable jacket. Labels on each side shall be different indicating the location of the other side of the cable
  - 2. All faceplates indicating all jacks terminated in the faceplate.
  - 3. All patch panels.
  - 4. All racks
  - 5. All termination blocks
  - 6. All telecommunication rooms and outdoor enclosures.
  - 7. All interbuilding backbone cables inside in ground pull boxes outside of the building shall have a visible label in each box they pass through.
- B. The SCS installer shall follow the owner provided identification system. If owner does not have any preference or standard the SCS installer shall provide a system for approval of the A&E and the owner as indicated in the submittal paragraph of this specification. The identification system shall follow the TIA/EIA 606-B standard.

## 3.3 TESTING OF COPPER CABLING

- A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA/EIA-568-C, Cabling Transmission Performance and Test Requirements.
- B. For all 4-pair copper cabling terminated for the use of building systems or system provided under the contract, such as surveillance cameras, emergency phones, elevator phones, WAPs, Access control panels and building automation equipment, the required test shall be a Channel style test. This means copper test shall be done with patch cords that will be used for permanent installation of those devices.
- C. For all 4-pair copper terminated for the use in work areas such as computers and phones, the test method selected for all 4-pair copper cabling is a permanent link style test. Permanent link test is defined as a test that does not include the patch cords to be used in the project.
- D. General: In the event the A&E elects to be present during the tests, provide notification to the engineer two weeks prior to testing.
- E. General: The installer's RCDD shall sign off on all copper and fiber optic cable test results, indicating that he/she was in responsible charge of all cable testing procedures and that all

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cables were tested in compliance with the contract documents and met or exceeded the requirements stated herein.

- F. Testing Equipment: Tester shall be as manufactured by Agilent, Fluke, IDEAL or Wavetek. Tester shall be 100 Level IIIe compliant with ANSI/EIA/TIA 568C specifications for testing of the CAT6 and CAT6A cabling. No tester will be approved without meeting these requirements.
  - G. Each jack in each outlet shall be tested at a minimum to the manufacturer's performance of the cable to verify the integrity of all conductors and the correctness of the termination sequence. Testing shall be performed between work-areas and the equipment rack patch panel. Prior to testing UTP runs, the tester shall be calibrated per manufacturer guidelines. The correct cable NVP shall be entered into tester to assure proper length and attenuation readings.
  - H. Documentation of cable testing shall be required. The SCS installer shall provide the results of all cable tests in electronic format (final results in PDF format and raw data). Each test page shall be separated by standard page break (one test per page). The test results shall include: sweep tests, continuity, polarity checks, wire map, Attenuation, NEXT, PSNEXT, FEXT, PSFEXT, ELFEXT, PSELFEXT, ACR, Return Loss, Delay Skew, and the installed length. Cables not complying with the EIA/TIA 568C tests results shall be identified to the A&E for corrective action which may include replacement at no additional expense to the Owner. All identification names of the cables used in the test shall match the labeling system approved for the project and the corresponding shop drawings.
  - I. Any Fail, Fail\*, Pass\* or WARNING test result yields a Fail for the channel or permanent link under test. In order to achieve an overall Pass condition, the result for each individual test parameter must be passed. All test results shall come from a tester with the permanently enabled marginal reporting feature.
  - J. Test results shall show and comply with the margin claimed by the manufacturers over CAT6 and CAT6A permanent link specifications on all transmission parameters across the entire frequency range as shown on the manufacturer's cut sheets.
  - K. General: Copper multipair backbone cabling shall be tested for length, continuity, polarity checks and wire map. The SCS Installer shall provide the results of all Copper Riser cable tests in electronic format. The use of pigtails or special harness could be required to properly test these cables.
  - L. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.
  - M. All 4-pair patch cords shall be factory tested only.
- 3.4 TESTING OF FIBER OPTICS CABLING
- A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA/EIA-568-C and the addendum for fiber optic testing.
  - B. General: In the event the Engineer elects to be present during the tests, provide notification to the engineer two (2) weeks prior to testing.

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- C. Cleaness: All fiber optics connector shall be cleaned properly before any testing and after testing. Proof of cleaness shall be required during the acceptance test for the SCS by the A&E. SCS installer shall have available during this test a 200X microscope or a video probe to demonstrate the cleaness of the randomly selected connectors by the A&E.
- D. End to End Attenuation Test: The SCS installer shall perform end-to-end attenuation testing for each multimode fiber at 850 nm and 1300 nm from both directions for each terminated fiber span in accordance with EIA/TIA-526-14A (OFSTP 14) and single-mode fibers at 1310 nm and 1550 nm from both directions for each terminated fiber span in accordance with TIA/EIA-526-7 (OFSTP 7). A one jumper reference shall be used for all testing. For spans greater than 90 meters, each tested span must test to a value less than or equal to the value determined by calculating a link loss budget. For horizontal spans less than or equal to 90 meters, each tested span must be < 2.0 dB. When calculating the link loss budget for spans greater than 90 meters use the values listed below. End to end attenuation shall be done with a Level II meter using a meter and light source equipment (also known as main and remote unit)

ATTENUATION DUE TO	FIBER TYPE	MAX. ATTENUATION
Terminating connectors. Field terminated options	All fiber types	0.75 dB per connector
Terminating connectors, pre-term fibers	All fiber types	No more than 0.2 dB additional to total dB loss measured at the factory in report sent by cable manufacturer.
Splices	All fiber types	0.3 dB per splice
Distance	OM1 (850nm/1300)	3.4 dB /1.0 dB per Km.
Distance	OM2, OM3 and OM4 (850nm/1300)	3.0 dB /1.0 dB per Km.
Distance	OS1 and OS2 (1310 nm/1383 nm/1550 nm)	0.65 dB /0.65 dB/ 0.5 dB per Km.

- E. OTDR Test. Additional to end to end attenuation test, all fiber optic cables shall be tested with a Level III OTDR equipment for the following conditions:
- Each known event (connector/splice) insertion loss at both windows for each fiber type (850/1300 nm for multimode and 1310/1550 nm for single mode). All events shall pass maximum allowed insertion loss for the event type as indicated in table above.
  - Reflective events (connections) shall not exceed:
    - 0.75 dB in optical loss when bi-directionally averaged
    - 35 dB Reflectance for multimode connections
    - 40 dB reflectance for UPC singlemode connections
    - 55 dB reflectance for APC singlemode connections
  - Non-reflective events (splices) shall not exceed 0.3 dB.
  - Estimated distance for multiple strands of the same cable shall not vary more than 1% between strands.

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5. Cable signature in the form of traces along the complete distance of the cable. Unexplained cable reflections shown in the OTDR shall require the installer to submit letter explaining such events and pictures of cable conditions in the locations where the unexplained events are located to demonstrate cable has not been kinked or damaged during installation.

F. OTDR Test conditions. All OTDR testing shall be performed with the following conditions:

1. Use a launch cable and a tail cable in accordance with fiber type being tested and requirements indicated by OTDR equipment manufacturer.
2. Launch and tail cables shall be products sold by testing equipment manufacturer and not field made cables.
3. Launch and tail cables shall be selected according to the type of connector being tested such as APC or UPC type connectors.
4. Use launch compensation mode during the test to subtract the effects of the launch and tail cables.
5. Test from one direction only, unless the presence of “gainers” are spotted during the test. In such case the installer shall test in both directions and adjust the test equipment to average measurements from both directions.
6. The SCS installer shall verify the backscatter coefficient use in the test to make sure it matches the coefficient of the cable being tested.

G. OTDR Testing Equipment used on this project shall have the specifications indicated in this following table:

SPECIFICATION	MULTIMODE	SINGLE MODE
Wavelengths	850 nm $\pm$ 10 nm 1300 nm $\pm$ 35 / -15 nm.	1310 nm $\pm$ 25 nm. 1550 nm $\pm$ 30 nm.
Event Dead Zone. Measured at 1.5 dB below non-saturating reflection peak with the shortest pulse width. Reflection peak < -40 dB for mm and < -50 dB for sm.	850 nm: 0.5m typical 1300 nm: 0.7m typical	1310 nm: 0.6m typical 1550 nm: 0.6m typical
Attenuation Dead Zone. Measured at $\pm$ 0.5 dB deviation from backscatter with the shortest pulse width. Reflection peak < -40 dB for mm. and < -50 dB for sm.	850 nm: 2.2m typical 1300 nm: 4.5m typical	1310 nm: 3.6m typical 1550 nm: 3.7m typical
Pulse Widths (nominal)	850 nm: 3, 5, 20, 40, 200 ns. 1300 nm: 3, 5, 20, 40, 200, 1000 ns.	3, 10, 30, 100, 300, 1000, 3000, 10000, 20000 ns



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Loss Threshold	0.01 dB to 1.5 dB	0.01 dB to 1.5 dB
Setting	Adjustable in 0.01 dB increments	Adjustable in 0.01 dB increments

H. The Test Report for each fiber strand shall include the following information:

1. Calculated Loss Budget for each optical fiber link (see attenuation table above)
2. Cable/strand ID matching shop drawings labeling system.
3. Name of technicians who performed the test.
4. Date and time the test was performed.
5. Measurement direction (from/to)
6. Jumper reference set up date/time and attenuation value
7. Equipment model and serial number used and calibration date.
8. End to End Attenuation Loss Data for each optical fiber link
9. OTDR Traces, one page per strand. Expand chart to cover most of the page
10. Each event loss data and test limits used, including test limit file date used.

I. For fiber optic cables with factory terminated connectors or pre-terminated pig-tails, The SCS installer shall provide also the test results performed at the factory for fiber optic cables with factory terminated connectors to compare with the field test done by the SCS installer. No significant variation between the factory test results and the field test results shall be encountered.

### 3.5 SYSTEMS WARRANTY AND SERVICE

- A. SCS Installer shall follow all warranty and service requirements indicated in specification section 270010.
- B. Warranty: The SCS shall be required to be under the manufacturer's warranty program for a complete channel configuration including cable, jacks, patch cords and patch panels and include cabling specifically approved for the channel configuration with the manufacturer's components. Manufactures shall provide the warranty worst-case performance data for the installed cabling system, and the performance data indicated in the warranty documents/certificate.
- C. A twenty five (25) year warranty available for the Structured Cabling System (Fiber optics and copper infrastructure) shall be provided for an end-to-end channel model installation which covers applications assurance, cable, connecting hardware and the labor cost for the repair or replacement thereof.
- D. Additional features of the warranty shall include:
1. That the SCS installed system complies with the margin claimed by the manufacturer above the category 6 or 6A channel specifications on all transmission parameters across the entire frequency range of 1-600 MHz as shown on the manufacturers catalogs and literature.

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## 3.6 ENGINEER'S FINAL ACCEPTANCE TEST

- A. SCS Installer shall follow all requirements for final acceptance indicated in specification section 270010.
- B. The Engineer's final acceptance test will not include testing of structured cabling components, but could include verification of cleanness of fiber optic connectors.

## 3.7 TRAINING AND INSTRUCTION

- A. Training shall only be done after all testing and identification process have been completed and passed as indicated in this specification. Any training done prior to final acceptance will not be accounted for the formal training requested and the SCS installer shall re-do all training after the final acceptance test is passed, at no additional cost to the Owner.
- B. SCS Installer shall follow all training requirements indicated in specification section 270010
- C. The training for the SCS shall include the following topics:
  - 1. Detail explanation of the identification system.
  - 2. A walkthrough of all spaces and locations where terminations have been done in the project.

## 3.8 AS BUILT DOCUMENTS AND PROJECT CLOSE OUT

- A. The SCS shall follow all requirements for as-built and close out documents indicated in specification section 270010
- B. The following are additional requirements supplementing the information provided in specification section 270010:
  - 1. Provide the Warranty certificate issued by the manufacturer of the SCS infrastructure.
  - 2. The installer's RCDD shall affix his/her stamp to the as-built drawings, indicating that he/she has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed.
  - 3. As built drawings inside each telecom room. The SCS installer shall plot all as-built drawings and locate them inside each of the telecom rooms in the project. Each telecom room shall have the as-built drawings of the areas being served from that room. Each drawing shall be placed inside a clear vinyl document protector the size of the actual design drawing and affixed to a wall/plywood in the telecom room. The document protector shall be re-usable and shall allow the owner to replace the drawings as changes are done to the SCS infrastructure in the future. Without this information, substantial use of the system will not be provided to the installer.
  - 4. The SCS installer shall provide Excel software spreadsheet that defines the telecommunications outlet number, location, number of voice, data and special jacks. This database shall also provide the outlet patch panel connection to the riser/inter-floor cable, equipment, and telephone company demarcation circuit pairs as part of the as-built documentation.
  - 5. Electronic copies of all test results (copper and fiber). Electronic copies shall include raw data files and PDF files with results. PDF files shall be organized the following way:

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- a. All copper cables for cables terminating in one telecom room in a single PDF files with the name equal to the label used in the shop drawings for the telecom room where the cables are terminated.
- b. All attenuation and OTDR test for all strands of a single cable shall be in one PDF file with the name corresponding to the Cable ID used in the shop drawings.

END OF SECTION 271000

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## SECTION 274134 - BROADBAND DISTRIBUTION SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.
- C. General: Telecommunications Drawings apply to work of this section. The overall and detailed Broadband distribution design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.
- D. General: Requirements indicated in the following standard apply to the work to be performed under this specification section:
  - 1. TIA-568-C.4 (July 2011) "Broadband Coaxial Cabling and Components Standard". Including addendum and errata.
- E. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
  - 1. 270010 Technology General Provisions
  - 2. 270528 Raceways for Technology
  - 3. 270526 Grounding and Bonding for Telecommunications Systems

#### 1.2 DEFINITIONS

- A. Agile Receiver: A broadband receiver that can be tuned to any desired channel.
- B. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.

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- C. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, it is spread out over a wider band. The carrier frequency is the center frequency on any television channel.
- D. CATV: Community antenna television; a communication system that simultaneously distributes several different channels of broadcast programs and other information to customers via a coaxial cable.
- E. CCTV: Closed-circuit television.
- F. CEA: Consumer Electronics Association.
- G. dBmV: Decibels relative to 1 mV across 75 ohms. Zero dBmV is defined as 1 mV across 75 ohms.  $\text{dBmV} = 20 \log_{10}(V1/V2)$  where V1 is the measurement of voltage at a point having identical impedance to V2 (0.001 V across 75 ohms).
- H. DOCSIS. Data Over Cable Service Interface Specification. This is an international telecommunications standard that permits the addition of high-speed data transfer to CATV system.
- I. Headend: The control center of the master antenna television system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "Central Retransmission Facility."
- J. MATV: Master antenna television; a small television antenna distribution system usually restricted to one or two buildings.
- K. RF: Radio frequency.

## 1.3 DESCRIPTION

- A. Broadband Distribution Systems shall provide distribution of video, television signals to all selected spaces in the buildings. The system design anticipates increasing demands for expanded channel capacity. The system shall include, but not be limited to passive and active infrastructure like distribution amplifiers, directional couplers, taps and splitters as required to achieve a fully functional system.
- B. General: Provide, complete with all accessories, a complete distribution system as describe herein and as indicated on the drawings
- C. Standards: Distribution system components and overall system performance shall meet or exceed the following standards:
  - 1. Federal Communications Commission Technical Specifications Title 47, Part 76 as applied to cable television systems.
  - 2. TIA – 568-C.4 “Broadband coaxial cabling and components”. July 2011.
  - 3. TIA-606-B (June 2012), “Administration Standard for Telecommunications Infrastructure” with addendum and errata.

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- D. RFI: Special emphasis shall be placed on radio frequency interference (RFI) integrity as licensed radio services outside the cable system share the same frequencies designated for use within.
- E. Intent of design drawings: The intent of the design drawings is to indicate the scope of work of the project and to allow the installer to properly bid the project. The design drawings are based on estimated distances between devices. Once all cable are run, the installer shall measure the exact cable footages between equipment locations and shall adjust the calculations of the system to comply with the performance criteria indicated in this specification section. The installer shall change any taps, equalizers or directional couplers to match the modified calculations by the installer, at no additional cost to the owner.

## 1.4 SERVICES SUPPORTED

- A. The system configuration will allow the forward distribution of the following incoming TV signals:
  - 1. Analog channels from Cable provider
  - 2. Digital channels from cable provider
  - 3. High Definition channels from cable provider
- B. The system bandpass shall allow for the following channel loading and forward distribution:
  - 1. One hundred and twenty nine (129) channels from 47 MHz to 860 MHz.
- C. The system shall allow for a return path with a loading of 3 channels from 5 MHz to 42 MHz.

## 1.5 INSTALLER QUALIFICATIONS

- A. Qualifications: The CATV installer installing this system shall be experienced in the design, installation, proof of performance testing and maintenance of broadband cable television systems comparable or larger in size and complexity to the system required on this project. Such experience shall be indicated in a list of successfully completed systems with the submittal for this system. Contact names and addresses for all references shall be provided.
- B. Equipment: The CATV installer executing this work shall own and maintain at least the following equipment for execution and maintenance of this system;
  - 1. A CATV signal level meter capable of measuring levels between 5 and 1000 megahertz for both digital and analog channels. For example Blonder Tongue BTPPRO-1000.
  - 2. CATV Plant certification meter such as JDSU DSAM Wavetek Series Field Meter Model DSAM 6300
  - 3. A flat noise generator or sweep/marker generator capable of providing a calibrated output between 5 and 1000 megahertz.
  - 4. An oscilloscope with a suitable RF detector for use in sweep testing system response.
  - 5. A return loss bridge and variable termination for on-site cable sweep testing prior to installation.
  - 6. A time domain reflectometer designed for operation into 75-ohm polyethylene dielectric cable for verification of installed cable.
  - 7. Composite test sets, simul-sweep equipment and other test systems capable of providing the required functions shall be considered equivalent to the equipment specified.

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8. A stripping/coring tool appropriate for 0.500" hardline cable or larger cables.

- C. Resume: A resume of personal cable television experience shall be submitted for the cable foreman, each splicer, each technician, and the system design engineer.
- D. Provisions: The CATV installer shall own and maintain all necessary equipment and tooling to properly provide the system in accordance with recommendations set forth by the manufacturers of each item of system equipment.

## 1.6 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. Substitutions are allowed for this system only for active components, as long as they have exactly the same performance as the basis of design.

## 1.7 SHOP DRAWINGS AND SUBMITTALS

- A. The CATV installer shall follow all requirements for shop drawings indicated in specification section 270010.
- B. Additional information to be included in the shop drawings
  - 1. Cut sheet of all devices to be provided as part of this systems. When multiple devices are in the same cut sheet, the installer shall highlight the specific part number to be used. Cut sheets of the following devices shall be provided:
    - a. All copper and fiber optic cables
    - b. All passive devices
    - c. All connectors
    - d. All outlets indicating colors
    - e. All surge suppressors
    - f. All amplifiers
  - 2. Proof of installer qualifications per paragraph 1.5
  - 3. A list of all testing equipment owned by the installer as requested in this specification. The list shall include all make and model number of all devices and the last time they were calibrated.
  - 4. Drawings indicating all outlets in the project, with cable distances included, types of cables and how they are connected to the backbone system. The drawings shall include all pad and equalization calculations to the input of all amplifiers in the system.

## 1.8 GENERAL SYSTEM PARAMETERS

- A. Devices and products described below may or may not be required for the overall design. If such devices are required in the course of this project to achieve the design distribution parameter, the installer shall provide such devices as a part of their design solution and said devices shall be included as part of the installers package in the bid. These items would include those listed below as well as splitters, taps, couplers and pads.

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- B. The CATV installer shall be familiar with the ANSI/SCTE standards and shall follow those standards during the installation process.
- C. Amplifiers: In most cases, the output from the amplifier shall be adequate for building distribution. However in larger building distribution systems, additional amplifiers will possibly be required. If such is the case, Input pad and equalizers shall be provided to compensate for short spacing and cable slope, respectively. Outputs shall be adjusted to the rated sloped output of the amplifier selection (typically 36 dBmv to 44 dBmv or rated output by equipment manufacturer) at the selected frequency range indicated in this specification section.
- D. Output: All outlets shall provide a minimum output of between +3 dBmv and +10dBmv for the complete frequency range specified in this section.
- E. Minimum acceptable distribution system performance at all outlets shall be as follows:
  - 1. RF Video Carrier Level: Between 3 and 12 dBmV.
  - 2. Relative Video Carrier Level: Within 3 dB to adjacent channel.
  - 3. Carrier Level Stability, Short Term: Level shall not change more than 0.5 dB during a 60-minute period.
  - 4. Carrier Level Stability, Long Term: Level shall not change more than 2 dB during a 24-hour period.
  - 5. Channel Frequency Response: Across any 6-MHz channel in 54- to 220-MHz frequency range, referenced to video, signal amplitude shall be plus or minus 1 dB, maximum.
  - 6. Carrier-to-Noise Ratio: 45 dB or more.
  - 7. RF Visual Signal-to-Noise Ratio: 43 dB or more.
  - 8. Cross Modulation: Less than minus 50 dB.
  - 9. Carrier-to-Echo Ratio: More than 40 dB.
  - 10. Composite Triple Beat: Less than minus 53 dB.
  - 11. Second Order Beat: Less than minus 60 dB.
  - 12. Terminal Isolation from Television to Television: 25 dB, minimum.
  - 13. Terminal Isolation between Television and FM: 35 dB, minimum.
  - 14. Hum Modulation: 2 percent, maximum.
  - 15. RF FM Carrier Level: 13 to 17 dB below video carrier level.
  - 16. FM Frequency Response: More than the 88- to 108-MHz frequency range, signal amplitude is plus or minus 0.75 dB, maximum.
  - 17. FM Carrier-to-Noise Ratio: More than 24 dB.
- F. RF Leakage: Radio frequency leakage into the system shall be in compliance of all FCC rulings and regulations.
- G. Delay: Combined reverse and forward path chroma delay, as measured at the most distant bridged port, to the headend and or main distribution point in the building and back, shall not exceed 28 nanoseconds.
- H. The complete CATV distribution system shall be certified form compliance with DOCSIS 3.1.



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## PART 2 - PRODUCTS

### 2.1 DISTRIBUTION AMPLIFIERS (NOT AT HEAD END)

- A. This amplifier shall be used only in the distribution system and shall have the following specifications:
  - 1. Frequency Range: As stated in paragraph 1.4. B of this section
  - 2. Forward gain: 43dB
  - 3. Gain Control Range: Greater or equal to 10dB
  - 4. Slope Control Range: Greater or equal to 8dB
  - 5. Input Return Loss: Greater or equal to 16dB
  - 6. Noise Figure: Greater or equal to 7dB
  - 7. Required output Level: 36/44 dBmV,
  - 8. Hybrid technology: Power doubling
  - 9. Input/Output Test Point Level: -30dB
- B. Design Selection: Blonder Tongue BIDA 5900 series, or approved equal with required pads and equalizers.

### 2.2 PASSIVE DEVICES

- A. All passive devices shall have a minimum bandwidth of 5 to 1000 MHz.
- B. Splitters for drops or backbones designed with RG-6 or RG-11 lines: Splitters shall be Blonder Tongue SXRS-2, 3, 4, 6 & 8 as required by the system configuration.
- C. Directional Couplers for drops or backbones designed with RG-6 or RG-11 lines: shall be Blonder Tongue SRT series, with dB TAP setting as required by the system configuration.
- D. Splitters for backbones designed with PIII-500 or bigger diameter cable: shall be Toner TLP-SP series as required by the system configuration.
- E. Directional couplers for backbones designed with PIII-500 or bigger diameter cable: Shall be Toner TLP-DC series as required for the system configuration
- F. Multi-taps shall be Toner Total tap with 3 or 6 tap housings as indicated by the system configuration. Tap values and quantity of tap ports as indicated in system configuration
- G. Equalizer. Equalizer shall be mounted in the tap housings and shall be a Toner TXMT plate. Equalizers could be mounted also inside distribution amplifiers. The value to equalize shall be as indicated in system configuration.

### 2.3 OUTLETS

- A. The television outlet shall provide (1) "F" type barrel connector mounted with other structured wiring connectors on a common face plate. Outlets shall be mounted as indicated on the documents, or as otherwise indicated and directly inline with the proposed television location. Coordinate final location based upon provided drawings and coordination with the Owner. A three wire grounded, 120 VAC power outlet shall be located adjacent to the television outlet and be provided by owner selected Division 26 Installer. Coaxial cable shall be provided by the

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CATV installer to each outlet location indicated on the drawings. Conduit and boxes shall also be provided according to specifications section 270528. Coordinate location with electrical installer if not already provided at time of installation of this work.

- B. Design selection: F- connector with a single barrel connector to match (faceplate style and color) de design selection of the structured wiring system as described in specification section 271000.

