



DESIGN & CONSTRUCTION GUIDELINES

DIVISION 26 ELECTRICAL

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SECTION 26 00 00 GENERAL ELECTRICAL REQUIREMENTS**1.1 SUMMARY**

This Section includes general electrical requirements for all projects.

1.2 PERMITS AND INSPECTIONS

- A. Follow USF Building Code Administrator (USF-BCA) requirements for permitting and scheduling inspections. Coordinate with USF-BCA department.
- B. Minor Projects: Contractor is responsible for all permitting and inspecting fees.
- C. Major Projects: Coordinate with USF Project Manager (USF-PM) for responsible party for permitting fees.
- D. Minor Projects with USF approved Contractor/Construction Manager (CM): Coordinate with USF-PM and assigned CM for responsible party for permitting fees.

1.3 COORDINATION

- A. Visit the site included in the scope of work to ascertain existing conditions. Verify all dimensions and locations before proceeding with work in the area and prior to purchasing equipment.
- B. Review and coordinate between all construction documents, all project specifications, and all sections in USF Design and Construction Guidelines (USF-DCG). Notify USF-PM of conflicts or discrepancies prior to proceeding with work.
- C. Locate all underground utilities required by the Sunshine 811 law prior to proceeding with work. Contact USF-PM to obtain latest USF Campus Utilities Map for the area in scope of work prior to proceeding.
- D. Coordinate with USF-PM, USF Parking and Transportation Services (PATS), and USF Police Department (UPD) for required lane closures and parking spaces closures minimum 72 hours prior to closures. Contractor is responsible for all closure barriers and signs subject to USF review and approval.

1.4 SITE

- A. All existing utilities shall remain in place unless otherwise noted on the contract documents.
- B. Contractor shall restore back to original installation transformers, primary gear, primary feeders, utilities, irrigation, etc. damaged by the contractor in the area of demolition or construction.
- C. Provide an erosion control plan addressing prevention, control, and abatement of water pollution to USF-PM for approval prior to proceeding with work.
- D. Safety fencing shall be neon green. Orange or black safety fencing shall not be used.
- E. Conduit trenches shall be backfilled completely to provide safe crossing by the end of work day or whenever the work zone becomes inactive.
- F. Maintain access to side streets, drives, and sidewalks at all times during construction.
- G. Existing pedestrian/sidewalk lighting and roadway lighting shall remain operational during all phases of the construction until new lighting is energized.
- H. Construction Sites: Provide protective barriers around primary switchgear (Vacuum switches and PMH switchgear), transformers, electrical and communications manholes, and temporary services. USF shall have clear vehicle access to these items at all times during construction.
 1. Vacuum switches and PMH switchgear protective barricades shall allow 5 feet clearance on the sides, and 10 feet clearance on sides with doors. The area in front of the sides with doors shall be clear of construction materials or equipment for 20 feet from the equipment.
 2. Transformers protective barricades shall allow 5 feet clearance on the sides and rear and 10 feet clearance in front. The area in front shall be clear of construction materials or equipment for 20 feet.
 3. Electrical and communications manholes: Provide 15 feet square barricade around manhole cover. Manhole cover shall be accessible to USF at all times. Remove construction debris such as dirt, sod, ground cover, etc.
 4. Temporary services protective barricades shall allow 3 feet clearance on sides and rear (or required by code if greater), and 5 feet clearance in front of equipment.
 5. No construction materials or construction tools shall be stored within the protective barricades.

6. No construction vehicles or personal vehicles shall be parked over electrical or communications manhole covers.
7. Project site design and final site constructed conditions shall include clear vehicle access to all above mentioned equipment for maintenance.
- I. USF Primary: Contractor shall develop site construction plan indicating all existing primary equipment including Vacuum switches, PMH switchgear, transformers, and underground primary after the first Sunshine 811 locate and maintain copies on site during construction. All underground work, digging, and trenching shall be coordinated with USF Facilities Management-Operations (FM-OPS) department prior to proceeding. Contractor shall not rely on multiple locates from FM-OPS once the site is disturbed by the site contractor or any sub-contractors.
- J. Fenced Construction Sites: An access point agreed to by USF-PM and FM-OPS shall be provided to USF. Chains shall have USF Standard 2000 Padlock and site contractor pad lock daisy chained. Project is responsible to provide the USF Standard 2000 Padlock, coordinate with USF-PM and FM-OPS.
- K. Areas where work is performed shall be kept clean of debris and materials and shall be cleaned at the end of each work day. Contractor is responsible to secure all tools and materials at all times.
- L. Adhere to USF Tagout Policy when servicing or working on electrical systems.
- M. Abandoned Raceways:
 1. Remove cables.
 2. Remove all abandoned raceways and duct banks. Where removal is not feasible and approved by USF-PM, USF-BCA, and FM-OPS, cut abandoned raceway at horizontal level (before turn up) and cap (do not use tape – use existing conduit type cap).
 3. Paint cap red.
 4. Indicate location on record documents.

1.5 WARRANTY

- A. Contractor shall provide minimum one (1) year warranty for all labor and materials, whether included or not included by equipment manufacturers. Contractor shall replace defective materials during the first year of warranty without additional compensation from USF.
- B. Manufacturer warranties greater than one (1) year, or where lengthier warranties are required in the project documents, or in DCG shall extend the standard one (1) year warranty.
- C. Warranty period shall begin on date of substantial completion.

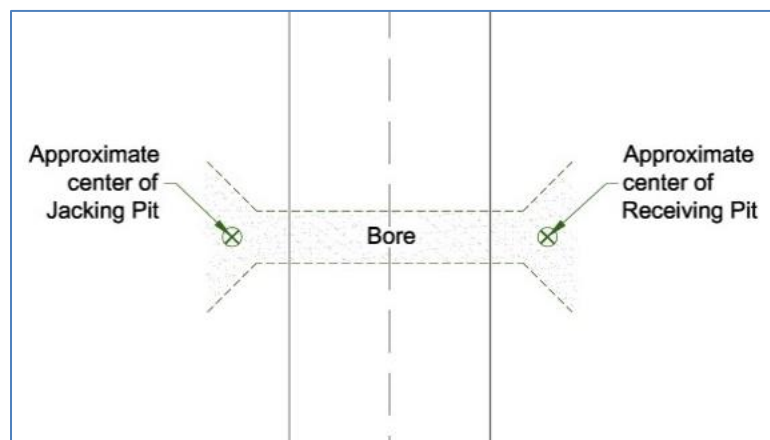
1.6 MISCELLANEOUS

- A. Main Electrical Rooms: Direct access from the exterior shall be provided.
- B. USF Furnished Equipment:
 1. Contractor shall be responsible for receipt from USF, storage after receipt, and installation if required.
 2. Verify equipment connection requirements prior to rough-in and ordering materials.
 3. Install equipment in accordance with manufacturer instructions.
 4. Maintain equipment until project is turned over to USF at Substantial Completion.
- C. Fault-Current Study: All projects shall include a fault current study. Indicate the available fault current and ampacity interrupting capacity for all switchboards, distribution boards, panelboards, transfer switches, enclosed circuit breakers, motor control centers, VFDs, and disconnect switches. Provide labels in accordance with National Electrical Code (NEC) 110.22 and 110.24.
- D. Coordination Study: Perform a coordination study for all overcurrent protection devices.
- E. Arc-Flash Hazard Analysis: Perform an arc-flash study on all new construction and major renovations that include electrical equipment additions. Provide arc-flash labels in accordance with NEC 110.16 on all electrical equipment, such as switchboards, distribution boards, panelboards, transfer switches, enclosed circuit breakers, motor control centers, VFDs, disconnect switches, and meter sockets.
- F. Branch Circuits: No more than six (6) current carrying conductors (3 circuits) shall be installed in any one raceway. Six (6) current carrying conductors shall consist of three (3) circuit conductors and three (3) neutral conductors. Provide dedicated neutrals for multi-wire branch circuits for compliance with NEC 210.4.

- G. Design team for new construction and renovations or contractor for miscellaneous additions shall demonstrate via load summary or per NEC 220.87 Determining Existing Loads that the service including pad mounted transformer, switchboard, panelboard, or equipment can accommodate the load being added.
- H. The project is responsible for all costs associated with the design and construction including purchasing materials and equipment to provide temporary construction site electric service and permanent electric service to the facility. The equipment and materials may include 13.2 kV primary equipment including raceways, conductors, PMH switchgear and pad mounted transformer. The Construction Manager, Contractor, and/or Design Team shall coordinate with USF Facilities Management (USF-FM) for requirements prior to Programming Phase for the Project.

1.7 PROJECT CLOSE OUT

- A. Closeout documents shall include laminated full size electrical site plan and electrical riser diagrams in the main electrical room. Provide on a chain hook system adjacent to the main electrical room entrance.
- B. Provide record documents per USF-FM requirements. Coordinate with USF-PM.
- C. Record documents shall include the following:
 - 1. Directional boring logs.
 - 2. Indicate directional boring “jacking and receiving pits” on a scaled site plan. Provide minimum of two (2) documented measures from two (2) separate existing physical features, such as from curbs, sidewalks, center of roadways, or structures, to the center of the “jacking or receiving pit”.



Jacking Pit and Receiving Pit Figure

END OF SECTION 26 00 00

SECTION 26 05 19 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS**PART 1 – GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 volt and less.
 - 2. Connectors, splices, and terminations rated 600 volt and less.

1.2 ACTION SUBMITTALS

- A. Product data for low voltage electrical power conductors and cables.
- B. Manufacturer's specification sheets inclusive of materials ratings and listings for intended applications and installation instructions.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in National Fire Protection Association (NFPA) 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with most recently adopted NFPA 70.

PART 2 – PRODUCTS**2.1 CONDUCTORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alan Wire.
 - 2. Encore Wire Corporation.
 - 3. Okonite Company.
 - 4. Southwire Company.
 - 5. LS Cable & System USA.
- B. Conductors shall be Copper: Comply with National Electrical Manufacturers Association (NEMA) WC 70. Aluminum conductors are not approved.
- C. Conductor Insulation: Type THHN/THWN. Color coding shall be employed throughout entire length of conductor for all conductor sizes. Phase taping is not allowed.
- D. Use of MC Cable is limited to the following applications and shall be installed per the following requirements.
 - 1. Approved in the following applications:
 - a. Final 6' connection from a junction box to light fixtures installed in accessible suspended ceiling.
 - b. Inside residential or dormitories rooms.
 - c. Inside non-bearing partitions when the home run is utilizing EMT or Rigid Conduits.
 - 2. Installation shall adhere to the following requirements:
 - a. Install parallel and perpendicular in a good workmanlike manner and properly supported.
 - b. Cable insulation colors shall adhere to Section 26 05 53, Identification for Electrical Systems.
 - c. Provide protection from physical damage. Any damaged MC Cable shall be replaced by the installing contractor.
 - d. Workmanship and quality control shall include labeling and proper support for trouble shooting.
 - e. Penetrations through fire-resistive assemblies shall be installed per UL listings. Design Professionals or installing contractor if project does not have a Design Professional shall specify and provide supporting submittal for USF-BCA review and approval allowable UL Listing for all fire rated penetrations.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Power Systems, Inc.
 - 2. O-Z/Gedney; EGS Electrical Group LLC.
 - 3. Polaris Electrical Connectors.
 - 4. Ideal Wire Connectors.
 - 5. ILSCO
 - 6. Tyco Electronics

7. Raychem
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
 - C. Connectors and splices in exterior in-ground handholes shall be Raychem GHFC H Frame weatherproof closures Underwriters Laboratory (UL) listed for the application. Ideal weatherproof connectors are acceptable for terminating single conductors, or for conductor sizes less than #6 AWG. Use Raychem GHFC H Frame closures for two or more conductors larger than #8 AWG.
 - D. Provide lugs for terminating service entrance conductors to USF primary transformers. Lugs shall be multiple lug kit, dual rated, mechanical lugs, double screw on each conductor. Conductor range shall be 750 KCMIL, 1/0 AWG. Provide two (2) spare lugs for each phase and neutral. Mounting hardware shall be stainless steel. Provide lock washer and flat washer at nut and flat washer at bolt head. Coordinate requirements with and submit lugs submittals to USF-PM and FM-OPS. Service entrance conductors for new services shall be no smaller than 1/0 AWG.

PART 3 – EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Coordinate minimum allowable feeder size for the intended installation with USF-PM prior to design.
- B. Branch Circuits: Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Minimum conductor size No. 12 AWG.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Feeders: Type THHN-THWN, single conductors in raceway.
- C. Branch Circuits: Type THHN-THWN, single conductors in raceway.
- D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS

- A. 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.
- B. Use pulling means such as fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- C. Identify and color-code conductors and cables according to [Section 26 05 53. Identification for Electrical Systems](#).
- D. 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.
- E. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors. Service entrance and panel feeders shall not be spliced.
- F. Wiring at Outlets: Install conductors at each outlet, with at least 6 inches of slack.
- G. Wiring in in-ground handholes: Loop all phase conductors, neutral conductors, and equipment grounds 360 degrees in handhole before terminating or before pulling to the next handhole.
- H. Wiring in light poles handholes: Provide at least 18 inches of slack at handhole.

END OF SECTION 26 05 19

SECTION 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**PART 1 – GENERAL****1.1 SUMMARY**

- A. Section Includes: Grounding systems and equipment.

1.2 ACTION SUBMITTALS

- A. Product data for ground bus bars, electrodes, mechanical and compression connectors, and exothermic connectors.

1.3 INFORMATIONAL SUBMITTALS

- A. Field measured ground impedance in Ohms for each grounding system.
B. Measuring instrument and test method.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.
B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 – PRODUCTS**2.1 CONDUCTORS**

- A. Insulated Conductors: Copper wire insulated for 600 volt unless otherwise required by applicable code or authorities having jurisdiction.
B. Equipment Ground Conductors: Insulated with green colored insulation.
C. Isolated Ground Conductors: Insulated with green colored insulation with yellow stripe.

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 Pipes: Copper or copper alloy, U clamp type, sized for the pipe and conductor, with at least two bolts.
C. Bolted connectors below grade or in ground handholes.
1. Pipe Connectors: U clamp type, sized for pipe and conductor. Clamp shall be copper or brass and UL listed for direct burial.
2. Ground connection for light pole (other than sports light pole) ground to driven ground rod: Acorn type, copper or brass, sized for the conductor and ground rod, and UL listed for direct burial.
D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions. Exothermic CADWELD shall be used for building grounding system connection to driven ground rods, connection to lightning protection driven ground rods, and connection to sports lighting driven ground rods.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad, sectional length; 3/4 inch diameter by 10 feet long each. Provide additional lengths in 10 feet sections to achieve specified minimum resistance to ground, measured in Ohms, at building services grounding systems.

2.4 GROUND BARS:

- A. Provide as follows:
1. Main electrical room ground bus bars: Newton Instrument Company insulated ground bar, copper, manufacturer pre-drilled holes. Minimum size shall be 1/4 inch X 4 inches X 20 inches. Bond to building grounding system with minimum 1/0 copper ground, or sized per code, for a continuous copper grounding system.
2. Electrical room ground bus bars (non-main electrical room): Newton Instrument Company insulated ground bar, minimum size 1/4 inch X 4 inches X 10 inches, copper, manufacturer pre-drilled holes. All ground bus bars shall be bonded to main electrical ground bus bar with minimum 1/0 copper ground, or sized per code, for a continuous copper grounding system. Utilizing building steel or footing is not acceptable.

3. Telecommunications, IDF, Data, computer, and similar rooms: Newton Instrument Company insulated ground bar, 1/4 inch X 4 inches X 20 inches, copper, manufacturer pre-drilled holes. Bond ground bus bar to main electrical ground bus bar or nearest electrical room ground bus bar with minimum 6 AWG copper.

PART 3 – EXECUTION

3.1 APPLICATIONS

- A. Conductors: Provide solid conductor for 4 AWG and smaller, and stranded conductors for 3 AWG and larger.
- B. Underground Grounding Conductors: Provide copper conductor, size per code but not smaller than 1/0 AWG, bury at least 24 inches below grade.
- C. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Provide insulated equipment grounding conductors in all raceways, except for service entrance feeders.
- B. Air-Duct Equipment Circuits: Provide insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 volt and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Provide a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. 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.
 1. For telephone, alarm, voice and data, and other communication equipment, provide 6 AWG minimum insulated grounding conductor in raceway from ground bus bar to each service location, terminal cabinet, wiring closet, cable tray, and central equipment location.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. Aluminum Poles Supporting Outdoor Lighting Fixtures: Provide ground lug with stainless steel screw in pole handhole, adjacent to handhole cover. Bond pole to 3/4 inch diameter by 10 feet long driven grounding rod located in in-ground handhole within 3 feet of pole with 8 AWG solid bare copper wire.
- F. Transformers: Bond XO to ground bus bar in electrical equipment room. Transformer XO bond grounding system shall be in accordance with NEC Handbook, Exhibit 250.15. Bond to grounding electrode conductor to electrical room ground bus bar. Provide equipment ground conductor from the primary source equipment ground bus bar to ground lug in transformer and from XO ground lug to secondary panel equipment ground bus bar. Transformer ground lug shall be multiple lug kit to accommodate the number of connections. Double wire on lug is not acceptable.
- G. All feeder metallic conduits and flexible metal conduits connections to panel cabinets, equipment cabinets, transformer enclosures, etc. shall be provided with grounding bushings.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, following major building/structure lines, 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 Rods: Drive rods until tops are 6 inches above bottom of inspection well or in-ground handhole gravel base. Connection to ground rod shall be above gravel base.
 1. Interconnect building driven ground rods with grounding electrode conductor below grade, inside inspection wells.
 2. For building's service grounding electrode system, install at least three rods spaced at least 10 feet apart in a Triad grounding configuration. For standalone services such as lighting, wells, etc., install at least two rods spaced at least 10 feet apart.
- C. Inspection Wells: Provide inspection wells for all building grounding system driven rods and lightning protection driven grounding rods.
 1. Non-vehicular traffic areas: Harger GAW910 with HDPE cover.

2. In concrete or subject to vehicular traffic including maintenance vehicles: Large traffic rated, GAW121212HD with heavy duty top
 3. Color shall be gray or green and labeled "Ground".
 4. Bolts shall be stainless steel.
 5. Provide gravel base, Stone 57 or similar. Crushed concrete or pea gravel is not acceptable. Provide additional gravel inside inspection well to allow proper drainage.
 6. Ground rod connection shall be above gravel base for easy inspection.
- D. Service Grounding Systems Bonding to Piping:
1. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main ground bus bar to main metal water service entrance to building.
 2. Water Meter Piping: Provide braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond gas piping system downstream from equipment shutoff valve.
- E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- F. Concrete encased electrode in building footer shall be a bare conductor, same size as the building systems grounding conductor, routed minimum 20 feet and tie wired to the reinforcing bars.

3.4 LABELING

- A. Comply with requirements in [Section 26 05 53, Identification for Electrical Systems](#) for instruction signs. The label or its text shall be green.
- B. Install labels at all ground bus bars indicating each ground conductor origin.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each service enclosure grounding terminal, and at driven ground rods inspection wells.
 4. Test shall be fall-of-potential method using megohmmeter.
- B. Report measured ground resistances that exceed 5 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds 5 ohms, provide additional driven grounding rods until the measured ground resistance does not exceed 5 ohms.

END OF SECTION 26 05 26

SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
PART 1 – GENERAL**1.1 SUMMARY**

- A. Section includes Hangers and supports for electrical equipment and systems.

1.2 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed.

1.3 ACTION SUBMITTALS

- A. Product Data:
1. Steel slotted support systems.
 2. Raceway and cable support systems.
 3. Mounting and support clamps.
 4. Mounting and support through bolts and toggle bolts.
 5. Mounting and support all thread hanger rods.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze hangers. Include Product Data for components.
 2. Aluminum/Steel slotted channel systems. Include Product Data for components.
 3. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

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

<ol style="list-style-type: none"> a. <u>Allied Tube & Conduit.</u> b. <u>GS Metals Corp.</u> c. <u>Wesanco, Inc.</u> d. <u>Kindorf.</u> 	<ol style="list-style-type: none"> e. <u>Cooper B-Line, Inc.</u> (Cooper Industries) f. <u>ERICO International Corporation.</u> g. <u>Thomas & Betts Corporation.</u> h. <u>Unistrut</u> (Tyco International, Ltd.)
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 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-.
 4. Channel Dimensions: Selected for applicable load criteria.
 5. Exterior mounted channel: stainless steel or aluminum.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported. Exterior and wet locations shall be stainless steel or aluminum with stainless steel hardware.
- D. Structural Steel for Fabricated Supports and Restraints: (American Society for Testing and Materials) ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - i. Hilti Inc.
 - ii. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - iii. MKT Fastening, LLC.
 - iv. Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - i. Cooper B-Line, Inc.; a division of Cooper Industries.
 - ii. Empire Tool and Manufacturing Co., Inc.
 - iii. Hilti Inc.
 - iv. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - v. MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.
 8. Mounting apparatus for exterior applications shall be stainless steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in [Section 05 50 00, Metal Fabrications](#) for steel shapes and plates.

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.
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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 two-bolt conduit clamps.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inches and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. 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.

- D. 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 Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. 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.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. Supporting raceways via other raceways is not approved.
- G. Supporting raceways via cable trays and wireways or cable tray and wireway supports is not approved.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in [Section 05 50 00, Metal Fabrications](#) for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

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.
 - a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in [Section 09 90 00, Painting](#) 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.

3.5 EXTERIOR SUPPORT FOR ELECTRIC PANELS, CABINETS & EQUIPMENT

- A. Support post shall be concrete sized for the intended installation. Minimum size for mounting panels, disconnect switches, etc. shall be 6 inches x 6 inches x 10 feet (4 feet embedded).
- B. Unistrut channel shall be stainless steel or aluminum.
- C. Mounting hardware shall be stainless steel.

END OF SECTION 26 05 29

SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**PART 1 – GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetal wireways and auxiliary gutters.
 - 5. Surface raceways.
 - 6. Boxes, enclosures, and cabinets.
 - 7. Handholes and boxes for exterior underground cabling.