## 2.4 VIDEO DISTRIBUTION CABLE

- A. Structural Return Loss Testing: All cable shall be 100% swept tested. Return loss shall not be less than 23dB at any given frequency between 5MhZ and 1000MhZ.
- B. Construction: Cable shall be constructed of a copper clad steel or solid copper center conductor, gas expanded cellular polyethylene dielectric, multiple aluminum braided shields, and an overall jacket. All cables shall have characteristic impedance of 75 Ohms.
- C. Attenuation: Attenuation characteristics in decibels per 100 feet at 20oC shall not deviate more than 10% from the following values:

<b>FREQUENCY (MHz)</b>	<b>RG-6</b>	<b>RG-11</b>	<b>PIII-500</b>
5	0.57	0.36	0.16
55	1.5	0.95	0.54
211	2.87	1.81	1.09
300	3.43	2.17	1.31
400	4.0	2.53	1.53
450	4.28	2.69	1.63
550	4.76	3.01	1.82
750	5.62	3.58	2.16
870	6.09	3.9	2.35
1000	6.54	4.23	2.53

- D. RG-6 Cable: No 18 AWG solid bare copper conductor. Four layers of shield, two aluminum foil-polyester tape aluminum foil, one 60% aluminum braid and one 40% aluminum braid. NEC article 820 compliant jacket suitable for the environment being installed.
- E. RG-11 Cable: No 14 AWG solid bare copper center conductor. Two layers of shield, one aluminum foil-polyester tape aluminum foil and one 60% aluminum braid. NEC article 820 compliant jacket suitable for the environment being installed.

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- F. PIII-500: 0.109" diameter copper clad center conductor. Solid aluminum tube swaged onto a high compression micro-cellular foam dielectric core. NEC article 820 compliant jacket suitable for the environment being installed.

- G. Indoor Cables: The following table indicates the design selection for all CATV cables. Cables shall be selected according to the environment in which they will be installed:

CABLE TYPE	GENERAL (CM)	RISER RATED	PLENUM RATED
RG-6	Belden 5339Q5	Use plenum rated cable	Belden 6339Q8
RG-11	Belden 1617A	Use plenum rated cable	Belden1617AP
PIII-500	Use riser rated cable	Commscope P3 500 JCAR	Commscope P3 500 JCAP

- H. Outdoor Cables: When coaxial cables are to be installed outdoors, or underground in conduit, they need to have a jacket with a water blocking compound.

- I. RG-59 cable shall never be used for the distribution system.

## 2.5 CONNECTORS AND ADAPTER

- A. Site Cable Connectors: All connector shall be as recommended by the Cable manufacturer for the cable size and jacket of the cable.
- B. Connectors for RG-6 cables. All connectors for RG-6 cable shall be one piece compression connectors with color coded sleeve. Design selection: Belden part number SNS1P6QS or equivalent.
- C. Connectors for RG-11 cables. All connectors for RG-11 cable shall be one piece compression connectors with color coded sleeve. Design selection: Belden part number SNS1P11 or equivalent.
- D. Connectors for PIII-500 cables. All connectors for PIII-500 cable shall use a 5/8" 3 pin type connector. Design selection: Amphenol ACC-500-CHT10 or equivalent.
- E. Adapters. The installer shall provide all adapters to connect all different cables listed above to an F type connector or a to a 5/8" 3 pin connector, as required in the design to make complete connections. Design selection: Amphenol ACC series or equivalent.
- F. Crimping: All connectors shall be installed using the connector manufacturer's recommended cutting, coring and pin crimping tools.

## 2.6 SURGE SUPPRESSION

- A. All coaxial cables entering or exiting a building (above or below ground) shall be surge protected as required by NEC article 820.

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- B. All surge suppression devices shall be grounded with an AWG-12 isolated wire to the closest electrical ground.
- C. All surge suppression devices shall be UL 497 listed, gas tube suppression, power passing and specifically designed for broadband network applications.
- D. Design selection: TII in-line coaxial lighting surge protector part number 212FF757225-31.

## 2.7 IDENTIFICATION AND LABELING TAGS

- A. The CATV installer shall follow labeling materials indicated in specification section 270010.

## PART 3 - EXECUTION

### 3.1 INSTALLATION PRACTICES

- A. The CATV installer shall follow all installation practices indicated in specification section 270010
- B. In Raceway: All cables shall be installed in raceways without kinks, dents, or abrasions. Specified pulling strength of cable shall not be exceeded.
- C. All indoor cables shall have no splices at any points.
- D. Terminal Locations: Cables at terminal locations shall be neatly formed using a bending form to prevent kinks or other discontinuities. Cables showing evidence of abuse or physical damage shall be replaced at the installer's expense.
- E. It is envisioned that television service will migrate into the overall telecommunications scheme for a given facility, therefore television distribution shall be accomplished via the following methods. In general, television distribution points shall be located throughout the facility such and all wiring shall be run back to the Telecommunication closet where the connection to the Broadband distribution backbone will take place.
- F. The facility contains telecommunications rooms or associated closets, which shall be used for amplification & distribution equipment as well as all TRUNK/FEEDER & DROP cable terminations. Cabling used shall conform to the specifications as previously outlined, with the addition of CMP type cables for use in plenum rated areas if applicable, and environmental air circulation spaces, if required by the facility air distribution system.
- G. All unused outputs of splitters, directional couples or distribution taps shall have a 75 ohm termination installed.
- H. All unused cavities of the Toner Total Tap housing shall be filled with blank plates
- I. All equipment with a grounding lug shall be grounded as recommended by the equipment manufacturer to an acceptable grounding point as described by the NEC.
- J. All amplifiers shall be used at the rated output. The installer shall provide the required equalization and attenuation pads for all amplifiers to operate at the rated output at only 80% of the maximum gain control of the unit.

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- K. Cable and equipment identifiers shall be provided and shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the CATV installer shall be submitted for approval to the A&E.
- L. The installer shall use attenuator or adjustment for fiber optic equipment to ensure proper budget levels are getting to each receiver.

## 3.2 INSTALLATION OF CONNECTORS

- A. Provisions: All connectors shall be installed in strict accordance with the manufacturers' instructions.
- B. Residue Removal: All dielectric residues shall be removed from surfaces of center conductors to insure proper electrical contact.
- C. Preparation: Semi-rigid cables shall have jacket removed to a length of 2" from the cable end to allow proper seating of connectors without scoring of the aluminum sheath. A tubing cutter shall not be used for this purpose. All flooding compound shall be removed from the connector location with a suitable solvent.
- D. Connections: All connections including terminations and connections on flexible cables shall be wrench tightened to insure RFI integrity. Connectors at manhole or exterior pedestal tap locations and antennas shall be filled with Dow Corning #5 compound prior to wrench tightening.
- E. Tooling: Cables shall be prepared to accept connectors using the manufacturer's recommended tooling.
- F. Crimp Connections: Crimp type connections on flexible cables in manholes shall be made with a Hex crimp tool and encapsulated with flooded heat shrink tubing.
- G. Heat Shrink Boot: All cables containing flooding compound shall be provided with a heat shrink boot at all termination points which covers the housing connector boss, body of the connector and extends not less than 12" along the cable jacket. Heat shrink boot shall be of the filled type.
- H. Splices: Cable splices below grade or in other locations shall be made according to manufacturers' recommendations, tested, and covered with a filled heat shrink boot approximately 30" in length. Boot shall contain a resilient compound which melts as heat is applied and fills all voids between the shrink tube and cable jacket. Resin casts shall not be acceptable.

## 3.3 EQUIPMENT MOUNTING

- A. Mounting: All remote terminal equipment (amplifiers, taps, couplers etc.) shall be neatly arranged and securely mounted. When installed above the ceiling all devices need to be in accessible places. All accessories required for wall mounting equipment shall be provided when equipment is to be wall mounted.
- B. Integrity: All equipment housing hardware including amplifiers shall be wrench tightened to insure full RFI integrity.

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## 3.4 SYSTEM ADJUSTMENTS

- A. Installation: System design drawings are based on estimated distances between devices. The installer shall measure the exact cable footages between equipment locations and submit a revised drawing to the engineer for review containing the following;
1. Exact footage of each cable
  2. Revised coupler and tap values
  3. Revised equalizer and pad values.

## 3.5 SYSTEM PERFORMANCE

- A. General: Upon completion the system shall be adjusted, tested, and left in perfect operating condition.
- B. Provisions: The system shall not exhibit any audible or visible components of hum, noise, or distortion.
- C. Before the system acceptance test, the installer shall test all outlets in the system and document the result in a spreadsheet or an automated test print out from the test equipment. This report is called TEST RESULT REPORT (TRR). The TRR report shall include the following information:
1. Project name and location
  2. Day test was done (if done in different days, the report shall be broken in sections by days the tests were done).
  3. Name of the installer that performed the test
  4. Serial number of the tester used.
  5. For each outlet in the project the report shall include:
    - a. Room number:
    - b. Room name:
    - c. Outlet number (with permanent label matching as-built drawings)
    - d. Lowest channel - signal level (in dBmV)
    - e. Mid bandwidth channel – signal level (in dBmV)
    - f. Highest channel (as identified in part 1 of this specification) – signal level (in dBmV)
  6. For each amplifier in the system the report shall include:
    - a. Room number:
    - b. Room name:
    - c. Lowest channel - signal level (in dBmV, measured @ test port)
    - d. Mid bandwidth channel – signal level (in dBmV, measured @ test port)
    - e. Highest channel (as identified in part 1 of this specification) – signal level (in dBmV, measured @ test port)

## 3.6 SYSTEMS WARRANTY AND SERVICE

- A. General: The CATV installer shall follow all warranty and service requirements indicated in specification section 270010.

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## 3.7 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The CATV installer shall follow all test requirements indicated in specification section 270010
- B. General: The Installer shall demonstrate the operation of the system to the Architect & Engineer (A&E) during the final inspection in the following manner:
  - 1. Measure signal levels with a calibrated field strength meter at outlets and or amplifiers selected by the A&E. At a minimum 5% of all outlets will be tested. The readings of the meter shall be between 1.5 dBmV of the value documented in the TRR
  - 2. Observe picture quality at outlets selected by the Engineer using a television receiver.
- C. If at least one measurement fails, the A&E can request to the installer to test more outlets (beyond the 5% indicated previously) until the A&E is satisfied with the results. Any failures shall be corrected by the installer at no additional cost to the owner.

## 3.8 TEST EQUIPMENT REQUIRED

- A. At a minimum during the acceptance test to the A&E the installer shall have the following equipment:
  - 1. TV Receiver: 17" minimum diagonal screen size color receiver in good working order.
  - 2. Signal Meter: This signal meter needs to be the same tester used during the TRR
- B. Age and Calibration: Test equipment used in demonstrating system performance shall be less than 6 months old or bear the calibration seal of a recognized lab which is dated within 6 months of the date of acceptance test.

## 3.9 TRAINING AND INSTRUCTION

- A. General: The CATV installer shall follow all training requirements indicated in specification section 270010.
- B. The training shall include the following topics:
  - 1. How to make connectors part of this system with the provided tools.
  - 2. How to balance the system with amplifiers at rated output
  - 3. A walk-through of the facility pointing out the location of all active and passive equipment part of this system and showing to the owner the as-built drawings with matching labels for those pieces of equipment.
  - 4. A complete training on the use of the test tool provided.

## 3.10 AS BUILT DOCUMENTS AND CLOSE-OUT INFORMATION

- A. General: The CATV installer shall follow all as built and close out information requirements indicated in specification section 270010.
- B. General: As built drawings shall include the following information:
  - 1. A block diagram of the entire system indicating all cable routing and lengths

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2. Revised coupler and tap values for each cable drop
  3. All cable types, active components, and passive components.
  4. All equalizing and attenuating pads used for each amplifier.
  5. All system settings.
  6. All brands and part number of all devices shall be indicated in the drawings.
  7. Location of each outlet and the unique label identifier of each outlet.
  8. High/low signal level measured at each amplifier test port.
- C. Additional information to be provided by the CATV installer, as part of the close out information:
1. A copy of the TRR signed approved by the A&E.

END OF SECTION 274134



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## SECTION 281000 - ELECTRONIC SECURITY SYSTEM

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.

- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

- C. The scope of work shall include furnishing all labor, materials, enclosures, wiring, equipment, programming, training, testing, documentation and warranty support, required to provide a completely operational and working Security System. Any materials or equipment necessary for the proper operation of this system.
- D. The Security System Installer (SSI) shall coordinate with the door frame installer, the door installer, the door hardware installer and gate installers on the placement of all electronic locking hardware and door controls for this project. The door hardware installer shall provide and install all electronic door locking hardware and the low voltage power supplies for delayed egress devices. The SSI shall provide the low voltage power supplies for all electric locks, wire and cable, terminate all connections, and shall interface this equipment with the integrated security system.
- E. All materials for the structured cabling system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair (25 pairs or higher) components required for the security system shall be in compliance with specification Section 27 10 00.
- F. The following parts of the system are not part of this contract:
1. All networking equipment (switches, routers, etc.) for the operation of the system
  2. All computers and software to run the security system with the exception of the items indicated in this specification.
  3. Software licenses for the security system.

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## 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. General Terms and Conditions of the Contract Documents
  - 1. Division 8 – Door Hardware
  - 2. Division 16 – Electrical
- C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
  - 1. 27 0010 Technology General Provisions
  - 2. 27 0528 Raceways for Technology
  - 3. 27 1000 Structured Cabling System
  - 4. 27 0526 Grounding and Bonding for Communication Systems

## 1.3 SECURITY SYSTEM INSTALLER QUALIFICATIONS

- A. The SSI selected for this project must be a direct manufacturer authorized representative of the product they propose to provide. All technicians assigned to install and configure this system shall be factory trained and certified for the proper installation of this equipment. The SSI must have a minimum of 5 qualified and factory trained technicians to support this system. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years. This company shall have a fully staffed office of sales and technical support representatives within 100 miles of travel to this project.
- B. Other required SSI qualifications are:
  - 1. The SSI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The SSI shall be able to perform any and all repairs to the system within 24 hours.
  - 2. The SSI, as a minimum, must carry a current state issued Alarm Contractors license.
  - 3. The SSI shall be a direct distributor of Kantech Global Dealer.

## 1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. Due to compatibility issues with other buildings under the control of the owner, the only approved system to be provided in this project is Kantech Entrapass. No substitutions are accepted for this type of equipment.
- C. Sensors or door security devices with the exception of card readers shall allow for substitutions.

## 1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The SSI shall follow all requirements for shop drawings indicated in specification section 27 00100.

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- B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 30 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the A&E for review and approval, as part of the product/installer approval process.
1. Proof of Installer qualifications, including the Kantech certification, on the name of the installer performing this work. Also, the submittal shall address all requirements of paragraph 1.3 of this specification.
  2. Product numbers, specifications, and data sheets for all equipment.
  3. Data sheets and samples of all labeling materials and equipment to be used in the project.
  4. A complete explanation of the identification method to be used for all equipment and cabling part of the security system.
  5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
  6. Detailed drawings of all custom products to be used in the project.
  7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.
- C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:
1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. Devices for alarm systems shall indicate the zone numbers. Access controlled doors shall have the door name. All other devices shall have a unique identifier, as they will be programmed in the system.
  2. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination. These diagrams shall be submitted for each door type and for each type of device in the system.
  3. Panel schedules in a table format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all access control panels, alarm panels, fiber optics distribution frames, Ethernet switches, patch panels, termination blocks, etc.
  4. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
  5. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
  6. Termination details for multi-conductor connectors and other details not included in item 2 of the shop drawings.
  7. Outline of the training process.

## 1.6 ABBREVIATIONS

- A. Additional abbreviations used in this document:

1. ADA - Americans with Disabilities Act
2. API - Application Programming Interface
3. ASCII - American Standard Code for Information Interchange

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4. BPS - Bits Per Second
5. DIN - German Institute of Standardization
6. DPS - Door Position Switch
7. FCC - Federal Communications Commission
8. GUI - Graphical User Interface
9. ID - Identification
10. I/O - Input /Output
11. ODBC - Open Database Connectivity
12. O&M - Operations and Maintenance
13. PIN - Personal Identification Number
14. PTZ - Pan/Tilt/Zoom
15. RAID - Redundant Array of Independent Disks
16. REX - Request to Exit
17. RoHS - Restriction of Hazardous Substances Directive
18. SCS - Security Control System
19. SDRAM - Synchronized Dynamic Random Access Memory
20. STP - Shielded Twisted Pair
21. UL - Underwriters Laboratories, Inc.
22. UPS - Uninterrupted Power Supply
23. USB - Universal Serial Bus
24. UTP - Unshielded Twisted Pair
25. VOC - Volatile Organic Compounds

## 1.7 GLOSSARY OF TERMS

### A. The following terms are defined for the purposes of this specification:

1. Access Group: A logical group of card readers (terminals) which may be connected to one or more sub-controllers and which represent a collection of readers for which a particular cardholder may have access privileges.
2. Access Mode: The mode of operation in which the security control system shall only annunciate tamper and trouble conditions at a monitored point. Alarm conditions shall not be annunciated in this mode. Also referred to as alarm shunting.
3. Acknowledge: The action taken by a security control system operator to indicate that he/she is aware of a specific alarm or tamper state.
4. Action Messages: A set of instructions automatically provided to the operator when an alarm condition is generated.
5. Advisory: A message provided by the security control system to the operator to inform him/her of a condition as reported by the security control system.
6. Alarm Condition: A change of state, as sensed by the security control system, indicating that the security control system has detected a condition which its sensors were designed to detect.
7. API Integration: a method to transfer information between two systems by means of APIs, though an Ethernet communication network.
8. Cardholder: A person who has been issued a valid access card.
9. Card Reader: A device usually located at access points, designed to decode the information contained on or within a card key credential for the purposes of making an access decision or for identity verification.
10. Clear: The action taken by a security control system operator to respond to an alarm condition or advisory so that other alarms may be serviced or so that other actions may be taken.

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11. Download: To send computer data from the File Server to a controller for the purposes of making access decision without the intervention of the File Server.
12. Facility Code: A coded number, in addition to the individual card number, stored within each card key that uniquely identifies the facility at which the card is valid. This feature prevents cards from one facility from being used at another facility that has a similar access control system.
13. File Server: Primary host computer in the networked security system which maintains the access control system database.
14. Line Supervision: The monitoring of an electrical circuit via electrical and software systems to verify the electrical integrity of the supervised circuit.
15. Off-line: A condition in which a controller(s) is not in communication with the File Server. In the off-line mode, the controller continues to make access decisions and process alarms according to the information stored at its local database.
16. Password: A combination of numbers or letters unique to security control system operator which defines commands and data fields he/she may view, edit, or command.
17. Relay integration: A method to transfer signals between two systems by means of using potential free contact closures to input points.
18. Reset: A command or feedback signal that indicates that a monitored point has returned to its normal state after having transferred to the alarm or trouble state.
19. Secure Mode: The normal state of an alarm input point from which it will be monitored for change of state to either an alarm or trouble condition.
20. Secured Area: A physical location within the facility to which access is controlled by one or more card readers.
21. Secured side: Side of a security door where a higher security level needs to be granted for a user to be authorized to be in that side of the door.
22. Serial line integration: A method to transfer information between two systems by means of an RS-232/RS-422 or RS-485 line, using ASCII strings.
23. Tamper: A condition within the circuitry of a monitored point which indicates the electrical integrity of that sensing circuit has been compromised.
24. Tamper proof screws: A screw with a security hexalobular internal driving feature as described in ISO 10664. As an example, a security TORX head, as developed by Camcar LLC.
25. Time Interval: A time stamp of one start time and one stop time within a time period.
26. Time Period: A user programmable period of time made up of days of the week and hours in the day.
27. Trouble: A condition within the circuitry of a monitored point which indicates that an equipment malfunction, single break, single fault or a wire-to-wire short exists.
28. Unsecured side: Side of a security door where a lower security level needs to be granted for a user to be authorized to be in that side of the door.
29. User Definable: An attribute of a security control system function that may be easily tailored by the System Administrator.
30. Workstation: A personal computer connected to the main security control system File Server via a local area network connection for the purpose of programming the system and responding to alarms.

## 1.8 SYSTEM DESCRIPTION

- A. The security systems primary purposes shall be to provide access control and alarm monitoring capabilities for this project. The system shall provide functionality such as the ability to regulate and control access through specific areas of the facility and fully integrate with other security

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components such as closed circuit television, alarm system, intercom and digital video recording.

## PART 2 - SYSTEM CHARACTERISTICS

### 2.1 INTELLIGENT SYSTEM CONTROLLER (ISC)

- A. An Intelligent System Controller (ISC) shall link the security software to all other field hardware components like card readers, inputs and outputs. Controllers shall operate as autonomous, microprocessor based processing units:
  - 1. ISCs shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
  - 2. ISCs shall be part of a fully distributed processing-control network.
  - 3. The portion of the database associated with an ISC, and consisting of parameters, constraints, and the latest value or status of points connected to that ISC, shall be maintained in the ISC.
- B. ISC can be one single hardware board or multiple hardware boards linked together. The following functions shall be fully implemented and operational within each ISC:
  - 1. Monitoring inputs (open, closed or fault).
  - 2. Controlling outputs.
  - 3. Automatically reporting alarms to the system server.
  - 4. Reporting of sensor and output status to the system server on request.
  - 5. Maintaining real time, automatically updated by the system server at least once a day.
  - 6. Communicating with the system server through a secured encrypted TCP/IP communication.
  - 7. Communicating with other ISC or hardware devices through serial RS-422/RS-232/RS-45 encrypted lines.
  - 8. Executing ISC resident programs.
  - 9. Diagnosing.
  - 10. Downloading and uploading data to and from the system server.
- C. ISC Operations at a Location:
  - 1. In the event of communication failure between the system server and a Location, there shall be no degradation in operations at the ISCs at that Location. ISCs at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
  - 2. Buffered events shall be handled in a first-in-first-out mode of operation.
- D. Individual ISC Operation:
  - 1. ISCs shall transmit alarms, status changes, and other data to the system server when communications circuits are operable. If communications are not available, ISCs shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the system server, shall be stored for later transmission to the system server. Storage capacity for the latest 1024 events shall be provided at each ISC.
- E. All ISCs shall be UL listed. Input points in ISCs shall be UL 294 listed.

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- F. Design selection for indoor applications Kantech KT400

**2.2 POWER SUPPLY/ENCLOSURES – ACCESS CONTROL SYSTEM**

- A. The built-in transformer that comes with the KT400 shall be used for powering up each ISC. A battery 12V 7AH battery shall be provided with each panel to provide power backup.

**2.3 TAMPER SWITCH**

- A. All security enclosures, including power supplies and all j-boxes with cable splices or terminations shall include a tamper switch for direct supervision of the cabinet door. Any opening of these doors shall initiate an alarm condition to the security monitoring system. All tamper contacts shall be a reed actuated self-adjusting plunger style switch. If a tamper contact is provided by the manufacturer with the enclosure this device may be used.
- B. Tamper switches shall be wired as to report separate alarms to the system for each panel.
- C. The tamper switch for this project shall be an Amseco PSW-1 or an approved equal.

**2.4 PROXIMITY CARD READER**

- A. Design selection: For the card reader: Kantech ioProx P325XSF. For card readers with keypad: Kantech ioProx P325KPSF.

**2.5 LOCKING DEVICES – SPECIFIED UNDER DIV 8**

- A. The SSI shall coordinate with the door hardware installer on the placement of electronic locking hardware required for this project. The SSI shall provide all necessary wire and cable, and the low voltage power supplies for door locks. The SSI shall also be responsible for terminating all connections and interface this equipment with the integrated security system.

**2.6 DOOR RELEASE BUTTONS**

- A. Design selection: Schlage 621-GR-DA-630 with 0-60 second timed activation.

**2.7 REQUEST TO EXIT EGRESS MOTION SENSOR**

- A. The egress sensors shall utilize passive infrared technology to detect the motion of individuals approaching a door. Upon activation this device shall release the lock, and shunt the magnetic door position switch to allow unobstructed egress through the door. This device shall be field adjustable to fit the monitoring requirements of the location where installed.
- B. Design selection: The egress motion sensor shall be a Detection Systems/Bosch model DS150i or an approved equal. Where required provide trim plate TP160 for mounting the detector over a standard single gang junction box.

**2.8 MAGNETIC DOOR POSITION SWITCH – DPS**

- A. The standard recessed door position switch shall be Interlogix 1078CW series or approved equal. The contact and the magnet shall be hermetically sealed in a one piece, molded, flame retardant ABS plastic housing for maximum strength and durability. The contact and magnet shall snap-

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lock into a predrilled 3/4" or 1" diameter hole. Color of the housing shall be off white, gray, or mahogany, and shall be provided in the appropriate color to match the door and doorframe. The magnet shall be made of Alnico V.

- B. The standard position switch for a sliding gate shall be an Interlogix 2507AD-L high security contact or approved equal.
- C. On exterior doors with impact resistant listings, use only surface mounted door position switches in lieu of the standard recessed door position switches. The design selection is the Interlogix 2500 Series High Security Biased switch or approved equal.

## 2.9 POWER SUPPLY – DOOR LOCKING HARDWARE AND SENSORS

- A. Power supplies for door locks or powered sensors (i.e. request to exit motion sensors) shall be completely separate from power supplies for ISC or electronic hardware part of the card access system.
- B. The power supply for door locks and powered sensors shall convert a 115 VAC 60 Hz input to a continuously supplied current of 24 VDC. The power supply shall be UL listed, NFPA compliant, and have multiple class 2 rated outputs. The power supply shall be housed in NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4 enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.
- C. The power supply for door locks and powered sensors shall include a battery charger and a battery input to provide power to the locks after a main power system failure. The switchover to stand-by battery shall be automatic when main AC power fails.
- D. Power supplies for regular locking hardware shall be installed next to access control panels.
- E. Maintenance free batteries shall be provided with all power supplies. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.
- F. The power supply for door locks and powered sensors shall have the following features:
  - 1. Number of outputs: 8 programmable as fail-safe or fail secure individually
  - 2. Fire alarm disconnect: Yes, latching or unlatching and individually selectable for any of the inputs.
  - 3. Output protection: PTC
  - 4. Monitoring: AC fail and low battery with dry contact closure.
- G. Basis of design: Altronix Maximal series.