1.2 ACTION SUBMITTALS

- A. Product Data: For raceways, fittings, outlet boxes, junction and pull boxes, floor boxes, hinged-cover enclosures, and cabinets.
- B. LEED Submittals:
 - 1. Product Data for LEED Credit: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
- C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

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. RMC (Rigid Metallic Conduit)
 - 1. GRC (Galvanized Rigid Conduit): Comply with American National Standards Institute (ANSI) C80.1 and UL 6.
 - 2. RAC (Rigid Aluminum Conduit): Comply with ANSI C80.5 and UL 6A.
- C. IMC (Intermediate Metal Conduit): Comply with ANSI C80.6 and UL 1242.
- D. EMT (Electrical Metallic Conduit): Comply with ANSI C80.3 and UL 797.
- E. FMC (Flexible Metal Conduit): Comply with UL 1; zinc-coated steel or aluminum.
- F. LFMC (Liquidtight Flexible Metal Conduit): Flexible steel conduit with PVC jacket and complying with UL 360.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B, compatible with raceway and tubing materials.
- H. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
- I. Fittings for EMT:
 - 1. Material: Steel or die cast.
 - 2. Type: Setscrew or compression.
 - 3. Fittings shall be die cast compression type in damp locations.
- J. 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.
- K. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- L. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic 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. ENT (Electrical Nonmetallic Conduit): Comply with NEMA TC 13 and UL 1653. Use requires USF-PM pre-approval.

- C. RNC (Rigid Nonmetallic Conduit): Type EPC-40-PVC (PVC), complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Fittings for ENT: Comply with NEMA TC 3; match to conduit or tubing type and material.
- E. Solvent cements and adhesive primers 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).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4, or Type 12 dictated by the application 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.

2.4 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles 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.
- C. Surface Nonmetallic Raceways: Two or three-piece construction, complying with UL 5A, and manufactured of rigid PVC. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
- D. Tele-Power Poles:
 - 1. Material: Galvanized steel with ivory baked-enamel finish or Aluminum with clear anodized finish as specified and subject to USF-PM approval.
 - 2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

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, aluminum, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. 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.
- F. Nonmetallic Floor Boxes (where use is approved by USF-PM): Nonadjustable, rectangular.
 - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. 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.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Gangable boxes are prohibited.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4, or Type 12 required by the application with continuous-hinge cover. Interior hinged cover

enclosures shall have flush latch. Exterior hinged cover enclosures shall be pad lockable with USF Standard 2000 pad lock.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures are not acceptable.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
4. Hinged Cover Enclosures located in chiller plants, tower yards, boiler plants, lift stations, and irrigation wells shall be stainless steel.

M. Cabinets:

1. NEMA 250, Type 1, Type 3R, or Type 12 required by the application galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge. Exterior hinged door shall be pad lockable with USF Standard 2000 pad lock.
3. Interior hinged door shall be key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets are not acceptable.
7. Enclosures and cabinets located in or exterior of chiller plants, tower yards, boiler plants, lift stations, and irrigation wells shall be stainless steel.

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.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover (traffic rated): Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two. USF Standard is Quazite: PG1118HA00 ANSI Tier 15 cover with open bottom PG1118BA12 ANSI Tier 22 open bottom (minimum size, or size per code if larger handhole is required).

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by stainless steel bolt 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".
6. Color: Gray.
7. Installation: Provide in concrete areas or where traffic rating required. Per manufacturer instructions with gravel base similar to Stone 57. Re-cycled concrete, crushed concrete or pea gravel is not acceptable. Open bottom base shall sit on top of minimum 6 inches gravel base. Provide additional gravel inside (4 to 6 inches) bottom base to allow proper drainage. Conduits stubbed inside handhole shall extend minimum 6 inches above gravel.

C. Plastic HDPE Handholes and Boxes: High-density polyethylene; thermoplastic. USF Standard is Carson: L Series 1419-12, T-Cover (1419-4B Bolt Down), Open Body (1419-12) (minimum size, or size per code if larger handhole is required).

1. Standard: Comply with ATSM D-635 or UL-94.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. T-Cover: Weatherproof, secured by stainless steel bolt 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".
6. Color: Gray.
7. Installation: Provide in landscape or grass areas not requiring traffic rating. Per manufacturer instructions with gravel base similar to Stone 57. Re-cycled, crushed concrete or pea gravel is not acceptable. Open bottom base shall sit on top of minimum 6 inches gravel base. Provide additional gravel inside (4 to 6 inches) bottom base to allow

proper drainage. Conduits stubbed inside handhole shall extend minimum 6 inches above gravel.

PART 3 – EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit subject to physical damage or roof applications: GRC.
 2. Concealed Conduit, Aboveground: GRC, IMC, EMT, or Type EPC-40-PVC for the approved application. Coordinate with USF-PM.
 3. Underground Conduit: Type EPC-40-PVC. Minimum size shall be 3/4 inch.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC or LFMC approved for the application and subject to USF-PM and FM-OPS approval.
 5. Boxes and Enclosures, Above ground: NEMA 250, Type 3R. Provide stainless steel enclosures where required by code, in lift stations areas, chiller plants, tower yards, boiler plants, and wells.
 6. Underground Raceways Warning Tapes: 6 inches wide by 0.004 inch thick polyethylene film with aluminum coil detectable tape with appropriate label:
 - a. TAPE COLOR RED WITH LABEL “CAUTION – ELECTRICAL LINE BELOW”
 - b. Tape color yellow with label “Caution – Communications Line Below”
- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed and Subject to Physical Damage: GRC. Raceway locations include the following:
 - a. Loading docks.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Main and panels feeder raceways in main electrical rooms.
 - e. Lift station, chiller plants, tower yards, and boilers areas.
 - f. Fire pump rooms.
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 4. Connection to Vibrating Equipment, including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment: FMC, except use LFMC in damp or wet locations.
 5. Wet Locations: GRC.
 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in kitchens areas, chiller areas, boiler areas, lift stations areas, wells areas.
- C. Minimum Raceway Size: 1/2 inch trade size. Minimum EPC-40 size is 3/4 inch.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use setscrew or compression fittings. Fittings in damp locations shall be die cast compression type. 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. Do not install aluminum conduits, boxes, or fittings in direct contact with concrete or earth.
- F. Install surface raceways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 degrees F.

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 NECA 102 for aluminum conduits. 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 flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Comply with requirements in [Section 26 05 29, Hangers and Supports for Electrical Systems](#) for hangers and supports.

- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit. Support within 12 inches of changes in direction.
- F. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated.
- G. Install conduits (concealed or exposed) parallel or perpendicular to building lines or major structural elements.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Raceways Embedded in Slabs (requires pre-approval from USF-PM):
 - 1. Run conduits parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10 feet intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by USF-PM for each specific location.
 - 5. Transition from PVC to GRC before rising above floor.
- 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.
- 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. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits 3/4 inch to 1-1/4 inches trade size and insulated throat metal bushings on 1-1/2 inches trade size and larger conduits terminated with locknuts.
- N. Install bell ends on all PVC conduits entering medium voltage (campus primary) transformers and gear.
- O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 24 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use. Label all spare conduits with origin.
- P. 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.
- Q. 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.
- R. 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 refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- S. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 degrees F and that has straight-run length that exceeds 25 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 degrees F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 degrees F temperature change.

- c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 degrees F temperature change.
- d. Attics: 135 degrees F temperature change.
- 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F of temperature change for PVC conduits.
- 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
- 5. 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.
- T. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed 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.
 - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- U. 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.
- V. 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 surface to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- W. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel and to maintain wall fire rating.
- X. Locate boxes so that cover or plate will not span different building finishes.
- Y. 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.
- Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
 - 1. Set metal floor boxes level and flush with finished floor surface.
 - 2. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
 - 3. Junction boxes, pull boxes, or other boxes (electrical and control) located in chiller plants, boiler plants, lift stations, and irrigation wells shall be stainless steel.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit.
 - 2. 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 tamped 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.
 - 3. Provide GRC conduit elbows at turn up to equipment and at building entrances through floor. Coat GRC below grade or slab with bitumastic.
 - 4. Underground Warning Tape: Provide underground metallic warning tape 24 inches above raceway, or 12 inches below grade if conduit is buried 24 inches below grade. Color Red for electric raceways.
 - 5. Electrical raceways shall have minimum of 24 inches cover (burial depth). Electrical feeders' raceways (service entrance and panel feeders) shall have minimum 36 inches cover (burial depth). Electrical raceways installed under concrete slabs shall have minimum 12 inches cover from slab bottom with electrical warning tap 6 inches above raceway. Electrical service entrance raceways installed under concrete slabs shall have minimum 24 inches cover from slab bottom with electric warning tap 6 inches above raceway.
 - 6. Provide directional boring under all existing roadways and sidewalks.

7. Raceways for site lighting, including pedestrian, roadway and parking lot, shall be routed 12 to 18 inches within roadway curb or sidewalk and sweep to the in-ground handhole to allow future trees.
8. Coordinate with USF-Electrical Engineer for 13.2 kV duct bank requirements prior to design.

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. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- C. In-ground handholes and boxes in finish grade:
 1. In landscaped areas: Set top 1 inch above finish ground cover.
 2. In sodded areas: Set top 2 inches above grade before sod is laid. Once sod is laid, the top shall be no more than 1 inch above the sod.
 3. Handholes shall be set to follow slope of grade.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies meeting required UL fire ratings.

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies meeting required UL fire ratings.

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 paint finishes with matching touchup coating recommended by manufacturer.
 3. Provide bitumastic coating prior to installation to all RMC installed in grade.

3.8 RENOVATIONS AND DEMOLITION

- A. Remove abandoned outlets and raceways, including conductors, back to last device to remain in service or back to source panel. Where removed back to source panel, label circuit breaker(s) not re-used as spare and provide an updated typewritten panel directory.

END OF SECTION 26 05 33

SECTION 26 05 36 CABLE TRAYS FOR ELECTRICAL SYSTEMS**PART 1 – GENERAL****1.1 SUMMARY**

- A. Section Includes:
1. Ladder cable trays.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
B. Shop Drawings: For each type of cable tray.

PART 2 – PRODUCTS**2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS**

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

2.2 LADDER CABLE TRAYS

- A. Description:
1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
 2. Rung Spacing: 12 inches on center.
 3. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
 4. Minimum Cable-Bearing Surface for Rungs: 7/8 inch width with radius edges.
 5. No portion of the rungs shall protrude below the bottom plane of side rails.
 6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200 lb concentrated load, when tested according to NEMA VE 1.
 7. Minimum Usable Load Depth: 2 inches.
 8. Straight Section Lengths: 10 feet except where shorter lengths are required to facilitate tray assembly.
 9. Width: 12 inches minimum and 24 inches minimum for major trunk lines. Coordinate with USF-PM and USF Information Technology (USF-IT) for cable tray layout and major trunk lines requirements.
 10. Fitting Minimum Radius: 12 inches.
 11. Class Designation: Comply with NEMA VE 1, Splicing Assemblies: Bolted type using serrated flange locknuts.
 12. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316.
 13. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.3 MATERIALS AND FINISHES

- A. Steel:
1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M.
 2. Steel Tray Splice Plates: ASTM A 1011/A 1011M.
 3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 4. Finish: Mill galvanized before fabrication.
 - a. Hardware: Galvanized, ASTM B 633.
 5. Finish: Electrogalvanized before fabrication.
 6. Finish: Hot-dip galvanized after fabrication.
 - a. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
 7. Finish: Powder-coat enamel paint.
 - a. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
 8. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.

9. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.
- B. Aluminum:
 1. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 according to ANSI H35.1/H 35.1M for fabricated parts.
 2. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
 3. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.4 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 WARNING SIGNS

- A. Lettering: 1-1/2 inches high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel".

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 – EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Fasten cable tray supports to building structure.
- D. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in [Section 26 05 29, Hangers and Supports for Electrical Systems](#).
- E. Install center-hung supports for single-rail trays designed for 60% versus 40% eccentric loading condition, with a safety factor of 3.
- F. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- G. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- H. Seal penetrations through fire and smoke barriers. Comply with requirements in [Division 07 Section 07 84 00, Penetration Firestopping](#).
- I. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- J. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in [Section 26 05 26, Grounding and Bonding for Electrical Systems](#).

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.
- C. Fasten cables on vertical runs to cable trays every 18 inches.

- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- E. Tie MI cables down every 36 inches where required to provide a 2 hour fire rating and every 72 inches elsewhere.
- F. Renovation Construction: Remove inactive or dead cables from cable trays. Coordinate with USF-PM and USF IT prior to removing any cables.

3.4 CONNECTIONS

- A. Connect raceways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 3. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 4. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
 6. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

3.6 PROTECTION

- A. Protect installed cable trays and cables.

END OF SECTION 26 05 36

SECTION 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS
PART 1 – GENERAL**1.1 SUMMARY**

- A. Section Includes:
1. Identification for raceways.
 2. Identification for conductors.
 3. Underground-line warning tape.
 4. Warning labels and signs.
 5. Instruction signs.
 6. Equipment identification labels.
 7. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Provide sample of each label for approval prior to ordering materials upon USF-PM request.

1.3 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.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 -- PRODUCTS**2.1 CONDUCTOR IDENTIFICATION MATERIALS**

- A. Color-Coding for conductors shall be consistent throughout entire length. Phase tape color coding is not acceptable. Applies to feeders' conductors and branch circuit conductors. Color coding shall be:

Voltage	Phase A	Phase B	Phase C	Neutral
277/480	Brown	Orange	Yellow	Gray
120/208	Black	Red	Blue	White
120/240	Black	Red	*****	White
120/240 (*)	Black	Orange	Blue	White

(*) Orange shall indicate high leg on three phase 240 Volt delta system.

2.2 FLOOR MARKING TAPE

- A. 2 inches wide, 5 mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.3 UNDERGROUND-LINE WARNING TAPE

- A. Provide warning tape to identify and locate underground electrical (color Red) and communications (color Orange) utility lines.
1. Printing on tape shall be permanent and shall not be damaged by burial operations.
 2. 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.
- C. Refer to [Section 26 05 33, Subparagraph 3.1 A 6 Raceways & Boxes for Electrical System](#) for additional requirements.

2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.

- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. 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.
- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4 inch grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches.

2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 square inches and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with white letters on black face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Interiors - Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed and pop rivet to enclosure, with white letters on a dark-gray background. Minimum letter height shall be 1/2 inch.
- B. Outdoors - Stenciled Legend: In nonfading, waterproof. Adhesive backed and pop rivet to enclosure, seal penetrations with silicone. Minimum letter height shall be 1/2 inch.
- C. Identifications:
 - 1. 277/480 Volt – White background with black letters.
 - 2. 120/208 (120/240) Volt – Black background with white letters.
 - 3. 277/480 Volt Emergency Systems – Red background with white letters.
 - 4. 120/208 (120/240) Volt Emergency Systems – Red background with black letters.
 - 5. Letters shall be 1/2 inch high.
 - 6. Each panel shall be labeled with the panel designation, voltage and phase, and source feeding the panel including circuit numbers. Label location on enclosure above the door.
 - 7. Each transformer shall be labeled with the transformer designation and primary source including circuit numbers and secondary fed equipment designation. Coordinate with USF-PM for labels descriptions.
 - 8. Each safety switch, enclosed circuit breaker enclosure, etc. shall be labeled with the equipment designation, voltage and phase, and source feeding the equipment including circuit numbers.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: 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. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Do not apply labels on panelboard door; locate on cabinet above the door.

- B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- C. Underground-Line Warning Tape: Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- D. Label outlet boxes/junction boxes indicating circuits contained therein and source panel, neatly with black permanent marker.
- E. Provide labels on outlets cover plates indicating source panel and circuit number. Labels shall be machine type onto permanent tape.
- F. Label outlets boxes, inside (not cover plates), indicating circuit contained therein and source panel, neatly with black permanent marker.
- G. Paint fire alarm systems outlet boxes/junction boxes red. Spot paint fire alarm conduit red every 10 feet to within 12 inches of box or enclosure.
- H. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- I. 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. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- J. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- K. 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.
- L. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 1/2 inch high letters for emergency instructions at equipment used for power transfer.
- M. Each branch circuit conductor shall be labeled with the panel circuit designated 1 inch from termination to the circuit breaker with 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.
- N. Installing contractor info, logos, or marking info on equipment is prohibited.

END OF SECTION 26 05 53

SECTION 26 09 23 LIGHTING CONTROL DEVICES**PART 1 – GENERAL****1.1 SUMMARY**

- A. Section Includes:
1. Time switches.
 2. Photoelectric switches.
 3. Indoor vacancy/occupancy sensors.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 USF BUILDING CODE ADMINISTRATOR DIRECTIVES

- A. BCA Directive 14.
1. AHSRAE 90.1-2010 Automatic Receptacle Control – Not required.
 2. FBC Energy Code Lights Manual On Control – Not required.

PART 2 -- PRODUCTS**2.1 TIME SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Cooper Industries, Inc.
 2. Intermatic, Inc.
 3. Leviton Mfg. Company Inc.
 4. NSi Industries LLC; TORK Products.
 5. Watt Stopper
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Contact Configuration: SPST, DPST, DPDT as required for the desired control scheme.
 3. Contact Rating: 20-A ballast load, 120/240-V ac or 277 V ac.
 4. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
 5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 6. Astronomic Time: All channels.
 7. Automatic daylight savings time changeover.
 8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.
- C. Electromechanical-Dial Time Switches are not approved.
- D. Time switches shall not be used for interior lighting control unless approved by USF-PM and FM-OPS. Provide an USF Design and Construction Guideline Change Form for review and approval prior to design.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. All exterior lighting control shall be via photoelectric. Provide TORK 2007 A for all outdoor photoelectric switches.
- B. Description: Solid state, with SPST dry contacts rated for 1800 VA, to operate connected load, complying with ANSI C136.10 and EEI NEMA.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Mounting: Twist lock complying with NEMA C136.10, with base.

2.3 INDOOR CEILING VACANCY/OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 6. Lutron Electronics Co., Inc.
 7. Watt Stopper.
- B. General Requirements for Sensors: Ceiling-mounted, dual technology type indoor vacancy/occupancy sensors.
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 3 to 30 minutes. Set range at 30 minutes unless directed otherwise by the USF-PM.
 3. Provide manual switch (dimmer controls for LED luminaires) to allow manual means to turn load off. Provide dual switching (dimmer controls for LED luminaires) in classrooms and computer labs, and research labs. Coordinate control scheme with USF-PM prior to design. Classroom row of luminaires at digital or smart board shall be controlled via separate dimmer.
 4. Provide 3-way switching for classrooms to control lights at the entrances and at the professor podium.
 5. Power Pack: Dry contacts rated for 20-A ballast load at 120 and 277-V ac, for 13-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. Use when multiple sensors are required. Equal to DT-300 Series Dual Technology Ceiling Sensors. Locate power packs above manual switches location at the entrance to the space.
 6. Use line voltage sensor equal to Watt Stopper DT-355 Dual Technology Line Voltage Ceiling Sensor when only one sensor is required.
 7. Automatic Light-Level Sensor Option: Adjustable from 10 to 300 FC; turn lights off when selected lighting level is present.
 8. LEDs to indicate occupancy detection.
 9. Provide five year warranty.

2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS (SMALL OFFICES AND SIMILAR SPACES)

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 6. Lutron Electronics Co., Inc.
 7. NSi Industries LLC; TORK Products.
 8. Watt Stopper.
- B. General Requirements for Sensors: Automatic-wall-switch vacancy/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 degrees F.
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V and 1200-VA fluorescent at 277 V. Dimming type for spaces with LED luminaires.

4. Standard Range: 180 degrees field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 square feet.
5. Sensing Technology: Dual technology - PIR and ultrasonic.
6. Switch Type: Provide with choice of Auto-On or Manual-On.
7. Provide means for manual-Off override via pushbutton.
8. Voltage: Dual voltage, 120 and 277 V; dual-technology type.
9. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 FC. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
10. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes. Set at 30 minutes unless directed otherwise by the USF-PM.
11. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.5 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Allen-Bradley/Rockwell Automation.
 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 3. Eaton Corporation.
 4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
 5. Square D; a brand of Schneider Electric.
- B. Description: Electrically operated and mechanically/electrically held (as required for the control type), complying with NEMA ICS 2 and UL 508.
 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.

2.6 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in [Section 26 05 19 Low-Voltage Electrical Power Conductors & Cable](#).
- B. All wiring shall be installed in raceways.

PART 3 -- EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Spaces control schemes:
 1. Dusk to Dawn via photoelectric switch: Exterior
 2. Vacancy/occupancy sensor on/off with manual override switches: Offices, Open Offices, Work Rooms, Classrooms, Conference Rooms, Labs, Breakrooms, Corridors, Stairways (unless path of egress), Restrooms, Storage Rooms, and similar spaces.
 3. Vacancy/occupancy sensor on/off with manual override switches: Single Story Lobbies and Atriums.
 4. Building Automated System (time control) and vacancy sensor on/off: Multiple Level Lobbies and Atriums.
 5. Manual on/off: Elevator, Mechanical and Electrical Rooms.
 6. Lighting control systems are permissible in large Auditorium spaces or meeting spaces where AV is integral with lighting control. Automatic control vacancy off shall be incorporated into the system. The lighting control system shall be provided with BACnet module for FM-OPS remote control via the BAS. Dedicate closet space shall be provided for lighting control systems control units and control computer and terminal. This may be housed in the same room as the AV control system. Provide [USF Design and Construction Guideline Change Form](#) with minimum of two optional systems for USF-PM and FM-OPS review and approval prior to design.

7. Daylight Controls Area and Spaces:
 - a. Daylight controls are not desired.
 - b. If daylight controls are required, provide [USF Design and Construction Guideline Change Form](#) with minimum of two optional systems for USF-PM and FM-OPS review and approval prior to design.
- B. Install and aim sensors in locations to achieve 100 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- C. Identify components and power and control wiring according to [Section 26 05 53, Identification for Electrical Systems](#).
- D. Interior spaces lighting control shall be via line voltage occupancy sensors with means to manually override the load side off. Power packs with multiple occupancy sensors shall be used in large spaces or corridors requiring more than one sensor for adequate coverage. Small spaces control shall be via wall type occupancy sensor. Relay control panels are prohibited.
- E. Provide training for all lighting control devices to FM-OPS.

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 26 09 23

SECTION 26 22 00 LOW-VOLTAGE TRANSFORMERS**PART 1 – GENERAL****1.1 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.
 2. Buck-boost transformers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Indicate dimensions and weights.
1. Wiring Diagrams: Power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

PART 2 -- PRODUCTS**2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, provide products by the following:
1. ACME Electric Corporation; Power Distribution Products Division.
 2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
 3. Eaton Electrical Inc.; Cutler-Hammer Products.
 4. General Electric Company.
 5. Magnetek Power Electronics Group.
 6. Siemens Energy & Automation, Inc.
 7. Sola/Hevi-Duty.
 8. 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.
- B. Cores: One leg per phase.
- C. Indoor enclosure: Ventilated, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Outdoor enclosure: Ventilated with weathersheild, Type 3R.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Taps for Transformers Smaller than 3 kVA: One 5 percent tap above normal full capacity.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

- G. Taps for Transformers 25 kVA and larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 degrees C, UL-component-recognized insulation system with a maximum of 150 degrees C rise above 40 degrees C ambient temperature.
- I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Tested according to NEMA TP 2.
- J. K-Factor Rating where specified: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 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.
- K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

2.4 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Finish Color: Gray.