## 2.10 WIRE & CABLE

- A. Cables for un-powered security sensors shall have the following specification:
  - 1. Minimum cable gauge: AWG 22
  - 2. Number of conductors: 4, stranded conductors



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3. Conductor type: Bare copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black and red.
6. Voltage rating: 300V
7. Cable shield: No cable shields

**B. Cables for powered security sensors shall have the following specifications:**

1. Minimum cable gauge: AWG 18
2. Number of conductors: 4, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black, red, white and green.
6. Voltage rating: 300V
7. Cable shield: No cable shields

**C. Cables for access control readers shall have the following specifications:**

1. Minimum cable gauge: AWG 18
2. Number of conductors: 6, stranded conductors
3. Conductor type: Tinned copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black, red, white, green, orange (or brown) and blue.
6. Voltage rating: 300V
7. Cable shield: Aluminum/polyester foil (overall) with a AWG 24 tinned copper drain wire

**D. Cables for RS-232, RS-422 or RS-485 control lines shall have the following specifications:**

1. Minimum cable gauge: AWG 22
2. Number of conductors: 2-paired, stranded conductors
3. Conductor type: Tinned copper
4. Cable insulation: Polyethylene
5. Conductor insulation colors: White-blue, blue-white white-orange and orange-white
6. Voltage rating: 300V
7. Cable shield: Aluminum/polyester foil (each pair shielded), a tinned copper braid (90% coverage) and a AWG 24 tinned copper drain wire

**E. Cables for door locks and low voltage power supplies shall have the following specifications:**

1. Minimum cable gauge: AWG 18
2. Number of conductors: 2, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: PVC
5. Conductor insulation colors: Black and red.
6. Voltage rating: 300V
7. Cable shield: No cable shields

**F. Cables for loop detectors shall have the following specifications:**

1. Minimum cable gauge: AWG 16
2. Number of conductors: 1, stranded conductors

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3. Conductor type: Bare copper
  4. Cable insulation: Cross-linked polyethylene (XLPE)
  5. Conductor insulation colors: Black
  6. Voltage rating: 600V
  7. Cable shield: No cable shields
- G. All UTP Category horizontal cables and fiber optic cables for the security system shall be in compliance of all requirements in specification section 27 1000 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 27 1000. Color jacket for wiring for the CCTV system shall red.
- H. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The SSI shall always estimate proper values.
- I. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits. All spaces above ceilings in this project shall be treated as plenum spaces. All cables with a NEC type TC shall be run fully in conduit from the panel to the device and shall be separated from other communication or Class 2 rated cables.
- J. Cable jackets for this project: Except when cables are run continuously in conduit all cable jackets for access control cables shall be plenum rated.
- K. All cables shall be RoHS compliant and free of VOC. The SSI shall provide proof of compliance for all cables during the submittal process.
- L. Acceptable manufacturers: Belden, Windy City Wire, and West Penn Wire.
- 2.11 IDENTIFICATION AND LABELING TAGS
- A. The SSI shall follow labeling materials indicated in specification section 27 0100
- B. Panels shall be labeled with Phenolic labels, black with 1/4" white lettering.

## PART 3 - EXECUTION

### 3.1 SECURITY DOORS FUNCTIONALITY

- A. The following paragraphs described the expected functionality of the typical security doors. The SSI shall use this description to draw the one line diagrams part of the shop drawings and described in part 1 of this specification. The SSI shall make sure the proposed wiring for each door type produces the desired functionality for each door type.
- B. All control logic for this functionality shall be accomplished through local input/output events. Global events to accomplish these requirements are not allowed. Failure of the access control server shall not limit the functionality of the doors. When the word reader is used in the following descriptions, it means it is a generic device, it could be any type of reader (biometric, iClass, prox) with or without keypad, see the design drawings for particular selection for every door.

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## C. DOOR TYPE C3 (Single controlled entry with mortise lock, free exit, non-emergency)

1. Door type: Single leaf
2. Door mode: Operational door.
3. Devices on secured side: One (1) Power transfer, one (1) electric mortise lock with request to exit switch built in and one (1) door position switch.
4. Devices on unsecured side: One (1) reader, as indicated in floor plans.
5. Door operation: From secured side: Door shall be opened by mechanical means using the electric mortise lock. Activation of the built-in request to exit switch in the lock shall bypass all door alarms for a fixed period of time. From unsecured side: Door shall be unlocked by releasing the lock after a valid transaction at the reader. Door alarms shall be bypassed for a fixed period of time.
6. Key override: The use of a valid key in the lock's cylinder shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.
7. Fail mechanism: door lock shall be fail secure.
8. Reported Alarms: Door forced open, Invalid, lost or stolen card presented at the reader, Door held open. Installer to coordinate with the Owner held open time in a per door basis.

## 3.2 SECURITY SYSTEM INTEGRATION

- A. General: A. The access control system software shall integrate with the other security system components as indicated in this section. The SSI shall be responsible for programming all security systems in such a way that interaction between the different systems is achieved to provide a higher degree of security in the building. The minimum required integration features between the access control and the other security systems are described below:

### B. CCTV SYSTEM

1. Activation of access control system alarms (like door held open, door forced open, stolen/lost card used, duress alarm, alarms coming from other systems, etc) shall call presets in the nearest CCTV cameras (one or more) to point towards the device that is in alarm. This action shall take place without any operator's intervention.
2. Activation of access control system alarms shall call any associated camera to the triggered alarm to the operator's workstation alarm monitor. This action shall take place without any operator's intervention. When the alarm is cleared by the operator the image of the alarm monitor shall be removed.
3. Graphic camera calling: Surveillance cameras shall be represented with graphic icons in the graphic maps part of the Access control system GUI. Double clicking on those icons shall automatically open a video window with a live stream from that camera.

## 3.3 INSTALLATION PRACTICES

- A. General: The SSI shall follow all installation practices indicated in specification section 20010.
- B. Access control panels and multi-output power supplies shall be installed as to have in any cluster of panels no less than 2 spare ports (reader ports for access control) available per cluster of panels.
- C. All power supplies shall be monitored for AC failure. When power supply provides a form c relay with low battery signaling, this contact shall also be monitored. All AC fail and battery low

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alarms shall be monitored through individual alarm inputs. Series connections of multiple alarm points shall not be allowed.

- D. All buzzers inside card readers shall be wired as to function to alert users of different door status like (door held open alarm and door forced open alarm).
- E. All local alarms shall be wired with separate wires for the buzzer and for the strobe, so independent use of the strobe and buzzer can be selected by the user.

## 3.4 WIRING METHODS

- A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.
- B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.
- C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.
- D. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.
- E. All cable with gauges larger or equal to AWG-18 and all types of stranded conductors shall be terminated on termination blocks part of an active equipment or in termination blocks supplied by the SSI. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.
- F. All termination blocks shall always be mount inside a security enclosure, with a hinged cover and lock. Up to 2 conductors can be terminated in the same point in a termination block as long as the combined diameter of the conductors does not exceed the maximum cable diameter allowed by the termination block. No more than 2 conductors shall be terminated in the same point at a termination block regardless of the cable gauges.
- G. Termination blocks shall be used for wire terminations next to access control panels or for termination above the security doors. Termination blocks are not required for connection to security devices at the door side.
- H. When equipment supplied has wire leads instead of termination en points for connections, the only acceptable methods of connection to field wiring are insulated butt splices, quick release connectors (both ends provided) or quick lock self stripping pig tail connectors. All connectors or splices shall be selected according to the gauge of the cable to be terminated.
- I. All penetrations through fire rated barriers shall be provided, by the SSI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.
- J. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.

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- K. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY-Raps" (Thomas & Betts or equal).
- L. All cables run part of the security system in areas where ceiling is not accessible or in building exterior shall be in conduit at all times.
- M. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.
- N. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.
- O. Finger duct wire managers shall be used inside all equipment panels to properly dress cables.

## 3.5 IDENTIFICATION AND TAGGING

- A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by pre-printed labels or tags. The permanent markings shall clearly indicate the function, source, and destination of all cabling, wire, and terminals. All cables shall be labeled at both ends of the cable with the same and unique identifier label.
- B. Cable and equipment identifiers shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the SSI shall be submitted for approval to the A&E.
- C. All access control panels, alarm panels or Intercom exchanges shall include a work sheet attached to the interior of the panel/ equipment in plastic envelops. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the as-built information.

## 3.6 SECURITY SYSTEM PROGRAMMING

- A. Programming: It is the responsibility of the SSI to program all requested features in the access control system and the integration to other security systems. The programming responsibilities of the SSI include but not limited to:
  - 1. Program all security doors to achieve the desired operation as described in this specification section. The SSI shall coordinate with the owner the door names and numbers, building names, room names and numbers to be used for the programming.
  - 2. Program all components of the system to achieve the functionality described in this specification.
  - 3. Program the intercom system to accept the new intercom stations.
  - 4. Program all required security features like macros and integration with other security modules like intercom and CCTV system.
  - 5. The SSI shall coordinate with the owner what alarms from the access control system are to be considered major alarms. All major alarms shall be programmed by the SSI to provide the operator detail information on the type of operating procedure expected during those alarms. All major alarms shall be programmed as to provide the operator and input field to type the response taken by the operator.

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6. All programming of remote monitoring features for the security system like telephone numbers to dial, reporting codes and alarm formats.
7. All alarm messages and descriptive text of those messages shall be programmed.

- B. The SSI shall work with the owner during the programming of the access control system to fine tune all programming requirements of the system, as per owner's request. Fine tune is defined for this purpose as changing all field parameters available in the system, as specified, to complete software options available in the system. Fine tuning does not indicate adding additional software modules or additional hardware.

## 3.7 ADDITIONAL INSTALLER RESPONSIBILITIES

- A. Upon project commencement, the SSI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.
- B. During the installation process the SSI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
  1. Quantity and location of all equipment installed.
  2. Cable and wire runs along with the designations tags assigned to each.
  3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.
- C. The SSI Project Manager shall maintain continuous coordination with the A&E. The A&E shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction the SSI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

## 3.8 REQUEST OF IP ADDRESSES

- A. The SSI shall comply with all requirements indicated in specification section 27 0100 for requesting IP address for the security system.

## 3.9 SYSTEM WARRANTY AND SERVICE

- A. General: The SSI shall follow all warranty and service requirements indicated in specification section 27 0100.

## 3.10 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The SSI shall follow all test requirements indicated in specification section 27 0100.
- B. Additional requirements for the system acceptance test:
  1. The day of the final acceptance test the SSI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test

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substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.

2. The final acceptance test will be done with two groups of people. One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
3. During the final acceptance test every single device in the security system will be tested for normal operation and for simulated alarm conditions at both ends (the field devices and in the monitoring room). When possible, security equipment will be tested for operation during main power failure. All features requested in this specification will be tested.

- C. Testing of all structured cabling system part of the Security System shall be done in accordance of specification section 27 0100.

## 3.11 TRAINING AND INSTRUCTION

- A. General: The SSI shall follow all training requirements indicated in specification section 270010
- B. The SSI shall provide one (1) level of training for this project as explained in this section.
- C. MAINTENANCE TRAINING.

1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace the PLC and all field devices and hardware.
2. This training shall cover at least the following topics:
  - a. Trouble shooting and replacement of all field devices.
  - b. Installation of all field panels and settings (jumpers, dip switches, etc).
  - c. Wire labeling system.
  - d. Software system installation and recover from system crashes.
  - e. Detail explanation on all physical keys used in security devices.
  - f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
  - g. Detail explanation of source code programming for all devices that have software code specifically compiled for this project.
3. This training shall be provided by personnel working directly for the SSI or a direct employee of the manufacturer of the system.
4. One session of this type of training shall be provided and video-taped. This session shall last no less than 8 hours, broken down into day sessions no longer than 4 hours each.
5. Each session could have up to 5 trainees.
6. The approved O&M manuals shall be available at the time of the training.

## 3.12 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION.

- A. General: The SSI shall follow all as built and close out information requirements indicated in specification section 270010
- B. Additional requirements for as-built documentation shall include:

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1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
  2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.
- C. Close out information shall also include:
1. Two (2) digital backups of all configuration files and databases part of the security system not earlier than the day after the final acceptance test is approved. These backups shall include a list of all the file names used and a complete description of the system that each file name belong to. The media for these backups shall be a compatible media that can be read by the computer system running the specific software program.
  2. Testing reports for structured cabling system used for the Security system.

END OF SECTION 281000



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## SECTION 281010 - INTRUSION DETECTION SYSTEMS

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

- C. The scope of work shall include furnishing all labor, materials, enclosures, wiring, equipment, and documentation required to provide a completely operational and working Intrusion Detection System (IDS).
- D. The Intrusion Detection System Installer (IDSI) shall coordinate with other trades such as security system, CCTV, electrical system installer, the door frame installer, the door installer and the door hardware installer for all parts of this scope of work. With the exception of the door position switches, all parts for the IDS shall be provided under this contract.
- E. All materials and installation labor for structured wiring system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair (25 pairs or higher) backbone cables) components required for the intrusion detection system shall be in compliance with specification section 27 00 00.
- F. See responsibility matrix in design drawings for more details on the scope of work

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. General Terms and Conditions of the Contract Documents
  - 1. Division 26 – Electrical
- C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.

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SECTION	TITLE
270010	Technology General Provisions
270000	Communications
280526	Grounding & Bonding for Electronic Safety and Security
280528	Pathways for Electronic Safety and Security
280544	Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling
281000	Electronic Security Systems

## 1.3 INTRUSION DETECTION SYSTEM INSTALER QUALIFICATIONS

- A. The IDSI selected for this project must be a direct manufacturer authorized representative of the product they propose to provide. All technicians assigned to install and configure this system shall be factory trained and certified for the proper installation of this equipment. The IDSI must have a minimum of 5 qualified and factory trained technicians to support this system. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years under the current company name. This company shall have a fully staffed office of sales and technical support representatives within 50 miles of travel to this project.
- B. Other required IDSI qualifications are:
  - 1. The IDSI selected for this project must be an authorized reseller of the UTC product systems.
  - 2. The IDSI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The IDSI shall be able to perform any and all repairs to the system within 24 hours.
  - 3. The IDSI, as a minimum, must carry a current state issued limited energy license.

## 1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 27 00 10
- B. Substitutions are not acceptable for this system.

## 1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The IDSI shall follow all requirements for shop drawings indicated in specification section 27 00 10.
- B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 30 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the A&E for review and approval, as part of the product/installer approval process.

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1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
  2. Product numbers, specifications, and data sheets for all equipment.
  3. Data sheets and samples of all labeling materials and equipment to be used in the project.
  4. A complete explanation of the identification method to be used for all equipment and cabling part of the intrusion detection system.
  5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
  6. Detailed drawings of all custom products to be used in the project.
  7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.
- C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:
1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. Devices for alarm systems shall indicate the zone numbers. All other devices shall have a unique identifier, as they will be programmed in the system.
  2. Raceway Riser Diagrams: Detail raceway runs required for the IDS and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run
  3. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination.
  4. Panel schedules in a spreadsheet format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all alarm panels, zone expanders, output cards, fiber optics distribution frames, Ethernet switches, control panels, termination blocks, etc.
  5. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
  6. Termination details for multi-conductor connectors and other details not included in item 2 of the shop drawings.
  7. Sensor detection patterns and adjustment ranges.
  8. Power supply and battery calculations. The IDSI shall provide calculations of power supplies for the alarm panels and battery run time calculations for those panels. Power supplies can only be installed in telecom rooms.

## 1.6 ABBREVIATIONS

- A. The following abbreviations are used in this document:

- |    |       |  |
|----|-------|--|
| 1. | ADA   | Americans with Disabilities Act                    |
| 2. | ANSI  | American National Standards Institute              |
| 3. | API   | Application Programming Interface                  |
| 4. | ASCII | American Standard Code for Information Interchange |
| 5. | AWG   | American Wire Gauge                                |
| 6. | BMS   | Balanced Magnetic Switch. See also DPS             |
| 7. | BPS   | Bits Per Second                                    |
| 8. | CCTV  | Closed Circuit Television                          |

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9.	CPU	Central Processing Unit
10.	DIN	(German Institute of Standardization)
11.	DPS	Door Position Switch
12.	FCC	Federal Communications Commission
13.	GUI	Graphical User Interface
14.	ID	Identification
15.	I/O	Input /Output
16.	NEC	National Electrical Code
17.	NEMA	National Electrical Manufacturers Association
18.	ODBC	Open Database Connectivity
19.	O&M	Operations and Maintenance
20.	PIN	Personal Identification Number
21.	PTZ	Pan/Tilt/Zoom
22.	RAID	Redundant Array of Independent Disks
23.	REX	Request to Exit
24.	RoHS	Restriction of Hazardous Substances Directive
25.	SCS	Security Control System
26.	SDRAM	Synchronized Dynamic Random Access Memory
27.	STP	Shielded Twisted Pair
28.	UL	Underwriters Laboratories, Inc.
29.	UPS	Uninterrupted Power Supply
30.	USB	Universal Serial Bus
31.	UTP	Unshielded Twisted Pair
32.	VOC	Volatile Organic Compounds

## 1.7 GLOSSARY OF TERMS

### A. The following terms are defined for the purposes of this specification:

1. Acknowledge: The action taken by a security control system operator to indicate that he/she is aware of a specific alarm or tamper state.
2. Action Messages: A set of instructions automatically provided to the operator when an alarm condition is generated.
3. Advisory: A message provided by the security control system to the operator to inform him/her of a condition as reported by the security control system.
4. Alarm Condition: A change of state, as sensed by the security control system, indicating that the security control system has detected a condition which its sensors were designed to detect.
5. API Integration: a method to transfer information between two systems by means of APIs, though an Ethernet communication network.
6. Clear: The action taken by a security control system operator to respond to an alarm condition or advisory so that other alarms may be serviced or so that other actions may be taken.
7. Download: To send computer data from the File Server to a controller for the purposes of making access decision without the intervention of the File Server.
8. Line Supervision: The monitoring of an electrical circuit via electrical and software systems to verify the electrical integrity of the supervised circuit.
9. Off-line: A condition in which a controller(s) is not in communication with the File Server. In the off-line mode, the controller continues to make access decisions and process alarms according to the information stored at its local database.

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10. Password: A combination of numbers or letters unique to security control system operator which defines commands and data fields he/she may view, edit, or command.
11. PIR: Passive infrared.
12. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
13. Relay integration: A method to transfer signals between two systems by means of using potential free contact closures to input points.
14. Reset: A command or feedback signal that indicates that a monitored point has returned to its normal state after having transferred to the alarm or trouble state.
15. Secure Mode: The normal state of an alarm input point from which it will be monitored for change of state to either an alarm or trouble condition.
16. Secured Area: A physical location within the facility to which access is controlled by one or more card readers.
17. Secured side: Side of a security door where a higher security level needs to be granted for a user to be authorized to be in that side of the door.
18. Serial line integration: A method to transfer information between two systems by means of an RS-232/RS-422 or RS-485 line, using ASCII strings.
19. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes.
20. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
21. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
22. Tamper: A condition within the circuitry of a monitored point which indicates the electrical integrity of that sensing circuit has been compromised.
23. Tamper proof screws: A screw with a security hexalobular internal driving feature as described in ISO 10664. As an example, a security TORX head, as developed by Camcar LLC.
24. Time Interval: A time stamp of one start time and one stop time within a time period.
25. Time Period: A user programmable period of time made up of days of the week and hours in the day.
26. Trouble: A condition within the circuitry of a monitored point which indicates that an equipment malfunction, single break, single fault or a wire-to-wire short exists.
27. UPS: Uninterruptible power supply.
28. User Definable: An attribute of a security control system function that may be easily tailored by the System Administrator.
29. Workstation: A personal computer connected to the main security control system File Server via a local area network connection for the purpose of programming the system and responding to alarms.
30. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit

## 1.8 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. The intrusion detection systems primary purposes shall be to provide alarm monitoring capabilities for the new facility with the ability to be monitored from a third party monitoring system or a local office.

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- B. Description: Hard-wired modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.
- C. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
  - 1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
  - 2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
  - 3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.
- D. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.
- E. System Control: Master control unit shall directly monitor intrusion detection devices, and connecting wiring in a multiplexed distributed control system or as part of a network.
- F. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.
- G. Operator Commands:
  - 1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
  - 2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
  - 3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
  - 4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
  - 5. Protected Zone Test: Initiate operational test of a specific protected zone.
  - 6. System Test: Initiate system-wide operational test.
  - 7. Print reports.
- H. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
- I. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.
- J. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

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- K. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.
- L. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

## PART 2 - SYSTEM CHARACTERISTICS

### 2.1 SYSTEM COMPONENT REQUIREMENTS

- A. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:
  - 1. Door hardware specified in Division 08 Section "Door Hardware."
  - 2. Door hardware specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."
- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
  - 1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
  - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.
- C. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
- D. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.
- E. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.
- F. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.
- G. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or

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other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

- H. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

## 2.2 SYSTEM ENCLOSURES

- A. All electronics part of the IDS system shall be installed inside protected metallic enclosures. This enclosure shall protect against dust, falling dirt, dripping noncorrosive liquids and tampering.
- B. Interior Electronics: NEMA 250, Type 12.
- C. All enclosures shall have a hinged doors with key locks (all keys shall be keyed alike) and tamper switches.
- D. Enclosures shall be sized by IDSI to be capable of housing all electronics, batteries, termination blocks and power supplies.
- E. Design selection: as recommended by manufacturer of the intrusion detection system.

## 2.3 TAMPER SWITCH

- A. All security enclosures, including power supplies and all j-boxes with cable splices or terminations shall include a tamper switch for direct supervision of the cabinet door. Any opening of these doors shall initiate an alarm condition to the security monitoring system. All tamper contacts shall be a reed actuated self adjusting plunger style switch. If a tamper contact is provided by the manufacturer with the enclosure this device may be used.
- B. Tamper switches shall be wired as to report separate alarms to the system for each panel.
- C. Basis of design: Amseco PSW-1 or an approved equal.

## 2.4 INTRUSION ALARM PANEL

- A. An intrusion alarm system shall be provided to connect, control and monitor wired duress buttons to the security system. The intrusion alarm system shall be provided with a panel, keypads, and additional system modules.
- B. The Intrusion Alarm panels shall be provided with an Ethernet network card or a RS-232 communication line to integrate with the other systems.
- C. Power supply: Power for the main intrusion alarm panel shall be done through multiple devices such as a transformer a power supply module/charger and batteries. All components of the power supply shall be housed in a system enclosure. Batteries shall be provided for the intrusion alarm panel with a minimum run time of 12 hours.
- D. The intrusion alarm panel shall be programmed and tested by the IDSI.
- E. The intrusion alarm panel shall have the ability add optional modules such as:



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1. Communicator module.
2. 8-Zone expansion module.
3. 8-Low current output expander module.
4. 4-High current output expander module.

F. The IDS shall configure all modules in the selected system to accomplish the design intent described in this specification and in the design drawings. The complete configuration of the alarm system shall be submitted as part of the as built information for this specification.

G. The Intrusion Alarm System shall have the following minimum capacities:

1. Main panel with 8 on-board zones, expandable to 192 hard wired zones.
2. Zone types: 40 zones types with 14 programmable zone attributes
3. Up to 240 access codes: one master code, one installer code and one maintenance code.
4. Programmable attributes for each user code
5. Up to 4 programmable outputs (PGM)
6. A maximum of 148 programmable outputs through expansion modules
7. The system shall be capable of monitoring the following events:
  - a. AC power failure
  - b. Zone trouble
  - c. Telephone line trouble
  - d. Communicator trouble
  - e. Low battery condition
  - f. RF jam
  - g. AUX power supply fault
  - h. Failure to communicate
  - i. Module fault
8. Additional features:
  - a. 2-way wireless device support
  - b. Visual verification
  - c. Proximity tag support
  - d. PGM scheduling
  - e. Quick arming
  - f. Up to 8 user partitions
  - g. Programmable system loop response
  - h. Door bell zones
  - i. Low battery PGM type

H. Basis of Design:

1. Main panel - Bosch B9512G

## 2.5 INTRUSION ALARM KEYPAD

A. The intrusion alarm keypad shall be a single unit capable of connecting to the main panel through a serial communication line. The unit shall have the following features:

1. Global partition status

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2. Up to 128 hardwired or wireless zones supported
3. Full 32-character programmable labels
4. Menu programming
5. Modern, slim-line landscape keypad
6. White backlit keys
7. Blue LCD display with 2X16 characters capacity
8. Displays outdoor temperature
9. 5 programmable function keys
10. Intuitive clock programming
11. Input/Output terminal
12. Fire, medical and panic keys
13. Adjustable backlight and keypad buzzer
14. Dual wall-mount and front cover tamper

B. Basis of design: Bosch B942

## 2.6 MICROWAVE-PIR DUAL-TECHNOLOGY SENSORS

- A. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.
- B. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
- C. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
- D. Minimum Detection Pattern: A room 20 by 30 feet
- E. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps across two adjacent segments of detector's field of view.
- F. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps. Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
- G. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
- H. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.
- I. Basis of Design: Interlogix, DSC, Bosch

## 2.7 360 DEG MOTION SENSOR – CEILING MOUNTED

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- A. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.
- B. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
- C. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
  - 1. Minimum Detection Pattern: A room 20 by 30 feet (6 by 9 m).
  - 2. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1 deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across two adjacent segments of detector's field of view.
  - 3. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
  - 4. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
  - 5. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.
- D. Basis of design: Interlogix, DSC, Bosch

## 2.8 DOOR POSITION SWITCH - DPS

- A. The IDSI shall coordinate with the door hardware installer on the placement of magnetic door position switch required for hollow metal doors for this project.
- B. When the design drawings indicate a door is to get a DPS for card access and a DPS for the IDS, the IDSI shall provide a DPS with DPDT contacts to allow for one set of contacts to be wired to the card access system and the second set of contacts to be wired to the intrusion alarm panel.
- C. On double doors where each leaf has a DPS, the devices shall be wired in series. Both sensors shall report alarms to the system as a single alarm point.
- D. Basis of design: Interlogix 1078 series or approval equal.