2.5 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic. Nameplates are specified in [Section 26 05 53, Identification for Electrical Systems](#).

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Wall mounted transformers: Mount level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers in accordance with structural engineer direction.
- B. Floor mounted transformers - Construct 4 inches housing keeping concrete base and anchor floor-mounting transformers according to manufacturer's written instructions.
- C. Dry-type transformers installed indoors and rated 112.5 KVA or less shall have a separation of at least 12 inches from combustible material, inclusive of drywall, unless separated from the combustible material by a fire resistant, heat-insulated barrier.
- D. Provide a non-fused disconnect switch at primary side of transformers located remote (not in site of) from their primary overcurrent protection device.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test secondary phase, neutral, and ground to ensure the transformer is connected properly (no floating neutral).

3.3 ADJUSTING

- A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare written report recording output voltages and tap settings.

END OF SECTION 26 22 00

SECTION 26 24 13 SWITCHBOARDS**PART 1 -- GENERAL****1.1 SUMMARY**

- A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
 2. Disconnecting and overcurrent protective devices.
 3. Instrumentation.
 4. Control power.
 5. Accessory components and features.
 6. Identification.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 2. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
 3. Include schematic and wiring diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

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. Comply with NEMA PB 2.
- C. Comply with NFPA 70.
- D. Comply with UL 891.

1.6 WARRANTY

- A. Manufacturer shall provide standard one year warranty against defects in materials and workmanship for products specified in this section. Warranty period shall begin on date of substantial completion. Project contractor shall replace defective materials during the one year warranty without additional compensation from USF.

PART 2 -- PRODUCTS**2.1 MANUFACTURED UNITS**

- 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. Enclosure: Steel, NEMA 250, Type 1.
1. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
 2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.
- C. Provide metering compartment in accordance with FM-OPS metering requirements for service entrance switchboards. If separate vertical section is required for metering, match and align

- with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- D. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
 - E. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
 - F. Pull Box on Top of Switchboard (if required by the project):
 - 1. Provide adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 2. Provide removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 - 3. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 - 4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
 - G. Phase and Neutral Buses and Connections: Three phase, four wire unless otherwise indicated. Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
 - 1. Ground Bus: 1/4 inch x 2 inches minimum size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors.
 - 2. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 3. Neutral Buses: 100 percent of the ampacity of phase buses, equipped with pressure connectors for outgoing circuit neutral cables.
 - H. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating 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. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. 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 $i^2 t$ response.
 - e. Current-Limiting Circuit Breakers: Frame sizes 40 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Ground-Fault Protection when required by NEC: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - d. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - e. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - g. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

- B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
 - 1. Fixed circuit-breaker mounting.
 - 2. Two-step, stored-energy closing.
 - 3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time time adjustments.
 - c. Ground-fault pickup level, time delay, and 12t response.
 - 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - 5. Remote trip indication and control.
 - 6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system.
- C. Disconnecting and overcurrent protection devices shall have a UL Label, factory applied, indicating the device is listed for the service voltage.

2.3 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
 - 1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 2. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 - 3. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, kilowatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Kilowatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
 - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.4 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.7 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install switchboards and accessories according to [NECA 400](#).
- B. Equipment Mounting: Install switchboards on concrete housekeeping pad base, 4 inches nominal thickness.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inches centers around the full perimeter of concrete base.
 - 2. For supported equipment, 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 switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Install filler plates in unused spaces of panel-mounted sections.
- E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Comply with [NECA 1](#).
- G. Comply with requirements for terminating feeder bus specified in [Section 26 25 00, Enclosed Bus Assemblies](#). Drawings indicate general arrangement of bus, fittings, and specialties.
- H. Comply with requirements for terminating cable trays specified in [Section 26 05 36, Cable Trays for Electrical Systems](#). Drawings indicate general arrangement of cable trays, fittings, and specialties.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in [Section 26 05 53, Identification for Electrical Systems](#).
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in [Section 26 05 53, Identification for Electrical Systems](#). Label each switchboard compartment with a factory applied nameplate indicating switchboard manufacturer's name, drawing number, manufacturer location, section number, amperage, voltage, phase, number of wires, short-circuit rating, ampacity interrupting capacity rating, and Arc Flash Warning label in accordance with NEC. Nameplate and factory applied nameplate voltage shall be listed as the service voltage.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- 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. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Switchboard will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 24 13

SECTION 26 24 16 PANELBOARDS**PART 1 -- GENERAL****1.1 SUMMARY**

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- 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.
 3. Detail bus configuration, current, and voltage ratings.
 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 5. Include evidence of NRTL listing for series rating of installed devices.
 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 7. Include wiring diagrams for power, signal, and control wiring.
 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.
- C. Drawings submissions – provide panel schedules including load summary on the design documents. Panel schedules inserted into the specifications or book format are not acceptable.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Panelboard schedules for installation in panelboards.

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.
- A. Comply with NEMA PB 1.
- B. Comply with NFPA 70.

1.6 WARRANTY

- A. Manufacturer shall provide standard one year warranty against defects in materials and workmanship for products specified in this section. Warranty period shall begin on date of substantial completion. Project contractor shall replace defective materials during the one year warranty without additional compensation from USF.

PART 2 -- PRODUCTS**2.1 GENERAL REQUIREMENTS FOR PANELBOARDS**

- A. Panelboards.
1. Enclosures: Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

4. Directory Card: Provide typewritten directory indicating areas, rooms, and loads being served by each circuit position inside panelboard door, mounted in transparent card holder. Update with new typewritten directory card for all renovations. Handwritten modifications are not acceptable.
- B. Phase, Neutral, and Ground Buses: Cooper or Tin-plated aluminum.
- C. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Tin-plated aluminum.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus Configured Terminators: Mechanical type.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- D. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- F. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series-connected short-circuit rating by an NRTL.
- G. Exterior Located Panelboards: Provide door handles that are lockable with USF standard New Standard padlock. Coordinate with USF-PM and FM-OPS.

2.2 DISTRIBUTION 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; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Mains shall be circuit breaker construction.
- E. Branch Overcurrent Protective Devices: Circuit-Breakers shall be bolt-on type.

2.3 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; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains shall be circuit breaker construction.
- D. Branch Overcurrent Protective Devices: Bolt-on type.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- 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 series-connected rating 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. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable 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 i²t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Ground-Fault Protection (where required by code): Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - d. Communication Capability (if required by the project): Universal-mounted communication module with functions and features compatible with power monitoring and control system specified in [Section 26 27 13, Electricity Metering](#).
 - e. Handle Padlocking Device: Fixed attachment for locking circuit-breaker handle in on or off position.
 - f. Handle Clamp: Loose attachment for holding circuit-breaker handle in on position.
- C. Disconnecting and overcurrent protection devices shall have a UL Label, factory applied, indicating the device is listed for the service voltage.
- D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
 1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in [Section 26 28 13, Fuses](#).

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to NECA 40.
- B. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- C. 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.
- D. Install overcurrent protective devices and controllers not already factory installed.
 1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Stub four 1 inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1 inch empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- H. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with [Section 26 05 53, Identification for Electrical Systems](#).
- B. Create a directory to indicate installed circuit loads and incorporating 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 [Section 26 05 53, Identification for Electrical Systems](#).
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in [Section 26 05 53, Identification for Electrical Systems](#).
- E. Panelboard Nameplates: Label each panelboard with a factory applied nameplate indicating manufacturer's name, drawing number, manufacturer location, section number, amperage, voltage, phase, number of wires, short-circuit rating, ampacity interrupting capacity rating, and Arc Flash Warning label in accordance with NEC. Factory applied nameplate voltage shall be listed as the service voltage.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- 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 each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- 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.

END OF SECTION 26 24 16

SECTION 26 25 00 ENCLOSED BUS ASSEMBLIES**PART 1 – GENERAL****1.1 OWNER APPROVAL**

- A. Enclosed bus assemblies shall not be used unless pre-approved by USF-PM and FM-OPS.

1.2 SUMMARY

- A. This Section includes the following:
1. Feeder-bus assemblies.
 2. Plug-in bus assemblies.
 3. Bus plug-in devices.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: For each type of bus assembly and plug-in device.
1. Show fabrication and installation details for enclosed bus assemblies.
 2. Show fittings, materials, fabrication, and installation methods for listed fire-stop barriers and weather barriers.
 3. Wiring Diagrams: Power, signal, and control wiring.

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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA BU 1, "Busways."
- C. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Derate enclosed bus assemblies for continuous operation at indicated ampere ratings for ambient temperature not exceeding 140 degrees F.

PART 2 -- PRODUCTS**2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Calvert Company (The).
 2. Eaton Electrical Inc.; Cutler-Hammer Products.
 3. General Electric Company; Electrical Distribution & Control Division.
 4. Siemens Energy & Automation, Inc.
 5. Square D; Schneider Electric.

2.2 ENCLOSED BUS ASSEMBLIES

- A. Feeder-Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.
1. Provide 100 percent neutral capacity.
 2. Temperature Rise: 55 degrees C above 40 degrees C ambient maximum for continuous rated current.
 3. Bus Materials: Current-carrying copper or aluminum, fully insulated with Class 130C insulation except at joints; plated surface at joints.
 4. Ground:
 - a. 50 percent capacity integral with housing.
 - b. 50 percent capacity internal bus bars of material matching bus material.
 - c. 50 percent capacity isolated, internal bus bar of material matching bus material.

5. Enclosure: Steel or aluminum with manufacturer's standard finish. Aluminum weatherproof with manufacturer's standard finish, sealed seams, drains, and removable closures where installed in damp or exterior locations.
6. Fittings and Accessories: Manufacturer's standard.
7. Mounting: Arranged flat, edgewise, or vertically without derating.
- B. Plug-in Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.
 1. Provide 100 percent neutral capacity.
 2. Temperature Rise: 55 degrees C above 40 degrees C ambient maximum for continuous rated current.
 3. Bus Materials: Current-carrying copper or aluminum, fully insulated with Class 130C insulation except at stabs and joints; plated surface at stabs and joints.
 4. Ground:
 - a. 50 percent capacity integral with housing.
 - b. 50 percent capacity internal bus bar of material matching bus material.
 - c. 50 percent capacity isolated, internal bus bar of material matching bus material.
 5. Enclosure: Steel or aluminum, with manufacturer's standard finish, plug-in openings 24 inches on center, and hinged covers over unused openings.
 6. Fittings and Accessories: Manufacturer's standard.
 7. Mounting: Arranged flat, edgewise, or vertically without derating.

2.3 PLUG-IN DEVICES

- A. Molded-Case Circuit Breakers: NEMA AB 1; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position.
- B. Accessories: Hookstick operator, adjustable to maximum extension of 14 feet.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.
 1. Design each fastener and support to carry 200 lb or four (4) times the weight of bus assembly, whichever is greater.
 2. Support bus assembly to prevent twisting from eccentric loading.
 3. Support bus assembly with not less than 3/8 inch rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
 4. Fasten supports securely to building structure according to [Section 26 05 29, Hangers and Supports for Electrical Systems](#).
- B. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed manufacturer's recommended distance between fittings.
- C. Construct rated fire-stop assemblies where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings.
- D. Install weatherseal fittings and flanges where bus assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight.
- E. Coordinate floor penetrations with Structural Drawings.
- F. Install a concrete curb at least 4 inches high around bus-assembly floor penetrations.
- G. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.
- H. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.
- I. Install bus-assembly, plug-in units. Support connecting conduit independent of plug-in unit.
- J. Set field-adjustable, circuit-breaker trip ranges and overload relay trip settings as indicated.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- 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. Infrared Scanning: 2 months after Substantial Completion, contractor shall perform an infrared scan of bus assembly including joints and plug-in units.
 - a. Use an infrared-scanning device designed to measure temperature or detects significant deviations from normal values. Provide documentation of device calibration.
 - b. Perform two (2) follow-up infrared scans of bus assembly, one at 4 months and the other at 11 months after Substantial Completion.
 - c. Prepare a certified report identifying bus assembly checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

END OF SECTION 26 25 00

SECTION 26 27 13 ELECTRICITY METERING**PART 1 – GENERAL****1.1 SUMMARY**

- A. Section includes equipment for electricity metering by Tampa Electric Company (TECO) and electricity metering by FM-OPS.
- B. Coordinate all requirements with USF-PM and FM Energy Department.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Dimensioned plans and sections or elevation layouts and wiring diagrams.

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.

PART 2 -- PRODUCTS**2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY (Not USF Owned)**

- A. Coordinate with USF-FM for areas that are fed from Tampa Electric Company (TECO) prior to project design.
- B. Provide meter bases and connections in accordance with TECO standards. Obtain standards from TECO customer service website, subject to USF-FM review, inspection, and approval.
- C. Services 400 Amps and less (loads 320 amps and less) shall be metered via a self-contained meter in accordance with TECO standards. Meter locations shall be coordinated with USF-FM prior to design and construction.
- D. Services larger than 400 Amps (loads larger than 320 amps) shall be metered via Current-Transformer Cabinets in accordance with TECO standards. Current transformer cabinets and meter locations shall be coordinated with USF-FM prior to design and construction. Current transformers in pad mounted transformer secondary are not approved.
- E. Meter cabinets and bases shall be provided by the contractor and shall be TECO approved. Meter sockets shall be provided by TECO. The installation shall be inspected by USF-BCA and obtain a USF-BCA Authorization to Connect Utility letter prior to TECO energizing the service.
- F. TECO meters cabinet shall be labeled with service address prior to inspection. Provide label complying with requirements for identification specified in [Section 26 05 53, Identification for Electrical Systems](#). Coordinate address with USF-PM.
- G. Coordinate with FM Energy Department to set up an account with TECO.

2.2 EQUIPMENT FOR ELECTRICITY METERING OF USF PROVIDED PRIMARY.

- A. Coordinate with USF-FM for areas that are fed from the USF provided primary prior to project design.
- B. Projects requiring self-contained meters or CT meters. Provide USF Energy Department approved, across the line or CT meter for appropriate application. CT meters shall be provided with split core CT's and three (3) inline fuses. Meters shall be submitted to USF-PM for USF-FM and FM-OPS review and approval prior to design and construction. Obtain meter number to apply to the generic label from FM Energy Department. Meters and CT cabinets shall be mounted on the building they are serving; location shall be coordinated and approved by USF-PM and USF-FM prior to design and construction. Meter options to include the following:
 - 1. Across the line socket mounted meters, self-contained Class 320 – Form 16S, Measurlogic DTS SKT or pre-approved equivalent.
 - 2. CT socket mounted meters shall be transformer rated Class 20 – Form 9S, Measurlogic DTS SIT or pre-approved equivalent.
 - 3. Enclosure: NEMA 250, Type 1 or Type 3R (suitable for application), with hasp for padlocking with USF Standard 2000 padlock.
 - 4. Meters shall have BACnet MS/TP communication capability. Data available for monitoring via BACnet communication shall include following:

- a. Display: LCD with characters not less than 0.25 inches high.
- b. Monitoring: A, V, VA, kW, kvar, kWh, kvarh, kVAh, PF, Hz.
- c. Demand metering: W, var, A, VA
- 5. Identification: Comply with requirements in [Section 26 05 53, Identification for Electrical Systems](#).
- 6. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
- 7. Current-Transformer Cabinet: Provide isolating means via circuit breaker or non-fused disconnect switch between CTs and monitoring module and between monitoring module and meter.
- 8. Across the line meters shall have a main circuit breaker on the line side to isolate the meter from the supply for maintenance.
- C. Projects with main switchboards or main distribution board shall be provided with integral meter Veris E50H2 or preapproved equivalent. Refer to Section 230900 for requirements. Features shall include the following.
 - 1. Provide isolating means via circuit breaker accessible near display meter allowing replacing the display meter without de-energizing the switchboard service.
 - 2. Meters shall have BACnet MS/TP communication capability.
- D. Provide meter integration for all installations.
 - 1. Facilities provided with a Utilities Control System, Building Control System or Building Automated System (BAS), refer to section 230519 for integration into building system.
 - 2. Facilities not provided with a Utilities Control System, Building Control System or Building Automated System (BAS).
 - a. Provide a BACnet MS/TP to BACnet/IP communication router in the nearest IDF room.
 - b. Provide 120 Volt connection to the router.
 - c. Provide a network port/data jack for the router to plug into. Coordinate with USF-FM and USF Information Technology for requirements.
 - d. Provide RS 45 twisted shield pair #18 wire in ½" conduit to router.
 - 3. Exterior located meters.
 - a. Provide a BACnet MS/TP to BACnet/IP communication router in the nearest building IDF room. Coordinate with USF-FM and USF Information Technology for nearest IDF room.
 - b. Provide 120 Volt connection to the router.
 - c. Provide a network port/data jack for the router to plug into. Coordinate with USF-FM and USF Information Technology for requirements.
 - d. Provide RS 45 twisted shield pair #18 wire in ¾" conduit to router.

2.3 USF SUB-METERING AND SEGREGATION OF LOADS

- A. Coordinate with USF-PM for sub-metering of auxiliary spaces, subleased spaces and loads. Follow requirements in section 2.2 for sub-metering.
- B. Coordinate with USF-PM for sub-metering requirements for LEED criteria or for code required segregation of loads. Design team shall provide the proposed design team approach during the programming phase prior to schematic design submission for USF-FM review and approval.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements.
- B. Comply with requirements for identification specified in [Section 26 05 43, Identification for Electrical Systems](#).
- C. New services shall be inspected and approved by USF-BCA inspector, USF Electrical Engineer, and FM-OPS prior energizing the service.
- D. Obtain a USF-BCA Authorization to Connect Utility letter prior to energizing the service.

END OF SECTION 26 27 13

SECTION 26 27 26 WIRING DEVICES**PART 1 – GENERAL****1.1 SUMMARY**

- A. Section Includes:
1. Receptacles, receptacles with integral GFCI, and associated device plates.
 2. Weather-resistant receptacles.
 3. Snap switches and wall-box dimmers.
 4. Solid-state fan speed controls.
 5. Wall-switch and exterior occupancy sensors.
 6. Communications outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
1. Receptacles for USF furnished equipment - match plug configurations.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
B. Shop Drawings: List of legends and description of materials and process used for marking wall plates.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 – PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
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 products by one of the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.4 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 products by one of the following:
 - a. Cooper.
 - b. Hubbell.
 - c. Pass & Seymour.
 - d. Leviton.

2.5 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 available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Single Pole:
 - i. COOPER; AH1221.
 - ii. Hubbell; HBL1221.
 - iii. Leviton; 1221-2.
 - iv. Pass & Seymour; CSB20AC1.
 - b. Two Pole:
 - i. Cooper; AH1222.
 - ii. Hubbell; HBL1222.
 - iii. Leviton; 1222-2.
 - iv. Pass & Seymour; CSB20AC2.
 - c. Three Way:
 - i. Cooper; AH1223.
 - ii. Hubbell; HBL1223.
 - iii. Leviton; 1223-2.
 - iv. Pass & Seymour; CSB20AC3.
 - d. Four Way:
 - i. Cooper; AH1224.
 - ii. Hubbell; HBL1224.
 - iii. Leviton; 1224-2.
 - iv. Pass & Seymour; CSB20AC4.
- C. Pilot-Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, 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 available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; AH1221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.6 DECORATOR-STYLE DEVICES

- A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 6252.
 - b. Hubbell; DR15.
 - c. Leviton; 16252.
 - d. Pass & Seymour; 26252.
- B. GFCI, Non-Feed-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
 - 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; VGF15.
 - b. Hubbell; GF15LA.
 - c. Leviton; 8599.
 - d. Pass & Seymour; 1594.
- C. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
 - 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 7621 (single pole), 7623 (three way).
 - b. Hubbell; DS115 (single pole), DS315 (three way).
 - c. Leviton; 56291-2 (single pole), 5623-2 (three way).
 - d. Pass & Seymour; 2621 (single pole), 2623 (three way).
- D. Lighted Toggle Switches, Square Face, 120 V, 15 A: Comply with NEMA WD 1 and UL 20.
 - 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 7631 (single pole), 7633 (three way).
 - b. Hubbell; DS120IL (single pole), DS320 (three way).
 - c. Leviton; 5631-2 (single pole), 5633-2 (three way).
 - d. Pass & Seymour; 2625 (single pole), 2626 (three way).
 - 2. Description: With neon-lighted handle, illuminated when switch is "off."

2.7 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 toggle switch; with single-pole or three-way switching. Comply with UL 1472.
- C. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
- D. LED Dimmer Switches: Compatible with dimmer LED drivers, capable of consistent dimming with low end not greater than 10 percent of full brightness. In new construction, utilize LED dimmable fixtures with compatible LED dimmer.

2.8 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, 0.035-inch thick, satin-finished.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum while in use cover listed and labeled for use in wet and damp locations.
 - 5. Material for kitchens or food processing areas – stainless steel.

- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum while in use cover.

2.9 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Color shall be coordinated with USF-PM. In renovated areas, the color shall match building standard and be approved by USF-PM prior to ordering.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. TVSS Devices: Blue.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 – EXECUTION

3.1 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.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough, meets NEC.
- 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.
 - 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.
 - 10. Do not install GFI type devices where readily inaccessible such as behind water fountain housings or where food prep equipment blocks access. In these instances, provide a GFI type circuit breaker protecting a standard device.

- E. Receptacle Orientation:
 - 1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- F. 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.
- G. Dimmers:
 - 1. Install dimmers within terms of their listing.
 - 2. Verify that dimmers used for fan speed control are listed for that application.
 - 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

3.2 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 115 to 126 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 5 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 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 26 27 26

SECTION 26 28 13 FUSES**PART 1 – GENERAL****1.1 SUMMARY**

- A. Section Includes: Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, fusible panelboards, switchboards, enclosed controllers, and motor-control centers.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.4 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 NEMA FU 1 for cartridge fuses.
C. Comply with NFPA 70.