## 2.9 POWER SUPPLY – FOR IDS SENSORS

- A. Power supplies for IDS sensors shall be completely separate from power supplies for the main alarm control panel. A short circuit line in the power to a sensor shall not disable the operation of the main alarm control panel.
- B. The power supply shall convert a 115 VAC 60 Hz input to a continuously supplied current of 12 VDC. The power supply shall also have a battery charger component and the ability to be powered from battery power. The power supply shall be UL listed, NFPA compliant, and have

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multiple class 2 rated outputs. The power supply shall be housed in NEMA 1 hinged cover enclosures where mounted indoors. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.

- C. Maintenance free batteries shall be provided with all power supplies. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.
- D. Basis of design: Altronix AL300ULXPD16 or approved equal.

## 2.10 POWER SUPPLY – FOR IDS HARDWARE

- A. Power supplies for IDS hardware shall be a plug in transformer secured to the outlet so it will not fall off from the outlet.
- B. The power supply shall convert a 115 VAC 60 Hz input to a continuously supplied current of 16 VAC at 40 VA. The power supply shall be UL listed, NFPA compliant, and have a class 2 rated output. The power supply shall be housed in NEMA 1 hinged cover enclosures where mounted indoors. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.
- C. Basis of design: Interlogix

## 2.11 WIRE & CABLE

- A. Cables for un-powered security sensors shall have the following specification:
  - 1. Minimum cable gauge: AWG 20
  - 2. Number of conductors: 2, stranded conductors
  - 3. Conductor type: Bare copper
  - 4. Cable insulation: Color coded PVC
  - 5. Conductor insulation colors: Black and red.
  - 6. Voltage rating: 300V
  - 7. Cable shield: No cable shields
- B. Cables for powered security sensors shall have the following specifications:
  - 1. Minimum cable gauge: AWG 20
  - 2. Number of conductors: 4, stranded conductors
  - 3. Conductor type: Bare copper
  - 4. Cable insulation: Color coded PVC
  - 5. Conductor insulation colors: Black, red, white and green.
  - 6. Voltage rating: 300V
  - 7. Cable shield: No cable shields
- C. Cables for RS-232, RS-422 or RS-485 control lines shall have the following specifications:
  - 1. Minimum cable gauge: AWG 24
  - 2. Number of conductors: 2-paired, stranded conductors

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3. Conductor type: Tinned copper
4. Cable insulation: Polyethylene
5. Conductor insulation colors: White-blue, blue-white white-orange and orange-white
6. Voltage rating: 300V
7. Cable shield: Aluminum/polyester foil (overall), a tinned copper braid (90% coverage) and a AWG 24 tinned copper drain wire
8. Nominal characteristic impedance: 120 Ohms
9. Nominal capacitance: 12.8 pF/ft.
10. Nominal delay: 1.6 ns/ft.
11. Nominal attenuation: 0.6 dB/100 ft @ 1 MHz.

D. Cables for low voltage power supplies shall have the following specifications:

1. Minimum cable gauge: AWG 18
2. Number of conductors: 2, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: PVC
5. Conductor insulation colors: Black and red.
6. Voltage rating: 300V
7. Cable shield: No cable shields

E. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The IDSI shall always estimate proper values.

F. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits. All spaces in this project shall be treated as non plenum spaces.

G. All cables shall be RoHS compliant and free of VOC. The IDSI shall provide proof of compliance for all cables during the submittal process.

H. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

## 2.12 IDENTIFICATION AND LABELING TAGS

A. The IDSI shall follow labeling materials indicated in specification section 27 00 10.

## PART 3 - EXECUTION

### 3.1 INTRUSION DETECTION SYSTEM FUNCTIONALITY

A. The purpose of the intrusion detection system is to protect the premises with additional controls beyond what the card access system will provide.

B. The IDSI shall program and install the system based on the Owner's Security Policy and Procedures Handbook. The IDSI shall coordinate with Owner all aspects of the installation of this system.

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## 3.2 INSTALLATION PRACTICES

- A. General: The IDSI shall follow all installation practices indicated in specification section 27 00 10.
- B. All AC power shall be fed from the buildings power source supported by an emergency backup generator where applicable. The source of the AC power feed shall be identified at termination point of equipment.
- C. All power supplies shall be monitored for AC failure. When power supply provides a form c relay with low battery signaling, this contact shall also be monitored. All AC fail and battery low alarms shall be monitored through individual alarm inputs. Series connections of multiple alarm points shall not be allowed.
- D. All power supplies shall be installed with means of disconnect from line power. The preferable method of disconnect is through a breaker in an electrical panel.
- E. Power to sensors and other field devices shall be made from individual power supply outputs. Paralleling multiple cables feeding multiple sensors in one terminal of a power supply shall not be allowed.
- F. All inputs alarm panels shall be wired with end of line resistors for supervisory conditions. Supervisory conditions shall be able to uniquely identify the following conditions:
  - 1. Cable open
  - 2. Cable shorted
  - 3. Sensor activate
  - 4. Sensor inactive.
- G. Each zone shall be wired with only one device. Daisy chain of multiple devices in one zone shall not be allowed.
- H. All intrusion Alarm panels shall be provided with at least a 20% spare zone inputs capacity installed.
- I. There is no need to use sirens or high output notification devices for the IDS on this project

## 3.3 WIRING METHODS

- A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.
- B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.
- C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.
- D. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.

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- E. When equipment supplied has wire leads instead of termination en points for connections, the only acceptable methods of connection to field wiring are insulated butt splices, quick release connectors (both ends provided) or quick lock self stripping pig tail connectors. All connectors or splices shall be selected according to the gauge of the cable to be terminated.
- F. All penetrations through fire rated barriers shall be provided, by the IDSI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.
- G. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.
- H. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY-Raps" (Thomas & Betts or equal).
- I. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.
- J. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.
- K. Finger duct wire managers shall be used inside all equipment panels to properly dress cables.

## 3.4 IDENTIFICATION AND TAGGING

- A. The IDSI r shall follow labeling materials indicated in specification section 270010 17010.
- B. All cables shall be labeled at both ends of the cable with the same and unique identifier label.
- C. Cable and equipment identifiers shall follow a standard labeling system like TIA 606. The identification system chosen by the IDSI shall be submitted for approval to the A&E.
- D. All alarm panels shall include a work sheet attached to the interior of the panel/ equipment in plastic envelopes. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the as-built information.

## 3.5 INTRUSION DETECTION SYSTEM PROGRAMMING

- A. Programming: It is the responsibility of the IDSI to program the IDS as indicated below:
  - 1. The IDSI shall program all zone names, sensors, keypads, partitions, IP addresses, dial out numbers, and all other hardware related programming.
  - 2. All programming related to user codes, shall be programmed by the owner.

## 3.6 ADDITIONAL INSTALLER RESPONSIBILITIES

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- A. During the installation process the IDSI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
  - 1. Quantity and location of all equipment installed.
  - 2. Cable and wire runs along with the designations tags assigned to each.
  - 3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.
- B. The IDSI Project Manager shall maintain continuous coordination with the A&E. The A&E shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction the IDSI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

## 3.7 REQUEST OF IP ADDRESSES

- A. The IDSI shall comply with all requirements indicated in specification section 27 00 10 for requesting IP address for the intrusion detection system.

## 3.8 SYSTEM WARRANTY AND SERVICE

- A. General: The IDSI shall follow all warranty and service requirements indicated in specification section 27 00 10.

## 3.9 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The IDSI shall follow all test requirements indicated in specification section 27 00 10.
- B. Additional requirements for the system acceptance test:
  - 1. The day of the final acceptance test the IDSI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
  - 2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, IDSI, General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
  - 3. During the final acceptance test every single device in the intrusion detection system will be tested for normal operation and for simulated alarm conditions at both ends (the field devices and in the monitoring room). When possible, security equipment will be tested for operation during main power failure. All features requested in this specification will be tested.
- C. Testing of all structured cabling system part of the IDS shall be done in accordance of specification section 27 10 00.



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## 3.10 TRAINING AND INSTRUCTION

- A. General: The IDSI shall follow all training requirements indicated in specification section 27 00 10.
- B. The IDSI shall provide one (1) levels of training for this project as explained in this section.
- C. MAINTENANCE TRAINING.
  - 1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
  - 2. This training shall cover at least the following topics:
    - a. Trouble shooting and replacement of all field devices.
    - b. Installation of all field panels and settings (jumpers, dip switches, etc).
    - c. Wire labeling system.
    - d. Software system installation and recover from system crashes.
    - e. Detail explanation on all physical keys used in security devices.
    - f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
  - 3. This training shall be provided by personnel working directly for the IDSI or a direct employee of the manufacturer of the system.
  - 4. One session of this type of training shall be provided and video-taped. This session shall last no less than 18 hours, broken down into three day sessions no longer than 6 hours each.
  - 5. Each session could have up to 5 trainees.
  - 6. The approved O&M manuals shall be available at the time of the training.

## 3.11 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION.

- A. General: The IDSI shall follow all as built and close out information requirements indicated in specification section 27 00 10.
- B. Additional requirements for as-built documentation shall include:
  - 1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
  - 2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.
- C. Close out information shall also include:
  - 1. Testing reports for structured cabling system used for the Security system.

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END OF SECTION 281010

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## SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specifications Sections, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fire-alarm control unit.
  - 2. Manual fire-alarm boxes.
  - 3. System smoke detectors.
  - 4. Heat detectors.
  - 5. Notification appliances.
  - 6. Remote annunciator.
  - 7. Addressable interface device.
  - 8. Digital alarm communicator transmitter.
  - 9. Interface with pre-action sprinkler system
  - 10. Interface with gaseous suppression system

#### 1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

#### 1.4 SYSTEM DESCRIPTION

- A. Extension of an existing noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

#### 1.5 ACTION SUBMITTALS

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- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
  - 2. Include voltage drop calculations for notification appliance circuits.
  - 3. Include battery-size calculations.
  - 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
  - 5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
  - 6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
  - 7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field quality-control reports.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," deliver copies to authorities having jurisdiction and include the following:
  - 1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
  - 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
  - 3. Record copy of site-specific software.
  - 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
    - a. Frequency of testing of installed components.
    - b. Frequency of inspection of installed components.
    - c. Requirements and recommendations related to results of maintenance.
    - d. Manufacturer's user training manuals.
  - 5. Manufacturer's required maintenance related to system warranty requirements.
  - 6. Abbreviated operating instructions for mounting at fire-alarm control unit.
  - 7. Copy of NFPA 25.

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## 1.8 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Keys and Tools: One extra set for access to locked and tamper proofed components.

## 1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

## 1.10 SERVICE MAINTENANCE AGREEMENT

- A. One-Year Maintenance Agreement: Provide one-year full maintenance agreement. Include testing and inspections per NFPA 72.

## 1.11 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
  - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Provide products to match existing:
  - 1. Simplex, 4100 control panel.

### 2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

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1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.
7. Fire sprinkler preaction system.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Activate voice/alarm communication system.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High or low air pressure switch of a preaction sprinkler system

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

## 2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
  - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
  - b. Include a real-time clock for time annotation of events on the event recorder and printer.

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2. Addressable initiation devices that communicate device identity and status.
    - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
    - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
  3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 80 characters, minimum.
  2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. Circuits:
1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
    - a. Device Circuits: Survivability Level 1.
    - b. Install no more than 50 addressable devices on each signaling line circuit.
  2. Serial Interfaces: Two RS-232 ports for printers.
- D. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
  2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
  3. Sound general alarm if the alarm is verified.
  4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- E. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- F. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- G. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

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1. Batteries: Sealed lead calcium.

- H. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

## 2.4 PREACTION SPRINKLER SYSTEM

- A. Initiate Presignal Alarm: This function shall cause an audible and visual alarm and indication to be provided at the FACP. Activation of an initiation device connected as part of a preaction system shall be annunciated at the FACP only, without activation of the general evacuation alarm

## 2.5 GASEOUS SUPPRESSION SYSTEM

- A. Presignal and Alarm Initiation: This function shall cause an audible and visual alarm and indication to be provided at the FACP. Activation of an initiation device connected as part of a gaseous system shall be annunciated throughout the building.

## 2.6 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
  2. Station Reset: Key- or wrench-operated switch.

## 2.7 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
  2. Detectors shall be four-wire type.
  3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
  4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
  5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
  6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
  7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.



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- a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
- b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
- c. Provide multiple levels of detection sensitivity for each sensor.

## B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - a. Primary status.
  - b. Device type.
  - c. Present average value.
  - d. Present sensitivity selected.
  - e. Sensor range (normal, dirty, etc.).

## C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - a. Primary status.
  - b. Device type.
  - c. Present average value.
  - d. Present sensitivity selected.
  - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

## 2.8 HEAT DETECTORS

### A. General Requirements for Heat Detectors: Comply with UL 521.

- ### B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
  2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.9 NOTIFICATION APPLIANCES

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- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
  - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
- B. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
  - 1. Rated Light Output:
    - a. 75 cd, minimum.
    - b. 15/30/75/110 cd, selectable in the field.
  - 2. Mounting: Wall mounted unless otherwise indicated.
  - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
  - 4. Flashing shall be in a temporal pattern, synchronized with other units.
  - 5. Strobe Leads: Factory connected to screw terminals.
  - 6. Mounting Faceplate: Factory finished, white.
- C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol

## 2.10 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
  - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

## 2.11 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

## 2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

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- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
  - 1. Verification that both telephone lines are available.
  - 2. Programming device.
  - 3. LED display.
  - 4. Manual test report function and manual transmission clear indication.
  - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
  - 1. Address of the alarm-initiating device.
  - 2. Address of the supervisory signal.
  - 3. Address of the trouble-initiating device.
  - 4. Loss of ac supply or loss of power.
  - 5. Low battery.
  - 6. Abnormal test signal.
  - 7. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. Inspections and testing shall be performed by Owner's third party testing agency, CEI, as described below.
- B. CEI to participate in inspections and testing to verify installation meets specifications.

### 3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
- C. Smoke- or Heat-Detector Spacing:

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1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
  2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
  3. Smooth ceiling spacing shall not exceed 30 feet.
  4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
  5. HVAC: Locate detectors not closer than 5 feet from air-supply diffuser or return-air opening.
  6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
- D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- E. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- F. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- G. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.
- H. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- I. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.
- J. Annunciator: Install with top of panel not more than 72 inches above the finished floor.
- 3.3 CONNECTIONS
- A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
1. Smoke dampers in air ducts of designated air-conditioning duct systems.
  2. Alarm-initiating connection to activate emergency lighting control.
  3. Supervisory connections at valve supervisory switches.
- 3.4 IDENTIFICATION
- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.
- 3.5 GROUNDING

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- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

## 3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by Architect and authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
    - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
  - 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
  - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
  - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
  - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
  - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

## 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

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END OF SECTION 283111

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## SECTION 310000 – CIVIL SUMMARY

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Project Name: Lehigh Acres Lee Tran Park and Ride Facility
- B. This project consists of, but is not limited to, the development of the infrastructure including water management system and storm sewer, sanitary sewer connection, waterline connection, parking and drive aisles.
- C. All civil site work related items having specifications listed in sections 31, 32, and 33 of these documents shall also comply with Lee County, and Florida Governmental Utility Authority (FGUA) technical specifications. If conflicting information is listed for any single item, the most restrictive specification shall govern.

#### 1.2 COORDINATION WITH OTHER CONTRACTORS

- A. Contractor has the responsibility to coordinate his work with work being done by others on the site. Any shutdown of existing utilities will be coordinated with Owner, FGUA, and contractors working on-site.

#### 1.3 DEFINITIONS

- A. The term "Local Standards" as used herein means the standard of design and construction in Lee County. Seven days prior to any construction the Contractor shall contact Owner and Johnson Engineering, Inc.
- B. The construction plans will be approved by South Florida Water Management District, FGUA, Florida Department of Environmental Protection, and Lee County Department of Health. Any requirements concerning testing and installation procedures required by these agencies shall be complied with by the Contractor.
- C. The OWNER shall engage a Construction Engineering & Inspection consultant (herein referred to as CEI) for this project.

#### 1.4 RELATED DOCUMENTS

- A. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

B. FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The

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certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

## PART 2 - EXECUTION

### 2.1 MOBILIZATION

- A. The work specified in this article will conform to the F.D.O.T Standard Specifications for Roadway and Bridge Construction.

### 2.2 MAINTENANCE OF EXISTING DRAINAGE

- A. Existing drainage shall be maintained at all times. At times when the Contractor is not on the job, drainage under construction shall be left open so as not to cause flooding due to blockage. Any damage to construction caused by this requirement shall be the responsibility of the Contractor.

### 2.3 MAINTENANCE OF TRAFFIC

- A. The work specified in this article will conform to the F.D.O.T Standard Specifications for Roadway and Bridge Construction.

### 2.4 PERMITS

- A. Owner will obtain the following permits:
  - (a) SFWMD ERP Modification
  - (b) Lee County Development Order
  - (c) Florida Governmental Utility Authority Approval
  - (c) FDEP Wastewater Permit
  - (d) LCDOH Watermain Extension Permit
  - (e) NPDES Permit
  - (f) SFWMD Water Use (Dewatering) Permit

The Contractor shall be responsible to secure all other necessary local, county, state and federal permits, as applicable.

A Stormwater Pollution Prevention Plan (SWP3) has been prepared and signed by the Owner and Contractor needs to provide their information to the Plan.

### 2.5 INSPECTION AND TESTING

- A. Inspections shall be made following completion of each phase of the work and at other times as required. It is the responsibility of the Contractor to notify the Engineer and all other relevant agency inspection personnel when inspections will be necessary. It will be the Contractor's responsibility to secure approvals as necessary for acceptance of each phase of the project. It will be the Contractor's responsibility to furnish the necessary guarantees and warranties required by all agencies for the acceptance of construction.



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It will be the Contractor's responsibility to submit field test reports of concrete and density tests of roadway fill, stabilized subgrade and base courses, as well as material site/lab testing and inspections performed by CEI firm.

## 2.6 PROTECTION OF EXISTING IMPROVEMENTS

This section describes the Contractor's responsibility for protection of existing improvements during construction activities.

### A. Protection of Streets

1. The Contractor shall not close or obstruct any portion of a street, road, or private way without obtaining permits from the proper authorities. If any street or private way shall be rendered unsafe by the Contractor's operations, he shall make such repairs or provide such temporary ways or guards as shall be required in accordance with safety requirements of the OWNER, LCDOT and Florida Department of Transportation (FDOT).
2. Streets, roads, private ways, and walks not closed shall be maintained passable by the Contractor at his expense and the Contractor shall assume full responsibility for the adequacy and safety of provisions made, including flagman, traffic control signs, and detour signs.
3. The Contractor shall, 72 hours in advance, notify the proper authorities in writing if the closure of a street is necessary. The Contractor shall then be responsible for maintaining proper notification and coordination with the Police Department, Sheriff's Department, Fire Department, and any other agency having jurisdiction and shall comply with all directed requirements.
4. Existing Improvements and Utilities. It is the responsibility of the Contractor to restore all existing street lights, decorative lights, meter boxes, utilities, walks, curbs, plantings, etc., damaged during construction. Replacement or repair of any damaged item is the responsibility of and at the expense of the Contractor.

### B. Protection of Existing Improvements

1. Prior to excavating any section of the work, the Contractor shall call the following utility companies and inform them that work on the specific section is about to commence and request that they field locate their underground utilities:

(a)	Sunshine State One	(800)432-4770
(b)	Florida Power and Light	(239)447-7383
(c)	Comcast Cable	(239)732-3805
(d)	Embarq	(239)336-2114
(e)	Florida Governmental Utility Authority	(239)543-1005
(f)	TECO Peoples Gas	(800)432-4770
2. When proceeding with the work, the Contractor shall exercise caution to protect all underground and overhead utilities and existing structures from damage. The Contractor shall repair, at his own expense and to the satisfaction of the Owner, any surface or subsurface improvement (including any existing utility not shown on the drawings) damaged during the course of the work (unless such improvement is shown to be abandoned or removed). Should any utilities be encountered that are not shown on the drawing, the Contractor shall immediately notify the Engineer and the OWNER and shall take whatever caution necessary to protect the utility.

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**C. Chemicals**

1. All chemicals used during project construction, or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant or of other classification, must show approval of either EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with instructions.

**D. Maintenance of Existing Drainage**

1. See Section 2.2 above.

END OF SECTION 310000

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## SECTION 311011 - SITE CLEARING

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 31 apply to the Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes: Requirements for clearing and grubbing.

#### 1.3 DEFINITIONS

- A. Clearing: Cutting, removal, and proper disposal of trees, stumps, brush, shrubs, rubbish, and other material as required to construct improvements shown and specified.
- B. Grubbing: Removal and disposal of stumps larger than 1-1/2-inch in diameter and other similar items to a depth of not less than 12 inches below finish grade.

#### 1.4 SYSTEM DESCRIPTION

- A. Clear and grub project site as shown on the Drawings and specified in this Section.
- B. Clear and grub project site as required to complete project.

### PART 2 – PRODUCTS (NOT USED)

### PART 3 – EXECUTION

#### 3.1 CLEARING AND GRUBBING

- A. Clear and grub areas to be occupied by facilities to be constructed, including areas to be excavated, filled, paved, or planted as shown on the Drawings.

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- B. Clear and grub right-of-way as required to complete project. Clear and grub easements as required to complete project. Do not clear or grub more than required to complete project.

**3.2 PROTECTION OF ADJACENT AREA**

- A. Protect areas shown on the Drawings or designated by the Architect/Engineer to remain protected from damage by construction operations by erecting suitable barriers or other acceptable means.
- B. Areas outside limits of construction as shown on the Drawings shall be protected and no equipment or materials shall be stored on these areas or allowed to damage these areas.

**3.3 DISPOSAL**

- A. Remove roots, vegetation, and other debris from the site. Dispose of roots, vegetation, and other debris removed from the site.
- B. Do not burn any material on the site or other areas where burning is not permitted.

END OF SECTION 311011

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## SECTION 312000 - EARTH MOVING

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes: Requirements for excavation, filling, and grading of the following:
  - 1. Swales, ditches, and other waterways not specified in other Sections.
  - 2. Embankments, berms, and other earth structures not specified in other Sections.
  - 3. Site areas to be landscaped, paved, or restored.

#### 1.3 REFERENCES

- A. General: References to standards, specifications, manuals, or codes of any technical society, organization or association, or to the Laws or Regulations of any government authority, whether such reference be specific or by implication, shall mean the latest standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
- B. ANSI/ASTM Standards
  - 1. ANSI/ASTM D698 Test Method for Laboratory Compaction Characteristics of Soil (AASHTO T-99) Using Standard Effort (12,400 ft.-lbf/ft<sup>3</sup>)(600 kN-m/m<sup>3</sup>)
  - 2. ANSI/ASTM D1557 Test Method for Laboratory Compaction Characteristics of Soil (AASHTO T-180) Using Modified Effort (56,000 ft.-lbf/ft<sup>3</sup>)(2,700 kN-m/m<sup>3</sup>)
- C. ASTM Standards
  - 1. ASTM D2922 Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

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D. Florida Department of Transportation (FDOT) Standard Plan

1. Standard Specifications for Road Construction

1.4 DEFINITIONS

A. General: Soil classifications presented in this Article are applicable to natural soils and processed materials.

B. ASTM D2487 Unified Soil Classification System (USCS)

1. Class I: Angular, one-quarter inch (1/4") to one and one-half inch (1-1/2") graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed shells and crushed stone.
2. Class II: Coarse sands and gravels with maximum particle size of one and one-half inches (1-1/2"), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. The following soil types are included in this class:
  - a. GW (well-graded gravel)
  - b. GP (pea gravel or crushed stone mixed with sand)
  - c. SW (well-graded sand)
  - d. SP (poorly graded sands and gravelly sands with little or no fines)
3. Class III: Fine sand and clayey (clay filled) gravels, including fine sands, sand-clay mixture and gravel-clay mixtures. The following soil types are included in this class:
  - a. GM (silty gravels)
  - b. GC (clayey gravels)
  - c. SM (silty sands)
  - d. SC (clayey sands)
4. Class IV: Silt, silty clays and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. The following soil types are included in this class:
  - a. CH (Inorganic clays of high plasticity)
  - b. CL (Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays)
  - c. MH (inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts)
  - d. ML (Inorganic silts, very fine sands, rock flour, silty or clayey fine sands)
5. Class V: This class includes the following organic soils as well as soils containing frozen earth, debris, rocks larger than one and one-half inches (1-1/2") in diameter and other foreign materials:
  - a. OL (Organic silts and organic silty clays of low plasticity)
  - b. OH (Organic clays of medium to high plasticity)
  - c. PT (Peat, muck, and other highly organic soils)

C. Maximum Density: Maximum weight in pounds per cubic foot of a specific material.

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- D. Optimum Moisture: Percentage of water in a specific material at maximum density.
- E. Rock: A natural aggregate of mineral particles connected by strong and permanent cohesive forces. Rock includes:
  - 1. Limestone, lime rock, sandstone, dolomite, granite marble, lava, and coral.
  - 2. Boulders 1/3 cubic yard or more in volume.
  - 3. Material which by actual demonstration cannot, in the Engineer's opinion, be reasonably excavated with a backhoe or 3/4 cubic yard capacity power shovel equipped with two rippers, or similarly approved equipment and which is, in fact, systematically drilled and blasted or broken by power operated hand tools. Engineer may waive demonstration requirement if material encountered is well-defined rock.
- F. Deleterious Materials: Household and construction debris, organic debris, peat and organic soils,

## 1.5 SYSTEM DESCRIPTION

- A. Perform excavation required to
  - 1. Construct swales and ditches to lines and grades shown on the Drawings.
  - 2. Construct drives and parking area to finish grades shown on the Drawings.
  - 3. Construct site to finish grades shown on the Drawings.
  - 4. Restore site to existing grades where no change in finish grade is indicated.
- B. Provide, place, and compact fill required to:
  - 1. Construct embankments, berms, and other earth structures shown on the Drawings.
  - 2. Construct drives and parking area to finish grades shown on the Drawings.
  - 3. Construct site to finish grades shown on the Drawings.
  - 4. Restore site to existing grades where no change in finish grade is indicated.
- C. Place, compact, and test fill as specified in this Section.
- D. Dispose of unsuitable and excess excavated material as specified in this Section.
- E. Grade site to elevations, lines, slopes, depths and cross-sections shown on the Drawings. Grade those areas of site where no change in finish grade is indicated to elevations, lines, slopes, depths and cross-sections that existed prior to start of construction.

## 1.6 QUALITY ASSURANCE

- A. General: Earthwork shall be performed by company with not less than five years of documented experience in earthwork construction.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall be responsible for delivery, storage, and handling of fill material from off-site sources.
- B. Comply with requirements of Federal, State, and County authorities regulating shipment of products.

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- C. Contractor shall be responsible for storage and handling of on-site excavated suitable fill material.
- D. Do not allow fill material from off-site sources or on-site excavated suitable fill material to be mixed with unsuitable material.
- E. Do not allow stored fill material from off-site sources to be mixed with stored on-site excavated suitable fill material.
- F. Protect stored fill materials so that the composition of materials is not altered and materials are not otherwise degraded or contaminated.

## 1.8 PROJECT/SITE CONDITIONS

### A. Regulatory Requirements

- 1. Conform to Federal and State regulatory requirements for excavations.
- 2. Obtain excavation permit prior to starting trenching and backfilling. Conform to requirements of excavation permit.
- 3. Provide barricades, warning signs, and lights as required by law, regulation, or law and regulation.

### B. Protection of Benchmarks, Monuments, and Other Reference Points

- 1. Maintain benchmarks, monuments, and other reference points.
- 2. Retain a Registered Land Surveyor who shall establish, for any benchmarks, monuments, and other reference points that might be disturbed by structural earthwork, references that will not be disturbed.
- 3. Registered Land Surveyor shall replace benchmarks, monuments, and other reference points removed or otherwise disturbed.

### C. Unanticipated Conditions

- 1. Notify Engineer of unexpected subsurface conditions and discontinue work in affected area until notified by Engineer to resume work.
- 2. Take emergency measures as required to protect persons and improvements.

## PART 2 – PRODUCTS

### 2.1 MATERIALS

#### A. Suitable Fill Material

- 1. Suitable fill material shall be non-cohesive, non-plastic, granular mixture of local sand and limerock, free from vegetation, organic material or muck.
- 2. Suitable fill material shall contain not more than 8% material by weight passing No. 200 sieve.
- 3. Suitable fill material containing limerock shall have sufficient sand to fill voids in limerock. Suitable fill material shall contain not more than 20% rock. Maximum rock size shall not exceed the following:



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- a. Maximum Rock Size in Upper 4" of Fill: 2"
- b. Maximum Rock Size below Upper 4" of Fill: 6"

## B. Unsuitable Material

- 1. Topsoil from ground surface to a depth of 12 inches or as determined by Engineer;
- 2. Class IV soils and Class V soils as defined in this Section.
- 2. Peat and other highly organic soils.
- 3. Broken Portland cement, asphaltic concrete, and debris.

## PART 3 – EXECUTION

### 3.1 INSPECTION

- A. Verify site conditions and note irregularities affecting work of this Section.
- B. Beginning work of this Section means acceptance of existing conditions.

### 3.2 EXCAVATION

- A. Dewater excavations as specified in Section 02240 Dewatering.
- B. Perform excavation work in accordance with F.D.O.T Standard Specifications for Roadway and Bridge Construction, in locations shown on the Drawings.
- C. Strip existing surfaces to be excavated to a depth of six inches minimum, unless otherwise directed by Engineer, to remove grass, roots and other vegetation. Stripped material is considered unsuitable for general fill purposes. Use stripped material only as topsoil.
- D. Locate underground structures and utilities in areas of work to avoid conflicts with existing facilities. Where conflicts are unavoidable, perform work so that interference with service rendered or facility disturbed is minimized. Repair facilities or structures damaged during prosecution of Work immediately. Repair facilities or structures damaged during prosecution of Work to pre-construction condition.
- E. Use suitable materials removed from excavation areas as far as practicable in the formation of embankments. Stockpile topsoil and other suitable materials in areas as directed by Engineer.
- F. Remove unsuitable material and excess excavated suitable material from the Project. Dispose of unsuitable material and excess excavated suitable material off of the Project.

### 3.3 ROCK EXCAVATION

- A. Use non-explosive methods for rock removal.
- B. Maximum dimension of rock removed shall not exceed three feet.
- C. Remove rock from site unless other arrangements are made to the Owners satisfaction.

### 3.4 FILL

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- A. Provide fill material from on-site excavated suitable fill or from off-site sources.
  - 1. If there is not sufficient on-site excavated suitable fill required to complete Work, provide suitable fill from off site at no additional cost to the Owner.
  - 2. Borrow areas or other sources of off-site material shall be accessible to examination by the Engineer prior to, and during, use of off-site of material.
- B. Use only suitable material in formation of embankments.
- C. Place fill material in lifts not to exceed eight inches. Compact fill material to density not less than 95% of Modified Proctor Maximum Dry density (ASTM D1557).
- D. Perform filling work in accordance with F.D.O.T Standard Specifications for Roadway and Bridge Construction, in locations shown on the Drawings.

## 3.5 COMPACTION

- A. Compaction Equipment
  - 1. Compaction shall be accomplished by use of appropriate compaction equipment.
  - 2. Compact each lift by repeated passes of appropriate compaction equipment.
  - 3. Select and operate compaction equipment so that pipe and structures are not damaged by compaction operation.
- B. Moisture Control
  - 1. Control moisture content of soil during compaction as required to achieve specified compaction.
  - 2. Moisture content of fill and backfill material shall be within plus or minus 2% of optimum moisture content during compaction of fill and backfill material.
  - 3. If necessary, add water or allow material to dry until the proper moisture content for the specified compaction is obtained.
- C. Compaction Testing
  - 1. Test compaction of fill as specified in this Section.
  - 2. Test each compacted soil layer, in place, prior to placement of succeeding layers.

## 3.6 TESTING

- A. Contractor to coordinate with Geotechnical Report. Material site/lab inspections shall be performed by CEI firm.
  - 1. Owner shall pay the cost of initial density test(s).
  - 2. Contractor shall pay cost for any additional testing required as a result of failure of any initial test.
- B. Perform one Proctor Test, according to ASTM D1557, for each source of fill used on the Project. If material from excavation is used as backfill material, take a test proctor from the best available location as determined by the testing lab.

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- C. Determine Optimum moisture content of fill, subgrade, and backfill material by Modified Proctor Method (ASTM D1557).
- D. Test the density of each compacted fill layer in place. Field density tests shall meet the requirements of ASTM D1556, ASTM D2922, or ASTM D2937.
  - 1. Fill/Backfill for 1 test per layer for each 500 feet of roadway Roadways (minimum 1 test per day)
  - 2. Fill for Embankments 1 test per layer for each 1,000 square feet of embankment (minimum 1 test per day)
  - 3. Fill/Backfill for Lawns: 1 test for each 1,000 square feet of fill and Landscaped Areas.
- F. Perform additional field density tests as follows:
  - 1. If test density of compacted backfill or fill is less than specified density, make additional tests at locations directed by Engineer.
  - 2. Make additional field density tests at no additional cost to the Owner.
- G. Allow for inspection of import fill by Engineer at the source before delivery to site.
- H. Allow for inspection and cross-sectioning of excavation and fill areas by Engineer as required to determine conformance of the final earthwork with the Drawings.

**3.7 FINE GRADING**

- A. Fine grade disturbed areas of site after structures, bases, and pavements are completed, yard piping trenches are backfilled, and excavations are backfilled.
- B. Remove construction debris in areas to be fine graded prior to fine grading.
- C. Shape and slope completed surface to drain away from structures. Completed surface shall be within 0.1 foot of finish elevations, contours, or elevations and contours shown on the Drawings, but not above the edges of adjacent walks, drives, aprons, or pads.

END OF SECTION 312000

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## SECTION 312300 - TRENCHING, BACKFILLING AND COMPACTING FOR UTILITY SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. The Work included under this Section consists of clearing, excavating, grading and backfilling as required for the construction of the utility systems consisting of piping and appurtenances as shown on the Drawings and specified herein.

### PART 2 - PRODUCTS

#### 2.1 BEDDING MATERIAL

- A. Bedding material will be required to meet F.D.O.T Standard Specifications for Roadway and Bridge Construction.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Clearing: The Contractor shall perform all clearing necessary for the proper installation of all piping and appurtenances in the locations shown on the Drawings. Plantings, shrubbery, trees, utility poles or structures subject to damage resulting from the excavation shall be transplanted, relocated, braced, shored, or otherwise protected and preserved unless otherwise directed by the Architect.

#### 3.2 PERFORMANCE

- A. Excavation:

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1. The Contractor shall perform all excavation of every description and of whatever substances encountered, to the dimensions and depth shown on the Drawings, or as directed by the Architect/Engineer. All excavations shall be made by open cut, unless otherwise specified on the Drawings. All existing utilities such as pipes, poles and structures shall be carefully supported and protected from injury, and in case of damage, they shall be restored or replaced at the Contractor's expense.
2. Trench walls shall be kept vertical, and, if required to protect the safety of workmen, the general public or adjacent property, this or other work or structures, or to maintain trench widths within the limits hereinafter specified shall be properly sheeted and braced. Where wood sheeting or certain designs of steel sheeting are used, the sheeting shall be cut off at a level 2 feet above the top of the installed pipe and that portion below that level shall be left in place. If interlocking steel sheeting is used, it may be removed providing removal can be accomplished without disturbing the bedding, pipe or alignment of the pipe. Any damage to the pipe bedding, pipe or alignment of the constructed utility caused by removal of sheeting shall be cause for rejection of the affected portion of the work. Not more than 100 feet of trench shall be opened ahead of pipe laying operations at one time unless a greater length of open trench is approved by the Engineer.
3. In areas where trench widths are not limited by right-of-way, and/or easement widths, property line restrictions, existing adjacent improvements, including pavements, structures and other utilities, and maintenance of traffic, the trench sides may be sloped to a stable angle of repose of the excavated material. A substantially and safely constructed movable shield, "box" or "mole" may be used in place of sheeting when the trench is opened immediately ahead of the shield and closed immediately behind the shield as pipe laying proceeds inside the shield.
4. Ladders or steps shall be provided for and used by workmen to enter and leave trenches.
5. Pipe trenches for utility lines shall be excavated to a width within the limits of the top of the pipe and the trench bottom so as to provide a clearance on each side of the pipe barrel, measured to the face of the excavation or sheeting, if used, of 8 inches to 12 inches. Where the pipe size exceeds 12 inches, the clearance shall be from 12 inches to 18 inches. All pipe trenches shall be excavated to a level 8 inches below the outside bottom of the proposed pipe barrel.
6. Excavation for appurtenances shall be sufficient to provide a clearance between their outer surfaces and the face of the excavation or sheeting, if used, of not less than 12 inches. Manhole excavations shall be carried to sufficient depth to permit their construction on the undisturbed bottom of the excavation.
7. Materials removed from the trenches shall be stored and disposed of in such a manner that they will not interfere unduly with traffic on public streets and sidewalks and they shall not be placed on private property. In congested areas, such materials as cannot be stored adjacent to the trench or used immediately as backfill shall be removed to convenient places of storage.
8. All materials suitable for use as backfill shall be hauled to and used in areas where not enough suitable material is available from the excavation.
9. All excess suitable or unsuitable material shall be disposed of as directed by the Architect/Engineer. Material disposed of within the limits of the project shall be finish graded upon completion of the work. Material to be removed from the project shall be hauled away and disposed of at the Contractor's expense.

## B. Removal of Water:

1. It is a basic requirement of these specifications that excavations shall be free from water before pipe or structures are installed.

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2. Once a Dewatering Permit is obtained, the Contractor shall provide all necessary pumps, underdrains, well-point systems, and other means for removing water from trenches and other parts of the work. The Contractor shall continue dewatering operations until the backfill has progressed to a sufficient depth over the pipe to prevent flotation or movement of the pipe in the trench and so that it is above the natural water table.
  3. Water from the trenches and excavation shall be disposed of in such a manner as will not cause injury to public health, to public or private property, to the work completed or in progress, to the surface of the streets, or cause any interference with the use of the same by the public. The contractor shall submit his proposed methods of handling trench water and locations at which the water will be disposed of to the Architect/Engineer for approval and shall receive approval before starting the excavation.
- C. Trench Stabilization: No claim for extras, or additional payments will be considered for cost incurred in the stabilization of trench bottoms which are rendered soft or unstable as a result of construction methods, such as improper or inadequate sheeting, dewatering or other causes. In no event shall pipe be installed when such conditions exist and the Contractor shall correct such conditions so as to provide proper bedding or foundations for the proposed installations at no additional cost to the Owner.
- D. Trench Excavations:
1. Contractor shall conform to OSHA Excavation Safety Standards 29, CFR part 1926.650 Subpart P incorporated under the Florida Trench Safety Act (90-96, Laws of Florida) effective October 1, 1990.
  2. The Contractor shall provide written assurance of compliance with this law.
  3. Trench safety system shall be the responsibility of the Contractor.
- E. Backfill:
1. Backfilling of utility trenches will not be allowed until the work has been approved by the Architect/Engineer, and the Engineer indicates that backfilling may proceed. Any work which is covered or concealed without the knowledge and consent of the Architect/Engineer shall be uncovered or exposed for inspection at no cost to the Owner. Partial backfill may be made to restrain the pipe during pressure testing.
  2. Backfill material shall be non-cohesive, non-plastic material free of all debris, organic material, lumps, clods and broken paving. Backfill material placed within 1 foot of piping and appurtenances shall not contain any stones or rocks larger than 2 inches in diameter (1 inch for PVC pipe) and no stones or rocks larger than 4 inches in diameter will be permitted in any backfill.
  3. If a sufficient quantity of suitable backfill material is not available from the trench or other excavations within the site of the work, the Contractor shall provide additional material suitable for this purpose. The additional material shall be installed as specified herein.
  4. Selected backfill material containing no stone or rocks larger than 2 inches shall be placed in 6-inch layers and thoroughly tamped to a depth of 12 inches over the top of the pipe. Particular attention and care shall be exercised in obtaining thorough support for the branch of all service connection fittings and compaction of the fill under the haunches of the pipe. Care shall be taken to preserve the alignment and gradient of the installed pipe.
  5. After the backfill has been placed to a level 12 inches over the pipe, the remainder of the backfill shall be placed in layers, not to exceed 6 inches, and compacted with mechanical vibrators or other suitable equipment to obtain a density of the backfilled material of not less than 95 percent of its maximum density as hereinafter defined.

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6. Within paved areas of trench excavation, the base and surfacing shall be constructed as specified in the F.D.O.T Standard Specifications for Roadway and Bridge Construction.
7. No more than 800 feet of trench with pipe in place shall be partially backfilled at any time.

**F. Additional Excavation and Backfill:**

1. Where organic material, such as roots, mulch, other vegetable matter, or other material which, in the opinion of the Engineer, will result in unsatisfactory foundation conditions, is encountered below the level of the proposed pipe bedding material, it shall be wholly or partially removed as directed by the Engineer and wasted. Sheeting shall be installed if necessary to maintain pipe trenches within the specified limits. The resulting excavation shall be backfilled with suitable backfill material, placed in 6-inch layers, tamped and compacted up to the level of the bottom of the proposed pipe bedding material. Sufficient compaction of this material shall be performed to protect the proposed pipe against settlement. Construction shall then proceed in accordance with the provisions of Article 3.2, C - Pipe Bedding, above.
2. Additional excavation shall be performed only when ordered by the Engineer. Where organic or other unsuitable material is encountered in the excavation, the Contractor shall bring the condition to the attention of the Engineer and obtain his determination as to whether or not the material will require removal, prior to preparing the pipe bedding.

**G. Restoration of Existing Surfaces:** Paved and grassed areas disturbed by the operations required under this Section shall be restored as indicated on the Drawings and/or specified herein.

**3.3 COMPACTION AND DENSITIES**

**A. Methods of control and testing of backfill construction to be employed in this work are:**

1. Maximum density of the material in trenches shall be determined by ASTM D3017 (Nuclear Method) or ASTM D1557 Method A; or AASHTO Designation T-180-74, where called for on the drawings.
2. Field density of the backfill material in place shall be determined by ASTM D2922 (Nuclear Method), ASTM D-1556 (Sand Cone Method) or AASHTO Designation T 238-79.

**B. Laboratory and field density tests will be conducted by CEI firm contracted by OWNER. Tests will be made at depths and locations selected by the Architect/Engineer or geotechnical report recommendation. It shall be the Contractor's responsibility for expense accrued for retesting if failed tests occur.**

**C. Trench backfill which does not comply with the specified densities, as indicated by such tests, shall be reworked and re-compacted until the required compaction is secured, at no additional cost to the Owner. The costs for retesting such work shall be paid for by the Contractor.**

END OF SECTION 312300



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## SECTION 313116 - TERMITE CONTROL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Soil treatment with termiticide.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include the EPA-Registered Label for termiticide products.
- B. Product certificates.
- C. Soil Treatment Application Report: Include the following:
  - 1. Date and time of application.
  - 2. Moisture content of soil before application.
  - 3. Termiticide brand name and manufacturer.
  - 4. Quantity of undiluted termiticide used.
  - 5. Dilutions, methods, volumes used, and rates of application.
  - 6. Areas of application.
  - 7. Water source for application.
- D. Warranties: Sample of special warranties.

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## 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.
- B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

## 1.5 PROJECT CONDITIONS

- A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
- B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, and ground-supported slabs before construction.

## 1.6 WARRANTY

- A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

- 1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SOIL TREATMENT

- A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. BASF Corporation, Agricultural Products; Termidor.
    - b. Bayer Environmental Science; Premise 75.
    - c. FMC Corporation, Agricultural Products Group; Dragnet FT.
    - d. Syngenta; Demon TC.
  - 2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

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## PART 3 - EXECUTION

### 3.1 APPLICATION, GENERAL

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

### 3.2 APPLYING SOIL TREATMENT

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.
- C. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
  - 1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.
- D. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
  - 1. Slabs-on-Grade: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
  - 2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
  - 3. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
- E. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- F. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
- G. Post warning signs in areas of application.

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- H. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116

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## SECTION 321216 - ASPHALT PAVING

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 31 Specification Sections, apply to the Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 31 Specification Sections, apply to the Section.

#### 1.3 SUMMARY

- A. This section describes the Contractor's responsibility for all roadway construction.

The work includes all the construction necessary to give a completed facility and to maintain local traffic during construction. The Contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, specifications and terms of the Contract.

### PART 2 – MATERIALS AND EXECUTION

#### 2.1 STABILIZING

The work specified in this article will conform to the F.D.O.T. Specifications for Roadway and Bridge Construction, except non FDOT asphalt plants are allowed for the source of asphalt material and material site/lab testing and inspections will be performed by CEI firm contracted by OWNER.

If stabilizing material is required, on-site materials may be used if satisfactory. The volume of material used will not be deducted from the excavation measurement.

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## 2.2 LIMEROCK BASE

The work specified in this article will conform to the F.D.O.T. Specifications for Roadway and Bridge Construction except material site/lab testing and inspections will be performed by CEI firm contracted by OWNER.

## 2.3 PRIME AND TACK COATS FOR BASE COURSES

The work specified in this article will conform to the F.D.O.T. Specifications for Roadway and Bridge Construction.

No asphalt escalator will be allowed.

## 2.4 HOT BITUMINOUS MIXTURES - PLANT, METHODS & EQUIPMENT

The work specified in this article will conform to the F.D.O.T. Specifications for Roadway and Bridge Construction.

The plant producing asphalt does not have to be approved by the F.D.O.T. However, if the Engineer elects, the plant must be capable of meeting any or all the requirements set forth in F.D.O.T. Specifications for Roadway and Bridge Construction.

## 2.5 HOT BITUMINOUS MIXTURES GENERAL CONSTRUCTION REQUIREMENTS

The work specified in this article will conform to the F.D.O.T. Specifications for Roadway and Bridge Construction.

## 2.6 TYPE SP ASPHALTIC CONCRETE

The work specified in this article will conform to the F.D.O.T. Specifications for Roadway and Bridge Construction.

No asphalt escalator will be allowed. Non F.D.O.T asphalt plants are allowed. Material site/lab testing and inspections will be performed by CEI firm contracted by OWNER.

## 2.7 PLASTIC FILTER BLANKET (GEOTEXTILE)

The work specified in this article will conform to the F.D.O.T. Specifications for Roadway and Bridge Construction.

## 2.8 ROADWAY SIGNING AND MARKING

The work specified in this article will conform to the F.D.O.T. Specifications for Roadway and Bridge Construction. Onsite signing and marking shall vary from F.D.O.T. Specifications for Roadway and Bridge Construction and shall be dictated by civil engineering and/or landscape architectural, and/or architectural plans and/or specifications.

END OF SECTION 321216

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## SECTION 321313 - CONCRETE PAVING, CONCRETE GUTTER, CURB ELEMENTS AND TRAFFIC SEPARATORS

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 31 Specification Sections, apply to the Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 31 Specification Sections, apply to the Section.

#### 1.3 SUMMARY

- A. This section describes the Contractor's responsibility for concrete paving, curbing and concrete separators construction.

The work includes all the construction necessary to give a completed facility and to maintain local traffic during construction. The Contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, specifications and terms of the Contract.

- B. The work specified in this article will conform to the F.D.O.T. Specifications for Roadway and Bridge Construction except material site/lab testing and inspections will be performed by CEI firm contracted by OWNER.

### PART 2 - MATERIALS AND EXECUTION

#### 2.1 STABILIZING

- A. The work specified in this article will conform to F.D.O.T. Specifications for Roadway and Bridge Construction.

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**2.2 PORTLAND CEMENT CONCRETE**

- A. The work specified in this article will conform to F.D.O.T. Specifications for Roadway and Bridge Construction.

Class I concrete shall have a minimum 28-day strength of 3000 psi.

Class II concrete shall have a minimum 28-day strength of 4000 psi.

**2.3 CEMENT CONCRETE PAVEMENT**

- A. The work specified in this article will conform to F.D.O.T. Specifications for Roadway and Bridge Construction.

**2.4 PLASTIC FILTER BLANKET (GEOTEXTILE)**

- A. The work specified in this article will conform to F.D.O.T. Specifications for Roadway and Bridge Construction.

**2.5 REINFORCING STEEL**

- A. The work specified in this article will conform to F.D.O.T. Specifications for Roadway and Bridge Construction.

**2.6 CONCRETE GUTTER AND CURB ELEMENTS AND TRAFFIC SEPARATOR**

- A. The work specified in this article will conform to F.D.O.T. Specifications for Roadway and Bridge Construction. Type D, E, and A curbs are F.D.O.T Non-Structural concrete with no testing requirement.

**2.7 ROADWAY SIGNING AND MARKING**

- A. The work specified in this article will conform to F.D.O.T. Specifications for Roadway and Bridge Construction.

END OF SECTION 321313



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## SECTION 321623 - CONCRETE SIDEWALKS

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. Section Includes: Requirements for concrete sidewalks.

#### 1.3 SYSTEM DESCRIPTION

- A. Furnish and install Portland cement concrete sidewalks as shown on the Drawings and specified in this Section.
- B. Furnish and install Portland cement concrete sidewalks in accordance with lines, grades and dimensions as indicated on the Drawings.