PART 2 -- PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
- | | |
|--------------------------|-------------------------|
| 1. Cooper Bussmann, Inc. | 2. Ferraz Shawmut, Inc. |
| 3. Edison Fuse, Inc. | 4. Littelfuse, Inc. |

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 -- EXECUTION**3.1 FUSE APPLICATIONS**

- A. Service Entrance: Class L, time delay.
B. Feeders: Class L, fast acting.
C. Motor Branch Circuits: Class RK5, time delay.
D. Other Branch Circuits: Class RK5, time delay.
E. Control Circuits: Class CC, time delay.
F. All pedestrian post top light fixtures, parking lot light fixtures, and roadway light fixtures shall be individually fused. Provide Bussmann FNQ 10 Amp, time delay fuse, in Little Fuse LEB AB series (rated for #10 AWG line side and #10 AWG load side) single-pole breakaway in-line fuse holder. Fuse holder shall be located in the pole's handhole. No exceptions.

3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in [Section 26 05 53, Identification for Electrical Systems](#) and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION 26 28 13

SECTION 26 28 16 ENCLOSED SWITCHES AND CIRCUIT BREAKERS**PART 1 -- GENERAL****1.1 SUMMARY**

- A. Section Includes:
1. Fusible switches.
 2. Nonfusible switches.
 3. Shunt trip switches.
 4. Molded-case circuit breakers.
 5. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 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.

PART 2 -- PRODUCTS**2.1 FUSIBLE SWITCHES**

- 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. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A thru 400 A: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept one padlock, and interlocked with cover in closed position.
- D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
 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: Suitable for number, size, and conductor material.
 5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- 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. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A thru 400 A: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept one padlock, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
 - 3. Lugs: Suitable for number, size, and conductor material.

2.3 SHUNT TRIP SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Ferraz Shawmut, Inc.
 - 3. Littelfuse, Inc.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight ON pilot light.
 - 3. Isolated neutral lug.
 - 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 5. Form C alarm contacts that change state when switch is tripped.
 - 6. Three-pole, double-throw, fire-safety and alarm relay; with appropriate coil voltage.
 - 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- 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. 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. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and i₂ t response.

- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- F. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Suitable for number, size, trip ratings, and conductor material.
 - 3. Ground-Fault Protection: Comply with UL 1053; integrally mounted type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 5. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 6. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.

2.5 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.
 - 3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 -- EXECUTION

3.1 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.
- E. Exterior located switches and circuit breaker enclosures shall be pad lockable with USF Standard 2000 pad lock.

3.2 IDENTIFICATION

- A. Comply with requirements in [Section 26 05 23, 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. Indicate manufacturer's name, amperage, voltage, phase, number of wires, short-circuit rating, ampacity interrupting capacity rating, and Arc Flash Warning label in accordance with NEC.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- 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. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- 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.

END OF SECTION 26 28 16

SECTION 26 32 13 ENGINE GENERATORS**PART 1 – GENERAL****1.1 SUMMARY**

- A. This Section includes packaged engine-generator sets for emergency and standby power supply with the following features:
 - 1. Natural gas or diesel engine. The fuel source shall be coordinated with USF-PM and FM-OPS prior to design and construction.
 - 2. Unit-mounted cooling system.
 - 3. Unit-mounted control and monitoring.
 - 4. Outdoor enclosure.
- B. See [Section 26 36 00, Transfer Switches](#) for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of packaged engine generator and accessory indicated.
- 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.

1.3 INFORMATIONAL SUBMITTALS

- A. Source quality-control test reports.
- B. Field quality-control test reports.
- C. Warranty: Special warranty specified in this Section.
- D. Provide PDF of load generator sizing program showing step loads input and sizing results.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for the project/facility.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of USF, a service center capable of providing training, parts, and emergency maintenance repairs.
- 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 [ASME B15.1](#).
- E. Comply with [NFPA 37](#).
- F. Comply with [NFPA 70](#).
- G. Comply with [NFPA 99](#).
- H. Comply with [NFPA 110](#) requirements for applicable Level 1 or 2 emergency power supply system.
- I. Comply with [UL 2200](#).
- J. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- K. Noise Emission: Comply with applicable state and local government requirements for maximum noise level due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation. Utilize critical grade exhaust silencer and sound attenuated enclosure so not to exceed 72 dBA 20 feet from generator.

1.6 PROJECT CONDITIONS

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: 5 to 40 degrees C.
 - 2. Relative Humidity: 0 to 95 percent.

3. Altitude: Sea level to 100 feet.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Caterpillar; Engine Div.
 2. Magnetek, Inc.
 3. Onan/Cummins Power Generation (Industrial Business Group)
 4. Kohler Co.; Generator Division.
 5. Spectrum Detroit Diesel.

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
- C. Batteries: Gel cell type.
- D. Generator-Set Performance:
 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
 8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

- A. Fuel:
 1. Natural gas or diesel. The fuel source shall be coordinated with USF-PM and FM-OPS prior to design and construction. Generators serving critical programming facilities such as research, mission critical IT, and surgical clinics shall have diesel fuel source.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.
- D. Lubrication System: The following items are mounted on engine or skid:
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
 3. Natural Gas System:
 - a. Carburetor.
 - b. Secondary Gas Regulators: One for each fuel type.
 - c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
 - d. Flexible Fuel Connectors: One for each fuel source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: Adjustable isochronous, with speed sensing.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 2. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 1. Sound level measured at a distance of 20 feet from exhaust discharge after installation is complete shall be 72 dBA or less.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System:
 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in [Paragraph 1.6, Project Conditions](#) above.
 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 4. Battery: Adequate capacity within ambient temperature range specified in [Paragraph 1.6 Project Conditions](#) above to provide specified cranking cycle at least twice without recharging.
 5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 - a. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.

2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30 and Chapter 62-762, F.A.C.
- B. Below grade, underground tanks are prohibited.
- C. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
 1. Tank level indicator.
 2. Capacity: Coordinate with USF-PM and FM-OPS for required fuel supply hours of continuous operation at 100 percent rated power output.
 3. Vandal-resistant fill cap. Coordinate fill cap type with USF-PM and FM-OPS.
 4. Containment Provisions: Comply with requirements of authorities having jurisdiction and minimum provisions of Chapter 62-762, F.A.C.
 5. Release Detection Requirements: Comply with the minimum requirements of Chapter 62-762, F.A.C. Coordinate with USF-PM, FM-OPS, and Facilities Management-Environmental Health & Safety (FM-EH&S) for review and approval of proposed release detection methods.

6. Provide structural supports and neoprene pads or similar means to lift skid base mounted tanks above concrete pad to prevent moisture accumulation around and in contact with tank. Include methods and details in generator shop drawings for USF-FM review and approval.
7. Tank Installation/Upgrade Application and Registration: Installation contractor shall complete all applicable tank installation/upgrade applications and FDEP registration requirements (per Chapter 62-762, F.A.C.) and shall obtain approval from all appropriate regulatory departments having jurisdiction prior to installation and addition of fuel to the tank.
8. Spill Prevention, Control and Countermeasure (SPPC) Plan – USF-FM maintains a comprehensive spill prevention, control and countermeasure (SPCC) plan adhering to the requirements of the United States Environmental Protection Agency (USEPA) regulations contained in 40 C.F.R. Part 112 – Oil Pollution Prevention. Coordinate with USF-PM, FM-OPS, and FM-EH&S regarding applicable information required to amend the SPCC Plan in accordance with 40 C.F.R. Part 112 prior to construction.
9. Other above ground storage tanks that are not skid base mounted require approval from USF-FM prior to design. Coordinate with USF-PM.

2.5 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
- C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- D. Indicating and Protective Devices and Controls: As required by NFPA 110 for applicable Level 1 or 2 system, and the following:
 1. AC voltmeter.
 2. AC ammeter.
 3. AC frequency meter.
 4. DC voltmeter (alternator battery charging).
 5. Engine-coolant temperature gage.
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter.
 8. Ammeter-voltmeter, phase-selector switch(es).
 9. Generator-voltage adjusting rheostat.
 10. Fuel tank derangement alarm.
 11. Fuel tank high-level shutdown of fuel supply alarm.
 12. Fuel level indicator.
 13. Generator overload.
- E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
 1. Overcrank shutdown.
 2. Control switch not in auto position.
 3. Battery low-voltage alarm.
 4. Coolant low-temperature alarm.
 5. Battery-charger malfunction alarm.
- G. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each

alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
 - 1. Tripping Characteristic: Designed specifically for generator protection.
 - 2. Trip Rating: Matched to generator rating.
 - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices. Generator EPO button shall simultaneously shut off the generator engine and shunt trip the generator circuit breaker(s).
 - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Drip proof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Subtransient Reactance: 12 percent, maximum.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof sound attenuated aluminum housing, wind resistant up to 145 mph unless directed otherwise by USF-PM, verify prior to design. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- C. Interior Lights with Switch (if required for larger enclosures): Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
 - 1. AC lighting system and connection point for operation when remote source is available.
 - 2. DC lighting system for operation when remote source and generator are both unavailable.
 - 3. Provide LED fixtures, 4100K.
- D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection. Do not wire lights or battery charger downstream from GFCI outlet.

2.9 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
 - 2. Report factory test results within 10 days of completion of test.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with elastomeric isolator pads or restrained spring isolators having a minimum deflection of 1 inch on 4 inches high concrete base. Secure sets to anchor bolts installed in concrete bases.
- D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Section 23 11 00, Hydronic Piping.
 - 1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints.
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- F. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- G. Connect engine exhaust pipe to engine with flexible connector.
- H. Connect fuel piping to engines with a gate valve and union and flexible connector.
- I. Ground equipment according to Section 26 05 26, Grounding and Bonding for Electrical Systems.
- J. Connect wiring according to Section 26 22 00, Low-Voltage Electrical Power Conductors and Cables.
- K. Identify system components according to Section 26 05 53, Identification for Electrical Systems.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 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.
 - 2. Provide fuel for testing and fill tank upon completion of test prior to turning project over to USF.
- B. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Tests shall include a minimum of ten (10) starts of generator set, minimum of ten (10) operations of transfer switches, 4 hour maintained operation under full load via load bank. Ensure manufacturer cool down period between the engine starts.
 - 3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - 4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

- b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 7. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
 8. Exhaust Emissions Test: Comply with applicable government test criteria.
 9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50% and 100% step-load increases and decreases, and verify that performance is as specified.
 10. Harmonic-Content Tests: Measure harmonic content of output voltage under 25% and at 100% of rated linear load. Verify that harmonic content is within specified limits.
 11. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at locations 20 feet from generator enclosure, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
 - D. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - G. Remove and replace malfunctioning units and retest and reinspect as specified above.
 - H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
 - I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
 - J. At conclusion of testing, service the generator set including replacing air, oil and fuel filters, changing lubrication oil, checking batteries, adjusting fan belts for manufacturer required tightness, and refilling cooling system.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train FM-OPS maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 26 32 13

SECTION 26 36 00 TRANSFER SWITCHES**PART 1 -- GENERAL****1.1 SUMMARY**

- A. This Section includes automatic transfer switches rated 600 V and less.

1.2 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 70.
- D. Comply with NFPA 99.
- E. Comply with NFPA 110.
- F. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 -- PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Transfer Switches:
- Caterpillar; Engine Div.
 - Emerson; ASCO Power Technologies, LP.
 - Generac Power Systems, Inc.
 - GE Zenith Controls.
 - Kohler Power Systems; Generator Division.
 - Onan/Cummins Power Generation; Industrial Business Group.
 - Russelectric, Inc.
 - Spectrum Detroit Diesel.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in project/facility under the fault conditions indicated, based on testing according to UL 1008.
1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 degrees C to plus 70 degrees C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles. Provide four-pole switches on services where NEC requires GFCI.
- H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- I. Enclosures: General-purpose NEMA 250, applicable Type 1, 3R, or 12 complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- D. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.
- E. Automatic Transfer-Switch Features:
 - 1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 - 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from 0 to 6 seconds, and factory set for one second.
 - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 - 4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 - 5. Test Switch: Simulate normal-source failure.
 - 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
 - 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
 - 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
 - 9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
 - 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and

normally open; rated 10 A at 32-V dc minimum.