#### 1.4 SUBMITTALS

- A. General: As specified in:
  - 1. Division 1;
  - 2. This Section.
- B. Submit product data and shop drawings for the following prior to starting concrete sidewalks:
  - 1. Joint material; and
  - 2. Mix designs.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: As specified in Division 1.

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- B. Storage And Handling: As specified in Division 1.

## PART 2 – PRODUCTS

### 2.1 CONCRETE

- A. Concrete shall be Class B, as specified in Section 03300 Cast-In-Place Concrete, unless otherwise shown or specified.

### 2.2 REINFORCING AND WELDED WIRE FABRIC

- A. Joint reinforcing and welded wire fabric shall meet the requirements of Section 03300 Cast-In-Place Concrete, unless otherwise shown or specified.

### 2.3 PREFORMED JOINT FILLER

- A. Preformed joint filler shall be sponge rubber and conform to the requirements of AASHTO Designated M148, Type 1.

## PART 3 – EXECUTION

### 3.1 SUBGRADE CONDITION

- A. Maintain finished subgrade in a smooth, compact condition, and restore any areas which are disturbed, prior to placing of the concrete, at the no additional cost to the Owner. Subgrade shall be moist when concrete is placed. If the subgrade cannot not maintained in the required moist condition, provide a vapor barrier sheet between the subgrade and the concrete.
- B. Accurately trim subgrade to the required elevation with a 1/4-inch tolerance. Trim high areas to proper elevation. Low areas may be filled with suitable material and compacted to the specified density or filled with concrete integrally placed with concrete sidewalk.

### 3.2 SETTING FORMS

- A. Forms shall be accurately set to line and grade and so that forms rest firmly upon compacted subgrade surface throughout entire length of forms.
- B. Forms shall be joined neatly and tightly and braced to resist pressure of wet concrete and finishing operations.
- C. Alignment and grade of forms shall be approved before and immediately prior to the placing of concrete.

### 3.3 CONCRETE MIXING AND DELIVERY

- A. Concrete mixing and delivery shall meet the requirements of Section 03300 Cast-In-Place Concrete. Material site/lab testing and inspections will be performed by CEI firm.

### 3.4 PLACING CONCRETE

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- A. Distribute concrete on subgrade to such depth, that, when concrete is consolidated and finished, slab thickness shown on the Drawings will be obtained at all points and surface of concrete will at no point be below grade specified for finished surface, after application of the allowable tolerance. Deposit concrete on subgrade in a manner which will require as little rehandling of concrete as possible.
- B. Place fabric reinforcement at mid slab depth, and maintain fabric at mid slab depth during placing and finishing of concrete.
- C. Thoroughly consolidate concrete against and along faces of forms, by means of hand-operated, spud-type vibrators. Do not allow vibrators to come in contact with the subgrade or a side form. Do not continue vibration at any one location so long as to produce puddling or accumulation of excessive grout on surface. In no case shall vibrator be operated longer than 15 seconds in any one location.

## 3.5 STRIKING-OFF, CONSOLIDATING AND FINISHING CONCRETE

- A. Immediately after placing concrete, strike-off concrete, consolidate concrete, and finish concrete, to produce finished sidewalk conforming to cross section and width
- B. Surface finishing sequence shall be as follows:
  - 1. Strike-off;
  - 2. Vibratory consolidation;
  - 3. Screeding;
  - 4. Floating;
  - 5. Removal of laitance; and
  - 6. Final surface finish.

## 3.6 FINAL FINISH

- A. As soon as water sheen has disappeared from surface of the concrete and just before concrete becomes nonplastic, give surface a light broom finish.

## 3.7 EDGING

- A. After final finish has been applied, but before concrete has become nonplastic, carefully round edges of sidewalk to 1/4 inch radius along each side of strip being placed, on each side of construction joints and along any structure extending into sidewalk, unless otherwise shown on the Drawings. Produce a well defined and continuous radius and obtain a smooth, dense mortar finish.
- B. Remove any concrete from the top of joint filler.

## 3.8 JOINTS

- A. Construction Joints: Locate construction joints as shown on the Drawings.
- B. Expansion Joints

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1. Form transverse expansion joints by placing premolded expansion joint material at 50 feet intervals, and as indicated on the Drawings.
2. Form expansion joints around structures by placing premolded expansion joint material along structures and features projecting through, into or against sidewalk.
3. Unless otherwise indicated, expansion joints shall be 1/2-inch in width.
4. After the sidewalk has been finished, edge expansion joints with a tool having a 1/2-inch radius.

C. Scored Joints

1. Scored joints shall be either formed or sawed at 5 foot intervals.
2. Scored joints shall extend to a depth of at least one fourth of the sidewalk slab thickness.

3.9 CURING

- A. After the finishing operations have been completed and as soon as the concrete has hardened sufficiently that marring of the surface will not occur, cover entire surface and edges of newly placed concrete and cured concrete with membrane curing compound.
- B. Uniformly apply curing compound to surfaces to be cured, in a single coat, continuous film, at rate of one gallon to not more than 200 square feet. Apply curing compound with a mechanical sprayer.
- C. Do not apply curing compound during periods of rainfall. Do not apply curing compound to inside faces of joints to be sealed.
- D. Should curing film become damaged from any cause within required curing period, immediately repair damaged portions with additional compound.
- E. Upon removal of side forms immediately coat sides of slabs exposes to provide a curing treatment equal to that provided for the surface.

END OF SECTION 321623

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## SECTION 321723 - PAVEMENT MARKING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 31 apply to the Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SCOPE

- A. This section specifies the pavement traffic painting, marking, striping, and signing shown on the plans or called for in the test of the specifications.

#### 1.3 GENERAL

- A. In general, all pavement traffic painting, marking, striping, and signing shall comply with the FDOT Standard Specifications for Roadway and Bridge Construction and the Manual of Uniform Traffic Control Devices, U.S. Department of Transportation Federal Highway Administration, 1971 or latest revision, hereafter referenced as "MUTCD."

#### 1.4 SIGN PANELS AND POSTS

- A. Sign panels shall be aluminum unless otherwise detail on the construction plan set. All sign posts shall be frangible aluminum and shall have a standard extruded aluminum sign bracket clamped to the post 12 inches below grade. Bracket size shall match post diameter.

#### 1.5 SIGN BLANKS AND FACES

- A. Regulatory and Warning signs as defined in the MUTCD shall be "High Intensity" reflectorized grade.
- B. Street Name and Guide signs as defined in the MUTCD shall be "Standard reflectorized grade."
- C. The Contractor shall submit documentation from the sign supplier which identifies the reflector grade of each sign. All materials shall meet the requirements of the FDOT Standard

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Specifications for Roadway and Bridge Construction and the Manual of Uniform Traffic Control Devices, U.S. Department of Transportation Federal Highway Administration, 1971 or latest revision, hereafter referenced as "MUTCD."

## 1.6 SIGN HARDWARE

- A. The signs shall be attached to the posts with vandal-resistant nuts and carriage bolts with washers. Vandal-resistant nuts shall be Tufnut, Tamper-Pruf, Vandal-Pruf, or approved equal. The nuts and bolts shall be manufactured from high strength aluminum. Button head bolts shall not be used.

## 1.7 PAVEMENT STRIPING AND PAINTING

- A. Painting Traffic Stripes. Painted pavement striping shall conform to the FDOT Standard Specifications for Roadway and Bridge Construction and the Manual of Uniform Traffic Control Devices, U.S. Department of Transportation Federal Highway Administration, 1971 or latest revision, hereafter referenced as "MUTCD."
- B. Thermoplastic Striping & Marking. Thermoplastic pavement striping shall be reflective and shall conform to the FDOT Standard Specifications for Roadway and Bridge Construction and the Manual of Uniform Traffic Control Devices, U.S. Department of Transportation Federal Highway Administration, 1971 or latest revision, hereafter referenced as "MUTCD." (For use within the rights-of-way)

## 1.8 REFLECTIVE PAVEMENT MARKERS

- A. Reflective pavement markers and their installation shall conform to the FDOT Standard Specifications for Roadway and Bridge Construction and the Manual of Uniform Traffic Control Devices, U.S. Department of Transportation Federal Highway Administration, 1971 or latest revision, hereafter referenced as "MUTCD."

## 1.9 BASIS OF PAYMENT

- A. Payment for pavement marking, striping, and signing shall be on a unit price basis in accordance with the accepted proposal. Such payment shall constitute full compensation for furnishing all labor, materials, and equipment necessary to complete the construction in accordance with the plans and specifications. The Owner reserves the right to add to or deduct from the scope of the work, and such additions or deductions will be made at the unit price established in the proposal. The said additions or deductions shall not exceed twenty-five percent (25%) of the base bid of the successful bidder or bidders unless otherwise noted.

END OF SECTION 321723

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## SECTION 323113 – CHAIN-LINK FENCES AND GATES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Galvanized steel chain-link fabric.
  - 2. Galvanized steel framework.

#### 1.3 DEFINITIONS

- A. CLFMI: Chain Link Fence Manufacturers Institute.
- B. Zn-5-Al-MM Alloy: Zinc-5 percent aluminum-mischmetal alloy.

#### 1.4 SUBMITTALS

- A. Product Data: Material descriptions, construction details, dimensions of individual components and profiles, and finishes for the following:
  - 1. Fence and gate posts, rails, and fittings.
  - 2. Chain-link fabric, reinforcements, and attachments.
  - 3. Gates and hardware.
- B. Provide Shop Drawings: Show locations of fence, each gate, posts, rails, and tension wires and details of extended posts, extension arms, gate swing, or other operation, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans,

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elevations, sections, gate swing and other required installation and operational clearances, and details of post anchorage and attachment and bracing.

- C. Product Certificates: Signed by manufacturers of chain-link fences and gates certifying that products furnished comply with requirements.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed chain-link fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

## 1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

## PART 2 - PRODUCTS

### 2.1 CHAIN-LINK FENCE FABRIC

- A. Steel Chain-Link Fence Fabric: Height indicated on Drawings. Provide fabric fabricated in one-piece widths for fencing in height of 10 feet and less. Comply with CLFMI's "Product Manual" and with requirements indicated below:
  - 1. Mesh and Wire Size: 2-inch mesh, 0.148-inch.
  - 2. Zinc-Coated Fabric: ASTM A 392, with zinc coating applied to steel wire before weaving according to ASTM A 817
- B. Selvage: Knuckled at both selvages.

### 2.2 INDUSTRIAL FENCE FRAMING

- A. Round Steel Pipe: Standard weight, Schedule 40, galvanized steel pipe complying with ASTM F 1083. Comply with ASTM F 1043, Material Design Group IA, external and internal coating Type A, consisting of not less than 1.8-oz./sq. ft. zinc; and the following strength and stiffness requirements:
  - 1. Line, End, Corner, and Pull Posts and Top Rail: Per requirements for Light Industrial Fence.
- B. Post Brace Rails: Match top rail for coating and strength and stiffness requirements. Provide brace rail with truss rod assembly for each gate, end, and pull post. Provide two brace rails extending in opposing directions, each with truss rod assembly, for each corner post and for pull posts. Provide rail ends and clamps for attaching rails to posts.
- C. Top Rails: Fabricate top rail from lengths 21 feet or longer, with swaged-end or fabricated for expansion-type coupling, forming a continuous rail along top of chain-link fabric.



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## 2.3 TENSION WIRE

- A. General: Provide horizontal tension wire at the following locations:
  - 1. Location: Extended along bottom of fence fabric.
- B. Metallic-Coated Steel Wire: 0.177-inch- diameter, marcelled tension wire complying with ASTM A 824 and the following:
  - 1. Coating: Type II, zinc coated (galvanized)
  - 2. Matching chain-link fabric coating weight.

## 2.4 INDUSTRIAL SWING GATES

- A. General: Comply with ASTM F 900 for the following swing-gate types:
  - 1. Double gate.
- B. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F 1083 and ASTM F 1043 for materials and protective coatings.
  - 1. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F 900
- C. Frame Corner Construction: As follows:
  - 1. Welded.
- D. Gate Posts: Fabricate members from round galvanized steel pipe with outside dimension and weight according to ASTM F 900
- E. Hardware: Latches permitting operation from both sides of gate, hinges, center gate stops and, for each gate leaf more than 5 feet wide, keepers Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

## 2.5 FITTINGS

- A. General: Provide fittings for a complete fence installation, including special fittings for corners. Comply with ASTM F 626.
- B. Post and Line Caps: Hot-dip galvanized pressed steel or hot-dip galvanized cast iron.
  - 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: Hot-dip galvanized pressed steel or hot-dip galvanized cast iron. Provide rail ends or other means for attaching rails securely to each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
  - 1. Top Rail Sleeves: Hot-dip galvanized pressed steel or round steel tubing. Not less than 6 inches long.

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- E. Tension and Brace Bands: Hot-dip galvanized pressed.
- F. Tension Bars: Hot-dip galvanized steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Tie Wires, Clips, and Fasteners: Provide the following types according to ASTM F 626:
  - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
    - a. Hot-Dip Galvanized Steel: 0.106-inch-diameter wire

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. General: Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.
  - 1. Dimensions and Profile: As indicated on Drawings.
  - 2. Posts Set into Concrete in Voids: Form or core drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

### 3.3 CHAIN-LINK FENCE INSTALLATION

- A. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment.
- B. Line Posts: Space line posts uniformly.
- C. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric.
  - 1. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same gage and type of wire.

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- D. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended by fencing manufacturer.
  - E. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
  - F. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.
  - G. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
    - 1. Maximum Spacing: Tie fabric to line posts 12 inches o.c. and to braces 24 inches o.c.
  - H. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.
- 3.4 GATE INSTALLATION
- A. General: Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

END OF SECTION 323113

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## SECTION 328010 – IRRIGATION WELL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SCOPE OF WORK

- A. Develop and provide a workable irrigation recharge well producing quality water as specified and shall prove satisfactory in all aspects to the Owner.
- B. The work contemplated by these specifications consists of the provisions of labor, materials, equipment, permitting and services required for all work as described herein.
- C. Unless otherwise specified, the plans and specifications are intended to include everything obviously requisite and necessary for the proper installation and completion of the work whether each necessary item is mentioned herein or not.
- D. The plans and specifications are intended to be cooperative and any item called for in one and not the other shall be as binding as if called for in both.

#### 1.3 DESCRIPTION OF THE WELL

- A. The well shall be a 6" well at an approximate depth as required by the permit. The well shall be capable of producing a minimum of 70 gallons per.

#### 1.4 UTILITIES AND PROTECTIONS

- A. The Owner shall make available to the Contractor all of the necessary information regarding the exact location of existing utilities, and shall mark the location of such utilities and/or any underground obstructions. The Contractor shall be liable for the damages to and the cost of repairing or replacing any buried conduit, cables, or piping encountered during the installation of

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the work, unless they were not marked or he was not previously informed of such underground utilities. If the Contractor is aware of such buried lines, he shall immediately have the incurred damages repaired at his own expense.

## 1.5 ELECTRICAL INSTALLATION

- A. The Contractor will be required to make connections to the electrical systems as is required for the proper operation of the pumping system.
- B. Contractor shall verify all electrical requirements prior to ordering the pump.
- C. Power for well shall be brought to the vicinity of the well by the general contractor as indicated on the drawings.

## 1.6 EQUIPMENT, TOOLS AND LABOR

- A. The Contractor shall furnish all such equipment, tools, and labor necessary to construct the well in an acceptable manner and to a speedy completion. This Contract is based on the Contractor furnishing equipment, tools and labor which are suitable to carry out this contract in a professional manner, unless otherwise herein specified.

## 1.7 CODES AND INSPECTIONS

- A. The entire installation shall fully comply with all local and state laws and ordinances, and with all the established codes applicable there to.
- B. The Contractor shall take out all required permits, arrange for all necessary inspections and shall pay any fees and expenses in conjunction with the same as a part of the work under this contract.

## 1.8 CLEANING THE PREMISES

- A. The Contractor shall at all times keep the premises on which the work is being done, and the adjoining premises, clean of rubbish caused by his work. Upon completion of the job, the Contractor shall clean up all debris caused by his work and leave the job in a neat and clean condition. All debris removed from the job will be taken away from the premises.

## 1.9 WATER WELL AND PUMP

- A. General: The work specified in this section consists of drilling the hole, furnishing and installing casing, cementing the casing and installing the well head as located on the plans. The well shall be of the general design described herein. The well shall be constructed of PVC, Schedule 40, cased down to the limits shown on plan. All efforts shall be directed at preventing iron intrusion into the well.
- B. Well Construction: This well is to be drilled by the rotary method and shall be drilled in such a manner as to allow the collection of representative samples of the formations encountered. Well casings shall be of nominal Schedule 40 PVC and shall be installed and cemented in place. Upon completion of drilling, the well shall be developed by blowing air and allowing the well to flow until the water produced by the well is clear and free of drilling mud, sand, shell or cuttings, as per Florida State Specifications.

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- C. **Equipment and Personnel:** The Contractor shall furnish capable licensed personnel and equipment to construct the well by rotary drilling with reverse circulation. The Contractor's drilling rigs, tools, equipment and personnel shall be subject to the Owner's approval. The Contractor shall furnish the services of skilled and experienced drillers in the type of formations to be encountered along with the support of competent helpers. The drillers shall be capable of keeping good and clean well logs and reports of the drilling, developing and testing operations. The drillers shall also be capable of recognizing and making lithologic classifications of the formations encountered and know how to collect and handle representative formation samples. Contractor shall provide the drillers log to the Owner for record keeping.
- D. **Well Casings:** PVC pipe used for well casings shall be new Type 1 PVC. Pipe shall conform with ASTM Standard Specification D1785 or D2241 latest revision. The PVC casing pipe shall be joined watertight by solvent or fusion welding. Joining shall be in accordance with the manufacturer's recommendations for the material used. Joining of PVC to metallic pipe shall be made by means of a PVC socket to threaded adapter coupling. Installation of PVC casing by driving will not be permitted. The Contractor shall keep an accurate record of the size and length of the individual pieces of casing installed in the well.
- E. **Construction Operations:** The cost of furnishing and installing, or pulling out, any surface casing or pit casing which may be needed temporarily for the drilling operation of the well shall be included in the Contractor's unit price proposal for drilling. The well shall be drilled true, round, straight, and vertical throughout and shall be within two (2) degrees of plumb. Should the well fail to meet the requirements established by AWWA Standard A100-66, the plumpness and/or alignment of the well shall be corrected by the Contractor at his own expense. The Contractor shall take all necessary precautions to reduce to a minimum the nuisances of drilling wells and clean up the area surrounding the drilling operation, including mud spills. As described previously and as directed by the Landscape Architect, the well shall be constructed as an open-hole type with the exact depth to be established by actual conditions encountered in the field while drilling and when a satisfactory supply of water has been obtained. The well shall be cased down to the consolidated formation to be used as the water supply source. The bottom of the casing shall penetrate into the consolidated formation to effectively seal off all the water, sand or any other material from overlying formation.
- F. **Well Development:** The purpose of well development is to remove from the well, well walls, and from the formation immediately adjacent to the well, materials; such as mud, clay, fine particles of sand, shell or any other fine material. The Contractor shall furnish all necessary pumps, compressors, tools, piping, hoses, and any other equipment needed, and shall develop the well to obtain the maximum yield of water under a sand-free and turbidity-free condition while pumping the well continuously. Development work must be done in a manner that will not cause undue settlement or disturbance of the strata above the water bearing formation, or disturb the seal around the well casing. The water shall be considered sand-free when the samples taken during testing contain no more than one part per million of sand by weight.
- G. **Irrigation contractor shall provide and install submersible pump per plans. The irrigation contractor shall also furnish and install the necessary materials and equipment.**
- 1.10 **GUARANTEE:**
- A. The contractor shall guarantee that all materials, equipment, structures and work performed are free from defects in workmanship or materials for a period of one (1) year after installation and acceptance and, if any part of the work shall fail within this period, it shall be replaced and

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restored to production at no cost to the Owner. Undue reduction in yield, cave ins or settling around the well, pumping sand from the finished well after being placed in service, will be considered a defect to be covered by this Guarantee.

## 1.11 QUALIFICATIONS:

- A. Drawings and general provisions of the contract apply to the work of this Section.
- B. Subcontractor shall be a firm with not less than five (5) years' experience in the type of work specified in this Section, or provide satisfactory substitute evidence which the Owner, at its sole discretion, may accept.

## 1.12 CONCLUSIONS TO THE SPECIFICATIONS

- A. It has been our purpose in preparing these specifications to supplement the plans and to provide a sprinkling system which is complete in every detail. The alignment of the water line, as shown on the plans, is only approximate and may be changed at the time of construction in order to avoid trees, shrubs, plantings and/or other obstacles. It has not been our purpose in preparing these plans and specifications to make omissions and/or errors. Such omissions and/or errors, in either the plans or the specifications shall be corrected when called to our attention. Discrepancies of any sort shall not be taken advantage of, as harmony shall be preserved at all times so that construction can be pursued efficiently and rapidly in the letter and spirit of these specifications. The true intent and meaning of the same is that all work of every kind that may be necessary for completely finishing the work, rectifying failures, and delivering a complete job, be done. This is implied, although the same may not be specifically expressed.

END OF SECTION 328010



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## SECTION 328020 – IRRIGATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SCOPE OF WORK

- A. Provide an assembled and installed automatic irrigation system, including well and pump, which will efficiently irrigate 100% of all areas to be covered and shall prove satisfactory in all aspects to the Owner.
- B. The work contemplated by these specifications consists of the provisions of labor, materials, equipment, and services required for all work as described herein.
- C. Unless otherwise specified, the plans and specifications are intended to include everything obviously requisite and necessary for the proper installation and completion of the work whether each necessary item is mentioned herein or not.
- D. The plans and specifications are intended to be cooperative and any item called for in one and not the other shall be as binding as if called for in both.
- E. All work herein specified or called for on the drawings will be executed in accordance with all governing ordinances, laws and regulations that meet all local conditions. Additionally, any changes and/ or additions in the work necessary to meet these ordinances, laws, regulations and/or conditions will be made without additional cost to the Owner. It is understood that no additional compensation is to be made by the Owner for any items omitted from the plans that may be required to irrigate the areas indicated on the plans. The intent of the contract is for a complete finished job including all labor and materials.
- F. The alignment of the waterline, as shown on the plans, is only approximate and may be changed at the time of construction in order to avoid trees, shrubs, plantings and/or other obstacles.

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- G. Provide record drawings as specified in Section Record Drawings in paragraph 15.01 of this Section.

**1.3 DESCRIPTION OF THE SYSTEM**

- A. Layout and details of the system shall be as shown on the accompanying drawings.

**1.4 UTILITIES AND PROTECTIONS**

- A. The Owner shall make available to the Contractor all of the necessary information regarding the exact location of existing utilities, and shall mark the location of such utilities and/or any underground obstructions. The Contractor shall be liable for the damages to and the cost of repairing or replacing any buried conduit, cables, or piping encountered during the installation of the work, unless they were not marked or he was not previously informed of such underground utilities. If the Contractor is aware of such buried lines, he shall immediately have the incurred damages repaired at his own expense.

**1.5 ELECTRICAL INSTALLATION**

- A. The Contractor will be required to make connections to the electrical systems as is required for the proper operation of the automatic control system.
- B. All control circuitry, whether electrical or hydraulic, passing through a wall or slab or beneath a sidewalk, road, or drive, shall be installed in a suitable sleeve; whereas in all other locations they shall be installed in the pipe trench and protected by the pipe whenever possible.
- C. Sleeves shall be installed by the irrigation contractor.
- D. The joining of all underground wires shall be by the use of wire nuts, covered with Snap Tite and PT-S5 sealer per installation instructions provided by manufacturer or approved equal.
- E. Power for the pump station and automatic control system shall be brought to the vicinity of the pump station by the general contractor as indicated on the drawings.
- F. Controller: Power for the controller shall be brought to the vicinity of the controllers by the general contractor as indicated on the drawings.

**1.6 GROUNDING OF SYSTEM**

- A. Surge protection devices are not effective unless there is a good grounding electrode located at each control location. This ground rod must be capable of discharging a lightning strike containing several thousand volts and from 20,000 to 100,000 amperes, protecting the controller and solenoids from costly damage.

**1.7 EQUIPMENT, TOOLS AND LABOR**

- A. The Contractor shall furnish all such equipment, tools, and labor necessary to install work in an acceptable manner and to a speedy completion. This Contract is based on the Contractor furnishing equipment, tools and labor which are suitable to carry out this contract in a professional manner, unless otherwise herein specified.

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**1.8 CODES AND INSPECTIONS**

- A. The entire installation shall fully comply with all local and state laws and ordinances, and with all the established codes applicable there to.
- B. The Contractor shall take out all required permits, arrange for all necessary inspections and shall pay any fees and expenses in conjunction with the same as a part of the work under this contract.

**1.9 CLEANING THE PREMISES**

- A. The Contractor shall at all times keep the premises on which the work is being done, and the adjoining premises, clean of rubbish caused by his work. Upon completion of the job, the Contractor shall clean up all debris caused by his work and leave the job in a neat and clean condition. All debris removed from the job will be taken away from the premises.

**1.10 EXCAVATION AND BACKFILLING**

- A. The Contractor shall perform all necessary excavating and backfilling required for the proper installation of the work unless otherwise noted on the plans.
- B. On sodded areas, the Contractor will remove and replace the sod where possible from the trench area to the necessary width and depth required to facilitate his installations.
- C. When backfilling, all backfill material shall be free from rock, large stone or other unsuitable substances to prevent damage to the pipe. Backfilling of trenches containing plastic pipe and copper pipe shall be done when the pipe is cool to avoid excessive contraction in cold weather. And, all backfill material will be compacted to 6" layers as it is brought up to finish grade so as to insure that no settling results.

**1.11 EXISTING TREE PROTECTION**

- A. Comply with tree protection as specified.

**1.12 ROCK EXCHANGE**

- A. If rock is encountered in the alignment and depth shown on the plan, the alignment and/or depth shall be adjusted in order to avoid its excavation. If alignment and depth adjustment cannot be made and it becomes necessary to remove the same, the Contractor shall not receive additional compensation in the handling of it.

**1.13 DEPTH OF COVER**

- A. Minimum depth of cover over piping used as lateral water distribution piping down stream of a control valve, shall be 12"; whereas, control wires and main water distribution piping under continuous pressure, shall be 24".

**1.14 TESTING THE MAINLINE**

- A. The entire system shall be tested at the 100 psi pressure and upon visual inspection of the ground, should any leak be found, it shall be promptly repaired. The line shall then be re-tested until satisfactory.

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**1.15 RECORD DRAWINGS**

- A. After completion of all the piping installation and prior to final inspection, the Contractor shall furnish a record drawing showing all sprinkler heads, valves, drains, and pipelines to scale with dimensions where required. Instruction sheets and parts lists covering all operating equipment will be bound into a folder. One set to be furnished to the Landscape Architect for review and one set shall be provided to the Owner.

**1.16 INSTRUCTION**

- A. After completion and final inspection of the system, the Contractor will instruct the Owner's personnel in the proper operation and maintenance of the system.

**1.17 MATERIALS**

- A. The materials chosen for the design of the sprinkler system have been specifically referred to by the manufacturer so as to enable the Owner to establish the level of quality and performance required by the system design. Equipment by other manufacturers may be used only if approved by the Owner to allow him to evaluate the proposed substitution to assure that it is equal to the specified equipment.

**1.18 PVC PIPE**

- A. All PVC pipe specified on plan shall be virgin, high impact, polyvinyl chloride (PVC) pipe. All PVC pipe shall be continuously and permanently marked with manufacturer's name, material, size, and schedule or type. Pipe shall conform to U.S. Department of Commerce Commercial Standard CS 207-60, or latest revision. Material shall conform to all requirements of Commercial Standard (CS 256-63), or latest revision.
- B. All PVC pipe specified on the plans which shall be under constant pressure shall be Schedule 40 or Class 200 according to plan. All laterals and other distribution lines down stream of control valves shall be Schedule 40. All sleeves shall be Schedule 40.

**1.19 STEEL PIPE AND FITTINGS**

- A. Steel pipe shall be new, scale free, mild steel pipe and shall be standard weight schedule 40 galvanized pipe. Steel pipe fittings shall be heavy pattern, banded, galvanized malleable iron, threaded pipe fittings. All nipples shall be of the same material as the pipe and galvanized. Bushings, close nipples and crosses are not to be installed. Street elbows may be installed only as a part of the valve assembly.
- B. Pipe shall be carefully cleaned before installation. The ends of all threaded pipe shall be reamed out full size. Joints in all screwed piping shall be made by applying an approved oil base thread lubricant on the male thread only.

**1.20 POLYETHYLENE PIPE FITTINGS**

- A. Not Used.

**1.21 PVC PIPE FITTINGS**

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- A. PVC solvent weld, all Schedule 40 belled pipe fittings, PVC saddles or compression type fittings as specified on plan.
- 1.22 SPRINKLER RISER OFF POLYETHYLENE PIPE
  - A. Not Used.
- 1.23 SPRINKLER RISER OFF PVC PIPE
  - A. Not Used
- 1.24 MANUAL VALVES
  - A. Manual valves shall be as specified on plan.
  - B. Gate valves for use with 4" and 6" PVC shall be ring-tite, double disc, cast iron, brass trimmed, conforming to A.W.W.A. Specifications for Class 150 valves equipped with a 2" square head operating nut.
- 1.25 ELECTRIC REMOTE-CONTROL VALVES
  - A. Valves for use in electrically controlled automatic control systems shall be diaphragm actuated and hydraulically operated solenoid valves as specified on the plans and as manufactured by the Rainbird or approved equal.
  - B. All valves shall be installed in valve boxes of an appropriate size and type as detailed on the plan.
- 1.26 PRESSURE REGULATOR VALVE
  - A. Pressure Regulating Valve as specified on the plans and as manufactured by the Rainbird or approved equal.
  - B. All valves shall be installed in valve boxes of an appropriate size and type per details.
- 1.27 VALVE BOXES
  - A. Valve boxes shall be Ametek heavy duty plastic valve pit with evergreen cover or approved equal.
- 1.28 VALVE OPERATING KEYS
  - A. The Contractor shall provide two sets of all the valve operating keys required to properly operate the system.
- 1.29 COMMUNICATION CIRCUITRY
  - A. Electric: 24 volt electric control lines from controller to automatic valves shall be direct burial UF wire of a different color than the 110 volt service to controllers. The 24 volt common ground shall be of one continual color and a different color than the other 24 volt lines and the 110 volt service. All wire shall be furnished in minimum 2500' reels and splicing shall be minimized, with such splices made water proof with the use of waterproof Snap Tite and PT-S5 sealer. All 24 volt wiring shall be done in accordance with existing codes and sized to properly operate valves.

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Two wire irrigation system shall not be used without Owner's approval prior to bidding.

## 1.30 POP UP SHRUB AND LAWN SPRINKLER HEADS

- A. All full and part circle sprinklers shall be of the fixed spray or gear driven variety as is specified on the plans. These sprinklers shall be of the pop-up type with spring retraction. The body of the sprinkler shall be constructed of Cyclac Material and the sprinkler shall be easily serviced from the top. It shall have an accessible screening device and shall perform to the manufacturer's specifications with regard to the diameter of throw and gallons at a given pressure. Spacing of heads shall not exceed the manufacturer's maximum recommendation.
- B. Matched precipitation will be required on all full and part circle sprinklers operating

## 1.31 EMITTER PIPE

- A. Not Used.

## 1.32 FIXED SHRUB SPRINKLER HEADS

- A. Not used.

## 1.33 CONTROL EQUIPMENT

- A. Automatic controllers shall be as specified on the plans approved equal. Each station shall have an independent time control with up to 60 minutes maximum per station. Changes on station timing and program start time shall be easily made without interfering with set program. The controller operation shall provide for rapid advance between stations and a manual override on each station for manual operation. The controller shall provide for schedules up to 2 weeks and permit multi-cycle operation as often as three (3) times per day.
- B. The controller shall be capable of operating 24 V.A.C. electric remote control valves.

## 1.34 QUICK COUPLING VALVES AND KEYS (If Applicable)

- A. Quick coupling valves and keys shall be specified on the drawings.

## 1.35 GROUNDING DEVICES

- A. An 8' copper clad rod, 5/8 diameter shall be driven at each controller location. This rod must have a resistance of 25 ohms or less to the ground in which it is driven.
- B. If soil conditions prevent a driven rod or resistance to earth is too high, one of the following methods may be used:
  - 1. Subsoil 150' or more bare copper wire into an irrigated area. Wire should be at least one gauge larger than any single wire at the controller location. Wire must be buried at least 6" to 8" deep to avoid damage from aeration equipment. Soil must be packed tight around the wire for good contact to the earth.
  - 2. Copper plates 1/8" x 18" x 24" or larger when rods cannot be driven.

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- C. For grounding the 24-volt secondary loop from the field controller to the valves, use Toro Part # 991-03 surge protection device with 12 arrestors (or approved equal).
- D. The Controller shall be responsible for grounding the system to the minimum requirements of the manufacturer in order to comply with the manufacturers warranties.

## 1.36 EXECUTION

### A. System Design:

- 1. Location of Heads: Design location is approximate. Make minor adjustments as necessary to avoid plantings and other obstructions.
- 2. Minimum Water Coverage:
  - a. Turf areas, as shown on plans.
  - b. Planting areas, as shown on plans.
- 3. Layout may be modified, if necessary to obtain coverage, to suit manufacturer's standard heads. Do not decrease number of heads indicated unless otherwise acceptable to the Landscape Architect.

### B. Trenching and Backfilling:

- 1. General: Excavate straight and true with bottom uniformly sloped to low points.
- 2. Trench Depth: Excavate trenches to a depth of 3" below invert of pipe, unless otherwise indicated. Do not pull pipe as method of installation.
- 3. Minimum cover: Provide the following minimum cover over top of installed piping:
  - a. PVC Piping: Mainline 24"  
Lateral Lines 12"  
Lateral lines in Bermuda Fields 18"
- 4. Backfill: Backfill with clean material from excavation. Remove organic material, as well as, rocks and debris larger than 1" diameter. Place acceptable backfill material in 6" lifts, compacting each lift.

### C. Installation:

- 1. General: Unless otherwise indicated, comply with requirements of Standard Plumbing Code.
- 2. Circuit Valves: Install in valve box, arranged for easy adjustment and removal.
  - a. Provide union on downstream side.
  - b. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.
- 3. Pipe Sleeves: Shall be taped at the ends prior to installation. Following installation of the irrigation lines the end cavities shall be filled with self expanding foam spray to prevent excessive soil from washing into pipe sleeve. The Irrigation Contractor shall be responsible for the proper placement of sleeving necessary for the installation of the system.
- 4. Piping: Lay pipe on solid subbase, uniformly sloped without humps or depressions.

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- a. At wall penetrations, pack the opening around pipe with non-shrink grout. At exterior face, leave a perimeter slot approximately 1/2" wide by 3/4" deep. Fill this slot with backer rod and acceptable elastomeric sealant. Repair below grade waterproofing disturbed by this work and make penetration watertight.
  - b. Install PVC pipe in dry weather when temperature is above 40°F (4°C) in strict accordance with manufacturer's instructions.
  - c. Allow joints to cure at least 24 hours at temperature above 40° (4°C) before testing, unless otherwise recommended by manufacturer.
5. Installation of Identification: During backfilling operations over all main lines, install continuous underground-type plastic line markers, located directly over buried lines of 6" to 8" below finish grade.
  6. Sprinkler Heads: Flush circuit lines with full head of water and install heads after hydrostatic test is completed.
    - a. Install lawn heads at manufacturer's recommended heights.
    - b. Locate part-circle heads to maintain a minimum distance of 6" from walls and other boundaries, unless otherwise indicated.

## D. Testing:

1. General: Notify Architect/Engineer in writing when testing will be conducted. Conduct tests in presence of Architect/Engineer.
2. Hydrostatic Test: Test water piping and valves, before backfilling trenches, to a hydrostatic pressure of not less than 100 psi for two hours. Piping may be tested in sections to expedite work. Remove and repair piping, connections, valves which do not pass hydrostatic testing. Minimal coverage can be placed over piping to hold piping in place prior to testing.
3. Operational Testing: Perform operational testing after hydrostatic testing is completed, backfill is in place, and sprinkler heads adjusted to final position.
  - a. Demonstrate to Landscape Architect that system meets coverage requirements and that automatic controls function properly.
  - b. Coverage requirements are based on operation of one circuit at a time.
4. After completion of grading, seeding or sodding, and rolling of grass areas, carefully adjust lawn sprinkler heads so that they will be flush with finish grade and excessive overthrows are corrected.

## 1.37 INSTRUCTIONS

- A. After completion and final inspection of the system, the Contractor will instruct the Owner's personnel in the proper operation and maintenance of the system.

## 1.38 SUBMITTALS

- A. Certification: Submit certificates of inspection as required by governmental authorities and manufacturers that materials comply with specified requirements.
- B. Implementation Schedule: Submit a schedule showing times per week per zone. Coordinate this schedule with the Landscape Contractor so that damage to plant materials is avoided.



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- C. Maintenance Instruction: Submit typewritten instructions recommending procedures to be established by the Owner for maintenance of the system. Submit prior to the expiration of the required maintenance period(s).

1.39 PUMPS

- A. Contractor shall furnish and install pumps and controls as shown on plans or approved equal

1.40 GUARANTEE

- A. The contractor shall guarantee that all materials, equipment, structures and work performed are free from defects in workmanship or materials for a period of one (1) year after installation and acceptance and, if any part of the work shall fail within this period, it shall be replaced and restored to production at no cost to the Owner. Undue reduction in yield, cave ins or settling around the well, pumping sand from the finished well after being placed in service, will be considered a defect to be covered by this Guarantee.

1.41 QUALIFICATIONS

- A. Drawings and general provisions of the contract apply to the work of this Section.
- B. Subcontractor shall be a firm with not less than five (5) years experience in the type of work specified in this Section, or provide satisfactory substitute evidence which the Owner, at its sole discretion, may accept.

1.42 CONCLUSIONS TO THE SPECIFICATIONS

- A. It has been our purpose in preparing these specifications to supplement the plans and to provide a sprinkling system which is complete in every detail. The alignment of the water line, as shown on the plans, is only approximate and may be changed at the time of construction in order to avoid trees, shrubs, plantings and/or other obstacles. It has not been our purpose in preparing these plans and specifications to make omissions and/or errors. Such omissions and/or errors, in either the plans or the specifications shall be corrected when called to our attention. Discrepancies of any sort shall not be taken advantage of, as harmony shall be preserved at all times so that construction can be pursued efficiently and rapidly in the letter and spirit of these specifications. The true intent and meaning of the same is that all work of every kind that may be necessary for completely finishing the work, rectifying failures, and delivering a complete job, be done. This is implied, although the same may not be specifically expressed.

END OF SECTION 328020

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## SECTION 329000 – PLANTS & LANDSCAPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SCOPE OF WORK

- A. This section covers furnishing and installing all landscape plants and non- plant materials covered by the drawings and these specifications. The work shall include materials, labor, equipment and services as described herein and indicated on the drawings. Also, the work shall include the maintenance of all plants and planting areas until acceptance by the OWNER, and the fulfillment of all guarantee provisions as herein specified.

#### 1.3 PLANTING LAYOUT

- A. Before beginning work, the Contractor shall investigate and verify, in the field, the existence and location of all underground utilities and irrigation piping, and take precautions to prevent their disturbance. It shall be the responsibility of the Contractor to obtain all such information as it is made available. Plans and specifications of related work may be obtained from the OWNER.
- B. The Contractor shall locate all general reference points; take precautions to prevent their disturbance; perform the layout work; be responsible for all lines, elevations and measurements of work executed under the contract; exercise proper precaution to verify figures on drawings before laying out work; and be responsible for any error resulting from failure to exercise such precaution. The Contractor shall make field measurements for his own work and be responsible for its accuracy.
- C. Discrepancies between conditions existing on the site and conditions indicated on the drawings shall be called to the attention of the OWNER before or at the time plant locations are staked out.

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- D. In the event of a variation between the plant list and the actual number of plants shown on the plans, the plans shall control.

## 1.4 HORTICULTURAL STANDARDS

- A. Unless otherwise noted, plant material, including collected materials, shall be grade FLORIDA NO. 1 or better as outlined under Grades and Standards for Nursery Plants, Parts I and II, State Plant Board of Florida; and shall also conform to American Standard for Nursery Stock, ANSI (American National Standards Institute, Inc.) Z60.1-1986 as approved by the American Association of Nurserymen. Trees shall be grown by a certified "Roots Plus" Grower.
- B. All plant names shall conform to the names given in Standardized Plant Names, 1942 Edition, prepared by the American Joint Committee on Horticultural Nomenclature. Names of varieties not included therein shall conform generally with names accepted in the nursery trade. All plant materials shall be true to botanical, common and variety name. Botanical name shall have precedence over common name.
- C. The OWNER shall have the right, at any stage of the operations, to reject any and all work and materials which, in his opinion, do not meet with the requirements of these Specifications. Such rejected material shall be removed from the site and acceptable material substituted in its place.

## 1.5 CERTIFICATES OF INSPECTION

- A. All plant material shall be inspected by the Florida Department of Agriculture, as required by state law. Plants of a grade less than that specified in the article titled HORTICULTURAL STANDARDS will not be accepted.

## PART 2 - NONPLANT MATERIALS

### 2.1 SOIL BACKFILL

- A. If additional soil is required, it shall be furnished by the Contractor and shall be a natural, friable soil representative of productive, well-drained soils in the vicinity. It shall be obtained from well-drained areas which have never been stripped before; and shall be free of admixture of subsoil and foreign matter, stones, toxic substances, and any material or substance that may be harmful to plant growth soil shall be modified with the existing surface soil, free from subsoil, objectionable weeds, litter, sods, stiff clay, stones, stumps, roots, trash, toxic substances, mortar, cement, or any other material which may be harmful to plant growth or hinder planting operations. Poorly drained soil shall not be used.
- B. Soil amendments shall be added to the soil in the amount and manner prescribed by soil analysis to obtain a pH of 5.5 to 6.5. Results from soil analysis and a list of the prescribed amendments shall be presented to the Owners Representative prior to being incorporated into the soil.
- C. The Contractor shall provide the following information on imported topsoil:
  - 1. Specific location from which topsoil will be (or was) stripped.
  - 2. Present to the OWNER that property owner's approval.
  - 3. Approximate amount of topsoil available.
  - 4. Test results showing topsoil composition and analysis.

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- D. Soil test shall be performed by a qualified soils laboratory, in accordance with "Methods of Soils Analysis - Agronomy #9" as published by the American Society of Agronomy, and shall be performed at the Contractor's expense.

**2.2 FERTILIZER**

- A. Commercial fertilizer shall be 14-14-14 formulation of Osmocote brand, 3-4 month release of which 60 percent of the nitrogen is in urea-formaldehyde form and shall conform to the applicable state fertilizer laws. Fertilizer shall be uniform in composition, dry and free flowing. All fertilizer shall comply with local fertilizer ordinances.

**2.3 PRE-EMERGENCE WEED CONTROL**

- A. Weed control shall be Ronstar 2G as manufactured by Rhodia, Inc., Monmouth Junction, New Jersey 08852 or Princep (Simazine) as manufactured by Geigy Agricultural Chemicals, Ardsley, New York 10502, or an approved equal.

**2.4 WATER**

- A. Water will be available for use on site during the landscape installation via the irrigation system at no cost to the Contractor. Care shall be exercised to assure that water is kept free of harmful chemicals, acids, alkalis, or any substance which might be harmful to plant growth.

**2.5 ANTIDESICCANT**

- A. Antidesiccant shall be an emulsion type, film-forming agent designed to permit transpiration, but retard excessive loss of moisture from plants, such as Dowax by Dow Chemical Co., or Wilt-Pruf by Nursery Specialty Products, Inc., or an acceptable equal. The antidesiccant shall be delivered in the manufacturer's fully identified containers and shall be mixed in accordance with manufacturer's instructions.

**2.6 MULCH**

- A. All mulch shall be shredded mulch, 100 percent organic, fibrous type, Grade "B", or better. Alternative mulch types, if so identified on the drawings, shall be used.

**2.7 GUYING AND STAKING MATERIAL**

- A. Stakes for supporting trees shall be as detailed on the drawings. Wire for fastening trees to duckbill and turnbuckle shall be galvanized aircraft grade guying cable as specified in the detail. Wires in contact with trees shall be encased in two-ply reinforced garden hose.

**2.8 DRAINAGE GRAVEL**

- A. Where indicated on the drawings, or where soil conditions deem it necessary, the Contractor shall install gravel subdrains beneath trees and/or planting areas to aid in soil drainage and percolation. The subdrain shall be constructed as detailed on the drawings, or as directed by the Landscape Architect. Drainage gravel shall consist of washed, clean gravel 3/4 inch to 2 inches in size.

**PART 3 – PLANT MATERIAL**

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## 3.1 QUALITY OF PLANT MATERIAL

- A. The Contractor shall submit photograph of plant material for approval by the Landscape Architect.
- B. During inspection, as set forth hereinafter all plant material will be judged, and rejections shall be based upon these standards. All plants shall comply with federal and state law requiring inspection for plant diseases and infestations. Inspection certificates required by law shall be made available to the OWNER or the OWNER's Representative at his/her request.
- C. In determining the quality of plant material, the following elements will be valued:
  - 1. Root condition
  - 2. Plant size (above ground)
  - 3. Insect and disease free condition
  - 4. General appearance (color, shape, pruning)
  - 5. Trees not self-supporting will be rejected.
  - 6. A deficiency in one or more of these areas will be sufficient reason to reject selectively or by lot.
- D. The Landscape Architect and/or Owner shall have the right, at any stage of the operations, to reject any and all work and materials which, in his opinion, do not meet with the requirements of these Specifications. Such rejected material shall be removed from the site and acceptable material substituted in its place.

## 3.2 SIZE AND MEASUREMENTS

- A. Plants shall be measured when branches are in their normal position. Heights and spread dimensions specified refer to the main body of the plant and not to extreme branch tip to tip. The measurements specified are the minimum size acceptable and where pruning is required, these are measurements after pruning. When sizes are indicated as a range, the plant shall have the proper proportion as outlined in Florida Department of Agriculture, Grades and Standards for Nursery Plants Part I and II.
- B. Plants which have been headed back to conform to the size specified will not be acceptable. Plants larger than specified may be used if approved by the OWNER; however, the use of such plants shall not increase the contract price. Should replacement of larger trees be required, replacement size shall match size installed.

## 3.3 LABEL

- A. Plant materials shall have durable, legible labels stating, in weather resistant ink, the correct botanical and common names and size as indicated in the Plant List. Each plant, or sufficient representative samples of each delivered shipment, shall have labels securely attached in a fashion that will not interfere with normal plant growth. Plant materials which have (or will have) a seasonal bloom shall be tagged with labels indicating the specific variety of that species' botanical and common name.

## 3.4 BALLED & BURLAPPED & WIRE BALLED & BURLAPPED PLANTS

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- A. All ball sizes shall be of a diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant after planting. All balls shall be firm, shall not be broken or cracked, and shall be wrapped and securely tied with heavy twine or wire. All trees shall be root pruned a minimum of 6 weeks before delivery.
- B. When the tree is root pruned, the tree crown shall be selectively thinned to reduce the volume of the crown. This shall consist of thinning and shaping only. Care shall be taken to assure that the plant form will not be distorted and will remain typical of the species growth characteristics.
- C. Plants designated B&B or WB&B in the Plant List shall be adequately balled with firm, natural balls of soil in sizes at least equal to those set forth in ANSI Z60.1-1986. Balls shall be firmly wrapped with jute burlap or equivalent cloth capable of rotting in the ground.
- D. No balled plant shall be planted if the ball is cracked, mushroomed, or broken either before or during the process of planting. Trees grown in grow bags shall not be acceptable. Synthetic strings, straps, and burlap material shall be properly removed from the root ball. Synthetic burlap is to be totally removed from the root ball.

## 3.5 COLLECTED PLANTS

- A. All plant material (except Wax Myrtles and Sabal Palms) shall be nursery grown. Collected plants shall have been grown under climatic conditions similar to those in the locality of the project. All collected plants shall meet the requirements as specified and shall meet all specified grades and standards, unless otherwise qualified in the Plant List or these specifications. Root balls shall be increased in size one third greater than nursery grown plants.

## 3.6 CONTAINERIZED PLANTS

- A. All container grown plants shall be well rooted and established in the container in which they are delivered to the site. The plants shall have been in that container sufficiently long for the fibrous roots to hold the soil together when the plant is removed from the container. Plants designated to be container grown may be furnished with ball and burlap provided they conform to the size and quality required and that the requirements for balled and burlapped plants are met. Container grown plants found to be root-bound during planting will not be acceptable. Containerized trees have a tendency to dry out quickly. The Contractor shall be responsible for hand watering the trees at time of delivery through the time of final acceptance at a rate consistent with the nursery watering schedule to assure that the tree does not go into shock.

## 3.7 SPECIMEN PLANTS

- A. After receiving the Notice to Proceed, the Contractor shall locate all plants specified as specimen. The Contractor shall notify the OWNER so they may agree on a time to mutually inspect the selected plants. The OWNER will inspect and tag those plants which are acceptable for use. Expenses incurred by the OWNER for any subsequent inspection of specimen plants, at any time, in addition to the mutually agreed time, shall be the responsibility of the Contractor.

## 3.8 PALMS

- A. Palms, except cabbage palms and unless otherwise indicated, shall be burlapped. Buds of palms shall be tied and supported in an upright position in accordance with the guidelines of Florida Department of Agriculture, Grades and Standards for Nursery Plants, Part II, Palms and Trees.

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- B. Special care shall be applied to the handling and planting of palms. Unless otherwise indicated, palms shall have heavy straight trunks with full heads. Sabal palm root balls shall be dug with a minimum of 3' diameter ball 3' deep. The head shall be tied and supported during transport with a 2x4 tied parallel to the trunk extending up to the foliage. Avoid excessive pressure on the petioles when tying the head. Hurricane cuttings of Palms shall be acceptable.

## 3.9 SUBSTITUTIONS

- A. The use of materials differing in kind, quality or size from those specified will be allowed only after the OWNER is convinced that all means of obtaining the specified materials have been exhausted.
- B. Where it is indicated that the Contractor may furnish or use a substitute that is equal to the material or equipment specified and if the Contractor is to furnish or use a proposed substitute, he shall, make written application to the OWNER for acceptance of such a substitute. The substituted product or method shall be equal or superior in all respects to the specified product or method, shall perform adequately the duties imposed by the general design, shall be compatible with all other elements of the job, and shall be sufficient to complete the job. The substitution shall not add cost to the contract. Should it be necessary to accept a substitute of a size less than specified, the unit price shall be used to adjust the contract price downward accordingly. No substitution shall be ordered or installed without the written permission of the OWNER.

## PART 4 - DELIVERY, STORAGE AND HANDLING

### 4.1 PLANT MATERIAL

- A. The Contractor shall exercise care in handling, loading and unloading, storage and transporting all plant material and allied materials to prevent damage. The Contractor shall assume full responsibility for protection and safekeeping of products stored on the job.
- B. The Contractor shall dig and prepare B&B and WB&B plant material for shipment in a manner that will not damage roots, branches, shape and future development after planting.
- C. Trees indicated on the plans as WB&B and those where size, soil conditions and distance of transport to the site would warrant, shall be wireballed. Bottom wired baskets manufactured specifically for use in tree handling may be used.
- D. The Contractor shall handle all plants so that roots and branches are protected at all times from drying out, heating and from other injury. All plants shall be handled by the ball or container.
- E. Before moving plants from the nursery or storage area to the site, they shall be thoroughly sprayed with a solution of antidesiccant. Antidesiccant shall be applied to all collected pines, oaks and myrtle's. Two weeks after planting, or as specified by the product manufacturer, the material shall be sprayed again with the antidesiccant. The antidesiccant shall be applied using power spray to provide an adequate film over trunks, branches, stems, twigs and foliage.
- F. When transporting plants to and at the site, the Contractor shall make provisions to protect plants from wind damage by avoiding high-speed highways, transporting in enclosed or partially enclosed vehicles, or covering the plants with burlap or other suitable material. Plants severely damaged by wind will be rejected.



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- G. Any plant with signs of insects, their eggs or larvae, or disease will be rejected and shall be removed from the project site.
- H. Only the nursery stock intended for planting on a particular day shall be delivered and stored on the site during the day unless otherwise acceptable to the OWNER. All plants shall be stored in one location as designated by the OWNER, protected from wind and kept moist. The roots of all plants that cannot be planted immediately in soil shall be covered with mulch and other suitable material. No plants shall be taken from the temporary storage area for planting on the project until after the tree pits or holes for the plants in the section to be planted have been properly excavated and prepared ready to receive the trees and shrubs.
- I. Trees moved by mechanical means shall be thoroughly protected from chain marks, girdling, or other bark slippage by means of burlap, wood battens or other acceptable method.

## 4.2 NONPLANT MATERIALS

- A. Fertilizer shall be delivered to the site in original, unopened containers bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law. In lieu of containers and provided that it is to be applied at the time of delivery, fertilizer may be furnished in bulk, and a certificate indicating the above information shall accompany each delivery.
- B. Pesticide and herbicide materials shall be delivered to the site in the original, unopened containers. Containers that do not have a legible label that identifies the Environmental Protection Agency registration number and the manufacturer's registered uses will be rejected.
- C. Storage of materials shall be in the area designated for use by the OWNER. All materials shall be kept in dry storage and away from contaminants.

## PART 5 - INSTALLATION

### 5.1 PREPARATION BEFORE PLANTING

- A. The Contractor shall verify that final grades have been established prior to beginning planting operations. All unsatisfactory grading shall be reported to the OWNER, and the Contractor shall not proceed with the work until the unsatisfactory conditions have been corrected. When conditions detrimental to plant growth are encountered, such as rubble, fill or adverse drainage conditions, the Contractor shall notify the OWNER for directions.
- B. Planting areas shall be weed free prior to installation. Should undesirable existing vegetation be present on the site at the time of installation, the Contractor shall prepare the site for planting by use of chemicals, when used as recommended by the manufacturer, and/or mechanical means acceptable to the OWNER.
- C. Care shall be exercised to avoid any misuse of chemicals which would create detrimental residual conditions. Care must also be used not to alter final grades which have been established or cause damage to previously established turf areas.

### 5.2 SITE PREPARATION

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- A. If so called for by the OWNER, all plant locations and the areas of all planting beds shall be staked out on the ground, for acceptance by the OWNER, before planting operations begin. The Contractor shall stake the location of the center of each tree and paint the outline of each shrub and ground cover bed. The stakes shall be oriented in a vertical manner so that they can be viewed and read from one direction. The Contractor shall give the OWNER notice 24 hours prior to the completion of staking described herein.
- B. The Contractor shall verify the location of underground utilities, and irrigation heads and valves, and provide markers or other suitable protection, where necessary, to prevent damage.

## 5.3 EXCAVATION OF PLANTING AREAS

- A. No tree or shrub pit shall be dug or prepared until their location is acceptable to the OWNER. Reasonable care shall be exercised to have pits dug and soil prepared prior to moving plants to their respective locations for planting to ensure that they will not be unnecessarily exposed to drying elements or to physical damage.
- B. Circular pits with vertical sides shall be excavated for all plants. The depth of all plant pits shall be enough to accommodate the ball or roots and the prepared soil in the bottom of the pit. Diameter of pits for trees shall be at least 1 foot greater than the diameter of the ball.
- C. Plant beds and pits shall be tested for proper drainage by filling with water twice in succession. Conditions permitting the retention of more than 6 inches of water in 1 hour shall be brought to the attention of the OWNER.
- D. All tree pits in curbed planting islands, tree wells, or in areas in which the soil has been compacted to an undesirable density, shall be excavated to a depth at least two feet greater than the measured depth & diameter of the ball. The minimum depth & diameter of an excavation shall be four feet. Soil backfill in areas of densely compacted soil must meet specification 2.1.C. It is the Contractor's responsibility to dispose of the unsuitable soil to an approved location. All base rock shall be removed from parking planting islands.
- E. In shrub and ground cover beds where soils have been compacted to a density, which is detrimental to plant growth, the Contractor shall loosen soils to a depth of 18" minimum to allow root penetration beyond the planting pit.
- F. If acceptable for use, existing topsoil in shrub and ground cover beds shall be treated with the specified soil amendments, at rates determined by soil tests. Amendments shall be incorporated into the soil to a depth of 12 inches. Where soil is not acceptable as determined by soil tests, the soil in the entire area shall be removed to a depth of 12 inches and replaced with the specified planting soil.

## 5.4 PLANTING

- A. All plants, except as otherwise specified, shall be centered in their pits, faced for best effect and set plumb for backfilling.
- B. Burlap on B&B and WB&B plants shall be removed from top one third of the ball. Burlap shall not be removed from under balls. If the ball is cracked or broken before or during planting process, the plant shall not be planted and shall be removed from the site. All synthetic strings, straps, and

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wire cages shall be removed from the top third of the root ball. Synthetic burlap shall be removed completely.

- C. Plants shall be removed from cans by cutting two sides of a container with an acceptable can cutter. Sides shall not be cut with a spade. Sides of knockout cans shall not be cut. Plastic containers with slanted sides shall not require cutting. Plants shall be removed from the container carefully, without injury or damage to the plant and root system.
- D. Bottom of plant boxes shall be removed before planting. Sides of the box shall be removed, without damage to the root ball, after positioning the plant and partially backfilling around it. The Contractor shall hand water containerized trees from the time of delivery until the time of final acceptance at a rate consistent with the nursery conditions from which the trees were obtained. Trees which go into shock due to insufficient water may be rejected.
- E. Plants shall be set in the center of pits and shall be plumb and straight and at such a level that after settlement the root crown will be level with the surrounding grade.
- F. Plant holes shall be backfilled with the specified planting mixture placed in layers around the roots or ball. Each layer shall be carefully tamped in place in a manner to avoid injury to the roots or ball or disturbing the position of the plant. When approximately two thirds of the plant hole has been backfilled, the hole shall be filled with water and the soil allowed to settle around the roots. Balled and burlapped plants shall have the burlap cut away or folded back from the top of the ball before applying the water. After the water has been absorbed, the plant hole shall be filled and tamped lightly to grade. Any subsequent settlement shall be brought to grade.
- G. Immediately after each tree pit is backfilled, a shallow basin slightly larger than the pit shall be formed with a ridge of topsoil to facilitate watering. This soil saucer shall be formed in a circle and tamped around each tree so that the saucer will retain water. Where curbing occurs around plant pits, the saucer shall be omitted.

## 5.5 FERTILIZING

- A. Each tree and shrub shall be fertilized by placing the manufacturer's recommended amount around the base of the ball before backfilling.

## 5.6 STAKING, GUYING AND WRAPPING

- A. Staking or guying and wrapping of trees shall be done immediately after they are planted. Each plant shall stand plumb after staking or guying has been completed. It shall be the Contractor's responsibility to ensure that all trees are plumb and secure after planting. Staking of trees of a 10 foot height or less shall be at the discretion of the Contractor, however, the contractor shall be responsible for ensuring trees are upright. Nursery center bamboo stakes and tape shall be removed prior to staking. All other trees shall be staked.
- B. Immediately after planting, trees shall be staked and guyed for support. "Duck-bill" or approved equal earth anchors as indicated shall be placed at sides of each tree, and shall be driven into undisturbed ground to a depth deep enough to sufficiently secure the tree. Care shall be taken when driving anchors to avoid damaging the tree roots. Except as otherwise indicated or directed, the tree shall be fastened to each anchor as indicated on the plans. The wires shall be encased in hose at the tree to prevent direct contact with the bark and shall be placed around the trunk in a single loop. Wires shall be tightened and kept taut by twisting the turnbuckle. A brightly colored

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flagging tape approximately 12" in length shall be securely tied to each guy wire immediately above the turnbuckles.

- C. All tree staking to be within limits of tree mulch ring.

## 5.7 MULCHING

- A. Immediately after planting operations are completed, all tree and shrub saucers, and shrub and groundcover beds shall be covered with a 3inch layer of mulch. Limits of the mulch shall be as indicated on the drawings and with a minimum of a 4' diameter for all trees.
- B. Pre-emergent weed control shall be applied to all planting beds and tree saucers prior to planting.

## 5.8 PRUNING

- A. Each tree and shrub shall be pruned in accordance with standard horticultural practice to preserve the natural character of the plant and in the manner fitting its use in the landscape design. Pruning shall be done with clean, sharp tools and as indicated on the drawings.

## 5.9 CLEANUP

- A. During the course of planting, excess and waste materials shall be continuously and promptly removed daily, lawns kept clear and all reasonable precautions taken to avoid damage to existing structures, plants and grass. After completion of the work, the entire site shall be cleared of excess soils, waste material, debris and all objects that may hinder maintenance and affect the visual appearance of the site.
- B. Contractor shall clean all roads and walks of dirt film and soil clods.

## 5.10 DISTURBED AREAS

- A. All areas outside of the limits of work that are disturbed by the Contractor's construction activities shall be repaired and replanted to its original condition.

## PART 6 - GUARANTEES

### 6.1 GUARANTEED PROVING PERIOD

- A. There shall be a guarantee period of 1 year for trees and palms and 90 days for shrubs. This guarantee period shall start at the final acceptance date. Contractor shall replace any and all plant material that die or exhibit excess dieback during this guarantee proving period. Replacement of plants necessary during the guarantee period shall be the responsibility of the Contractor, except for possible replacements of plants resulting from removal, vandalism, acts of neglect on the part of others, or acts of God. All replacement material shall have the same guarantee time.
- B. Planting maintenance shall include all necessary watering, cultivation, weeding, pruning and spraying; wrapping and mulching; straightening of plants which lean or sag and which develop more than a normal amount of settlement; such adjustments to include excavating around and leveling or raising the ball when so directed; and all other incidental work necessary for proper maintenance as directed by the OWNER until final completion and written release.

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**6.2 FINAL INSPECTION AND ACCEPTANCE**

- A. The Contractor shall notify the OWNER in writing when the work has been completed in accordance with this Contract and request an inspection. The OWNER will make the inspection of the work and report findings as to acceptability and completeness. Any work remaining to be done shall be subject to re-inspection before final acceptance. The Contractor will be notified in writing by the OWNER of the final acceptance of the work.

**6.3 CONTRACTOR'S RESPONSIBILITY AFTER ACCEPTANCE**

- A. The OWNER may elect to assume maintenance of all work, at the time of acceptance, or may elect to contract for maintenance. Should maintenance after final acceptance be the responsibility of those other than the Contractor, the Contractor shall monitor all work for which he is responsible by guarantee, to assure that maintenance being performed will not jeopardize the condition and quality of the work and materials guaranteed by the Contractor. Any inadequate or damaging maintenance practices shall be reported immediately in writing to the OWNER so that appropriate measures may be taken to correct the condition. Failure to so notify the OWNER will invalidate any later claim of negligence or malpractice in maintenance.

**6.4 ACCEPTANCE AND REPLACEMENT OF PLANT MATERIAL**

- A. Prior to the expiration of the warrantee period, an inspection of the plantings will be made by the OWNER. Only those plants that are alive and normally healthy will be accepted. Unaccepted material shall be removed and replaced by the Contractor at his own expense. Material and method of replacement planting shall be the same as specified for the original planting unless otherwise directed. The Contractor shall continue to make replacements until a plant shows vigorous and healthy growth for a period of 1 year from the date of acceptance by the OWNER. All such replacements will be inspected for acceptance at the end of the proving period by the OWNER.

END OF SECTION 329000

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## SECTION 329223 – SODDING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections apply to this Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SCOPE

- A. The Scope of Work includes all sod, material, equipment, and labor necessary for installation of sod indicated on the drawings and/or in the Specifications herein.
- B. Grades: It shall be the responsibility of the Contractor to finish (fine) grade (Top 4") all sod areas, eliminating all bumps, depressions, sticks, stones, and other debris to the satisfaction of the Landscape Architect, prior to the application of sod. If supplemental topsoil is to be spread, no sod shall be laid until the depth of this soil has been approved. Any sod installed in areas not approved prior by the Landscape Architect may be removed, regraded, and re-installed at the Contractor's expense.

#### 1.3 GENERAL:

- A. Description: Provide sodded lawn areas as shown and specified. Work under this Section shall comply with all Division 1 Requirements and Special Provisions. Furnish all labor, materials, and equipment to conduct the following.
  - 1. Soil Preparation
  - 2. Fine Grading
  - 3. Sodding
  - 4. Maintenance
- B. Related Work:
  - 1. Section 329000: Plants and Landscaping
  - 2. Section 328020

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3. All other site work related provisions, Sections, and specifications.

C. Quality Assurance:

1. Sod: Comply with American Sod Producers Association (ASPA) classes of sod materials.

D. Submittals:

1. Submit sod growers certification of grass species. Identify source location.
2. Upon sodded lawn acceptance, submit written maintenance instructions recommending procedures for maintenance of sodded lawns.

E. Delivery, Storage, and Handling:

1. Cut, deliver, and install sod within a 24 - hour period.
2. Do not harvest or transport sod when moisture content may adversely affect sod survival.
3. Protect sod from sun, wind, and dehydration prior to installation.
4. Do not tear, stretch, shake, or drop sod during handling and installation.

F. Project Conditions:

1. Work Notification: Notify Owners Representative at least seven (7) days prior to start of sodding operations.
2. Protect existing utilities, irrigation, paving, and other facilities from damage that may be caused by sodding operations.
3. Perform sodding work only after planting and other work affecting ground surface has been completed.
4. Restrict traffic from lawn areas until grass is established. Erect signs and barricades as necessary.
5. Provide hose and lawn watering equipment as necessary to maintain sod survival. No exceptions will be made for sod survival due to irrigation failure during the warranty period or until final acceptance.
6. Sodded areas of the site without irrigation shall be watered to provide establishment.
7. The irrigation system shall be installed prior to sodding. Locate, protect, and maintain the irrigation system during sodding operations. Repairs to irrigation system components damaged by sodding operations will be at the Contractor's expense.

G. Warranty:

Provide a uniform stand of grass by watering, mowing, and maintaining lawn areas until final acceptance. Resod areas, with specified materials, which fail to provide a uniform stand of grass until all affected areas are accepted by the Owners Representative.

1.4 INSPECTION:

- A. The Landscape Architect will examine finished surfaces, grades, topsoil quality and depth. Do not start sodding work until satisfactory conditions have been approved by the Owners Representative or until unsatisfactory conditions are corrected.



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## 1.5 PREPARATION:

- A. Limit preparation to areas which will be immediately sodded.
- B. Loosen topsoil of lawn areas to minimum depth of 4". Remove stones over 1" in any dimension and sticks, roots, rubbish, and extraneous matter.
- C. Grade lawn areas to smooth, free draining and even surface with a loose, uniformly fine texture. Roll and rake; remove ridges and fill depressions as required to drain.
- D. Dampen dry soil prior to sodding.
- E. Restore prepared areas to the specified condition if eroded, settled, or otherwise disturbed after fine grading and prior to sodding.

## PART 2 -PRODUCTS

### 2.1 PRODUCTS

- A. The sod shall be as indicated on the plant list. Sod shall be nursery grown grass of firm tough texture, having a compact growth with good root development, and shall contain no weeds or any other objectionable vegetation. Sod shall not contain Tropical Soda Apple. Sod shall be a minimum of 3" thick at time of installation. The soil embedded in the sod shall be good earth, free of stones and debris and all sod shall be free from fungus, vermin and other diseases.
- B. Provide well-rooted, healthy sod free of diseases, nematodes, chinch bugs and other soil borne insects. Provide sod uniform in color, leaf texture and density, capable of vigorous growth and development when planted.
- C. Before being cut and lifted, the sod shall have been mowed at least three times with a lawn mower, with the final mowing not more than five (5) days before the sod is cut. The sod shall be carefully cut into uniform dimensions, not more than two (2) days prior to final installation on site.
- D. Solid sod shall be laid with closely abutting joints with a tamped or rolled, even surface. It shall be the responsibility of the Contractor to bring the sod edge in a neat, clean manner to the edge of all paving and shrub areas, keeping a minimum of 24" back from shrub foliage area flush with all paving surfaces. If, in the opinion of the Owners Representative, top-dressing is necessary after rolling, clean sand will be evenly applied over the entire surface and thoroughly washed in at the Contractor's expense.
- E. Quantities: All quantities indicated on the plant list are intended as a guide for bidding purposes and does not relieve the Contractor of his responsibility to do a comprehensive material take off. The amount of sod to cover the limits defined on the drawings will be applied.
- F. All sod shall be healthy, green and exhibit a habit of growth that is normal for the species and shall be free of insects. All sod shall meet satisfactory approval at the time of final acceptance. Sod that is not accepted shall be replaced at the Contractor's expense.

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## PART 3- EXECUTION

### 3.1 EXECUTION

- A. Layout: Outline of areas to be sodded shall be smooth and uniform as indicated on the drawings. Where changes have been made in the construction, necessary adjustments must be approved by the Owners Representative.
- B. Peg sod on slopes greater than 4:1 to prevent slippage at a rate of two stakes per square yard (staggered). Pegs are to be removed when sod is established.
- C. Contractor shall repair all washouts that occur during construction and within the warranty period at no additional cost to the Owner.
- D. Lay sod to form a solid mass with tightly-fitted joints. Butt ends and sides of sod strips. Do not overlay edges. Stagger strips to offset joints in adjacent courses. Remove excess sod to avoid smothering of adjacent grass. Provide sod pad top flush with adjacent curbs, sidewalks, drains, and seeded areas.
- E. Sod installed in rolls shall have the mesh removed during the sod installation.
- F. Do not lay dormant sod or install sod on saturated soil.
- G. Install initial row of sod in a straight line, beginning at bottom of slopes, perpendicular to direction of the sloped area. Place subsequent rows parallel to and lightly against previously installed row.
- H. Water sod thoroughly with a fine spray immediately after laying.
- I. Roll with a lawn roller to ensure contact with sub-grade and providing for a smooth grade.
- J. Sod areas adjoining contract limits disturbed as a result of construction operations.

### 3.2 MAINTENANCE

- A. Maintain sodded lawns until completion and final acceptance of the entire project as issued by the Owners Representative.
- B. Maintain sodded lawn areas, including watering, spot weeding, mowing, application of herbicides, fungicides, insecticides and resodding until a full, uniform stand of grass free of weed, undesirable grass species, disease, and insects is achieved and accepted by the Landscape Architect.
- C. Repair, rework, and resod all areas that have washed out or are eroded. Replace undesirable or dead areas with new sod.
- D. Apply herbicides as required to control weed growth or undesirable grass species.
- E. Apply fungicides and insecticides as required to control diseases and insects.
- F. Maintain sod at regular mowing intervals throughout the construction period.

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- G. Sod shall be mowed prior to final acceptance by the Owner.

**3.3 ACCEPTANCE**

- A. Inspection to determine acceptance of sodded lawns will be made by the Landscape Architect prior to Final Acceptance. Provide notification at least 10 working days before requested inspection date.
- B. Sodded areas will be acceptable provided all requirements, including maintenance, have been complied with, and a healthy, even colored viable lawn is established, free of weeds, undesirable grass species, disease, and insects.
- C. Upon final acceptance, the Owner will assume lawn maintenance notwithstanding those tasks herein imposed upon the Contractor.

**3.4 CLEANING**

- A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris, and equipment. Repair damage resulting from sodding operations.

**3.5 GUARANTEE AND REPLACEMENT:**

- A. Guarantee: The Contractor, as part of his Contract, shall furnish a written guarantee warranting all materials, workmanship and sod, for a period of sixty days from the time of final acceptance. All sod shall be alive and in satisfactory condition at the end of the guarantee period. There shall be an additional 60-day warranty on all replaced areas of sod. Where vandalism is agreed by the Owners Representative as the cause for replacement, the Contractor shall not be responsible for replacement without compensation.

**3.6 QUALIFICATIONS:**

- A. Drawings and general provisions of the contract, including General, Supplementary Second Special Conditions and Division 1, General Requirements of the Specifications, applies to the work of this Section.
- B. Subcontractor shall be a firm with not less than 5-years experience in the type of work specified in this Section, or provide satisfactory substitute evidence that the Owner, at its sole discretion, may accept.

END OF SECTION 329223

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## SECTION 334100 - STORM UTILITY DRAINAGE PIPING

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 31 apply to the Section.
- B. The Contractor and his sub-contractors shall conform to the Buy America requirements: <https://www.transit.dot.gov/buyamerica>.

FTA's Buy America requirements prevent FTA from obligating an amount that may be appropriated to carry out its program for a project unless "the steel, iron, and manufactured goods used in the project are produced in the United States" (49 U.S.C. § 5323(j)(1)). FTA's Buy America requirements apply to third-party procurements by FTA grant recipients. A grantee must include in its bid or request for proposal (RFP) specification for procurement of steel, iron or manufactured goods (including rolling stock) an appropriate notice of the Buy America provision and require, as a condition of responsiveness, that the bidder or offeror submit with the bid or offer a completed Buy America certificate in accordance with 49 CFR §§661.6 or 661.12. The certification requirements can be found at this link: <https://www.ecfr.gov/current/title-49/subtitle-B/chapter-VI/part-661>.

#### 1.2 SUMMARY

- A. The Contractor shall furnish all materials, labor, and equipment and construct storm sewer piping as shown on the Drawings and as specified herein.
- B. These specifications are intended to give a general description of what is required, but do not purport to cover all of the structural design details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, shop testing, delivery, and complete installation of the storm sewer piping.

#### 1.3 SUBMITTALS

- A. Submit to the Engineer the details of construction and shop drawings for Storm Sewer piping.
- B. Manufacturer's Literature: Manufacturer's recommended installation instructions.
- C. Manufacturer's certificates of material conformance with specifications.

#### 1.4 INSPECTION

- A. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the Engineer, or other representatives of the Owner. Such inspection may be made at the place of manufacture, or at the site after delivery, or at both places, and the sections shall be subject to rejection at any time on account of failure to meet any of the Specification requirements; even though sample sections may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the job shall be marked for identification and shall be removed from the job at once. All sections which have been damaged

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after delivery will be rejected, and if already installed, shall be acceptably repaired, if permitted, or removed and replaced, entirely at the Contractor's expense.

- B. At the time of inspection, the sections will be carefully examined for compliance with F.D.O.T Specifications, and with the approved manufacturer's drawings. All sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured.
- C. Imperfections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at the end of 7 days and 5,000 psi at the end of 28 days, Epoxy mortar may be utilized for repairs subject to the approval of the Engineer.

## PART 2 PRODUCTS

### 2.1 PIPE CULVERTS AND STORM SEWERS

- A. The work specified in this section will confirm to the F.D.O.T. Specifications as referred below: Reference F.D.O.T. Specification 430.

### 2.2 PLASTIC FILTER BLANKET

- A. The work specified in this article will conform to the F.D.O.T. Specifications as referenced below: Reference F.D.O.T. Section 514.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Earth excavation and backfill are specified in Section 02200 – Earth Moving, but are to be done as part of the work under this Section, including necessary sheeting and bracing. The Contractor shall be responsible for handling groundwater (*See* SFWMD Water Use (Dewatering) permit conditions to provide firm, dry subgrade for the structure, shall prevent water rising on new poured in place concrete or grouted joint sections within 24 hours after placing, and shall guard against flotation or other damage resulting from ground water or flooding.
- B. Backfill material above the pipe bedding shall be selected material as specified.

END OF SECTION 334100