11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7 day exercise cycle, 20 minute running period, and 5 minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.
- F. All automatic transfer switches shall report status to the building automation system (BAS) via BACnet protocol.
 1. Required monitoring points for reporting status to BAS.
 - a. Normal Power Available
 - b. Transfer Switch Position
 - c. Generator Run Status (running or not running).
 - d. Generator Fault Status
 2. Provide Alerton VLC-444 BACnet field controller, or FM-OPS preapproved equal, in general purpose enclosure adjacent to each automatic transfer switch. Provide connection between automatic transfer switch and field controller for the monitoring points as directed by the automatic transfer switch manufacturer instructions. Verify type of BACnet field controller for each installation with FM-OPS prior to the design.
 3. Provide connection to nearest active BAS controller with #18 shielded twisted pair cable in 3/4 inch conduit.

2.4 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
 1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated.
- B. Identify components according to [Section 26 05 53, Identification for Electrical Systems](#).
- C. Set field-adjustable intervals and delays, relays, and engine exerciser clock. Coordinate with USF-PM and FM-OPS.

3.2 CONNECTIONS

- A. Ground equipment according to [Section 26 05 26, Grounding and Bonding for Electrical Systems](#).
- B. Connect wiring according to [Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables](#).

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including

- connections. Report results in writing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- B. Coordinate tests with tests of generator and run them concurrently.
- C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train FM-OPS maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
- B. Coordinate transfer switch training with generator set training.

END OF SECTION 26 36 00

SECTION 26 41 13 LIGHTNING PROTECTION FOR STRUCTURES**PART 1 -- GENERAL****1.1 SUMMARY**

- A. Section includes lightning protection for structures, structure elements, and building site components. All structures shall have lightning protection.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
1. Layout of the lightning protection system, along with details of the components to be used in the installation.
 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by UL as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
1. UL Master Label.
 2. UL Master Label Recertification for renovations and expansions. If existing structure does not have a UL Master Label, provide "Letter of Compliance".
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

PART 2 -- PRODUCTS**2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS**

- A. Comply with UL 96A and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780, appropriate Class I or Class II, aluminum unless otherwise indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. East Coast Lightning Equipment Inc.
 - b. ERICO International Corporation.
 - c. Harger.
 - d. Heary Bros. Lightning Protection Co. Inc.
 - e. Independent Protection Co.
 - f. Preferred Lightning Protection.
 - g. National Lightning Protection.
 - h. Robbins Lightning, Inc.
 - i. Thompson Lightning Protection, Inc.
 2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
 3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in the roofing sections of the Division 07, Thermal and Moisture Protection.
- C. System Conductors and Down Conductors: Aluminum and copper-clad aluminum, sized per classification required in NFPA and for Master UL Label.
- D. Counterpoise System Ground: Copper, provide when required by NFPA and for Master UL Label. Maintain system if existing.
- E. Ground Rods: Copper-clad; 3/4 inch in diameter by 10 feet long.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Provide lightning protection components and systems according to UL 96A and NFPA 780 on all new facilities, renovated facilities, and where roof replacements require removing or modifying existing lightning protection systems.
- B. Conceal the following conductors:
 - 1. System conductors.
 - 2. Down conductors.
 - a. Do not use steel structure for down conductors.
 - b. Down conductors shall be installed in PVC Schedule 40 conduit concealed in the wall.
 - 3. Interior conductors.
 - 4. Conductors within normal view of exterior locations at grade.
- C. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- D. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- E. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.
- F. Ground Loop (Counterpoise System Ground): Install ground-level, potential equalization conductor and extend around the perimeter of structure.
 - 1. Bury ground ring not less than 24 inches from building foundation.
 - 2. Bond ground terminals to the ground loop.
 - 3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.
- G. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60 feet intervals.
- H. Ground conductors located outside of building shall have 24 inches minimum burial depth.
- I. Provide inspection wells for all building grounding system rods and lightning protection driven grounding rods.
- J. Provide dual conductor paths to all roof mounted equipment including metal drains.
- K. Provide lightning conductor connection to all air terminals. Do not solely use the equipment for the path between the air terminal and conductor.

3.2 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

- A. UL Inspection: Meet requirements to obtain a UL Master Label for system. Provide UL Master Label in accordance with UL 96A with project closeout documents.
- B. Test resistance to ground at each lightning protection driven ground rod, using fall-of-potential method using megohmmeter. If the measured resistance to ground is greater than 25 ohms, provide additional driven grounds per 2.1 E until the measured resistance is less than 25 ohms.

END OF SECTION 26 41 13

SECTION 26 43 13 TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS**PART 1 -- GENERAL****1.1 SUMMARY**

- A. Section includes field-mounted SPD for low-voltage (120 to 600 V) power distribution and control equipment.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include unit dimensions, rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
B. Warranty information.
C. Drawings: Provide shop drawings indicating mounting provisions, installation instructions, and wiring diagrams.

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 testing agency, and marked for intended location and application.
B. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
C. Comply with UL 1449.
D. Comply with NFPA 70.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 -- PRODUCTS**2.1 SERVICE ENTRANCE SUPPRESSORS – Type 1**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Current Technology Inc.
2. LEA International.
4. Leviton Mfg. Company Inc.
5. PQ Protection.
B. Surge Protection Devices:
1. LED indicator lights for power and protection status.
2. Comply with UL 1449.
3. Fabrication using bolted compression lugs for internal wiring.
4. Integral service disconnect switch when connected to line side of main service switch.
5. Redundant suppression circuits.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
C. Peak Single-Impulse Surge Current Rating: 150 kA per mode / 300 kA per phase.
D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277 V / 800 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V / 800 V for 208Y/120 V.
3. Neutral to Ground: 1000 V for 480Y/277 V / 700 V for 208Y/120 V.
E. Protection modes and UL 1449 VPR for 240/120 V, single-phase, 3-wire circuits shall be as

follows:

1. Line to Neutral: 800 V.
 2. Line to Ground: 800 V.
 3. Neutral to Ground: 700 V.
- F. Protection modes and UL 1449 VPR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
1. Line to Neutral: 1200V for 480Y/277 V / 800V for 208Y/120 V.
 2. Line to Ground: 1200V for 480Y/277 V / 800V for 208Y/120 V.
 3. Neutral to Ground: 1000V for 480Y/277 V / 700V for 208Y/120 V.
- G. Protection modes and UL 1449 VPR for 240 V or 480 V, 3-phase, 3-wire, delta circuits shall be as follows:
1. Line to Line: 1800 V for 480 V / 1800 V for 240 V.
 2. Line to Ground: 1800 V for 480 V / 1200 V for 240 V.
- H. Units integral with the switchboard are not allowed.

2.2 PANELBOARD SUPPRESSORS – Type 2.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Current Technology Inc.
 2. LEA International.
 3. Leviton Mfg. Company Inc.
 4. PQ Protection.
- B. Surge Protection Devices:
1. LED indicator lights for power and protection status.
 2. Fabrication using bolted compression lugs for internal wiring.
 3. Redundant suppression circuits.
 4. Arrangement with wire connections to phase buses, neutral bus, and ground bus via panel mounted 30 Amp, 3 Pole, circuit breaker.
- C. Peak Single-Impulse Surge Current Rating: 150 kA per mode / 300 kA per phase.
- D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277 V / 800 V for 208Y/120 V.
 2. Line to Ground: 1200 V for 480Y/277 V / 800 V for 208Y/120 V.
 3. Neutral to Ground: 1000 V for 480Y/277 V / 700 V for 208Y/120 V.
- E. Protection modes and UL 1449 VPR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
1. Line to Neutral: 800 V.
 2. Line to Ground: 800 V.
 3. Neutral to Ground: 700 V.
- F. Protection modes and UL 1449 VPR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
1. Line to Neutral: 800 V.
 2. Line to Ground: 800 V.
 3. Neutral to Ground: 700 V.
- G. Protection modes and UL 1449 VPR for 240 V or 480 V, 3-phase, 3-wire, data circuits shall be as follows:
1. Line to Line: 2000 V for 480 V / 1000 V for 240 V.
 2. Line to Ground: 1500 V for 480 V / 800 V for 240 V.
- H. Units integral to panelboards are not allowed.

2.3 ENCLOSURES

- A. Indoor Enclosures: NEMA 250 Type 1.
- B. Outdoor Enclosures: NEMA 250 Type 3R or Type 4.
- C. Stainless steel where required such as chiller plants and lift stations areas.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Provide Type 1 SPD devices at all service entrances on load side of main switch, with ground lead bonded to service entrance ground.
- B. Provide Type 2 SPD devices for panelboards and auxiliary panels with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground. Locations shall include all exterior panels, lab panels, panels serving exterior lighting and equipment loads, and process equipment panels. Coordinate with USF-PM for other panels requiring Type 2 connection prior to design.
 - 1. Provide multiple pole, 30-A circuit breaker as a dedicated disconnecting means for Type 2 SPD unless otherwise indicated.

3.2 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. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 - 2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
 - 3. Complete startup checks according to manufacturer's written instructions.
- C. SPD device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Do not energize or connect service entrance equipment or panelboards to their sources until SPD devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train FM-OPS maintenance personnel to maintain SPD devices.

END OF SECTION 26 43 13

SECTION 26 51 00 INTERIOR LIGHTING**PART 1 – GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Interior lighting fixtures.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
- B. Related Sections:
 - 1. [Section 26 09 23, Lighting Control Devices](#) for automatic control of lighting, including time switches, photoelectric relays, and occupancy sensors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of dimmer-controlled fixtures from manufacturer.
- C. Provide a fixture sample if directed by USF-PM.
- D. Submit photometric calculations superimposed onto the floor plan if directed by USF-PM. The photometric levels are to be legible when plotted to scale.
- E. Lighting fixture schedule indicating the fixture manufacturer, catalog number, input watts, CRI and Kelvin temperature color identification, and description shall be included on the electrical documents.
- F. Light levels shall meet IESNA recommendations unless directed otherwise by USF-PM.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 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](#).

1.5 WARRANTY

- A. LED Fixtures, Light Emitting Diodes (LEDs), and Drivers: Manufacturer shall provide five year warranty against defects in materials and workmanship for all products. Project contractor shall replace defective fixtures and components during the first year of warranty without additional compensation from USF.
- B. Warranty period shall begin on date of substantial completion.

PART 2 -- PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturers and products are subject to USF-FM review and approval.
 - 1. Provide electronic (PDF format) cutsheets of proposed fixtures with reflected ceiling plan at design development.
 - 2. Provide electronic (PDF format) cutsheets of specified fixtures at 100% Construction Documents.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with [NEMA LE 4](#) for ceiling compatibility for recessed fixtures.
- B. All fixtures shall be LED type.
- C. Incandescent, [MR16](#), and quartz lamp fixtures are prohibited.
- D. Fluorescent and induction lamp fixtures are prohibited.
- E. HID lamp fixtures are prohibited.

- F. LED: UL listed per document UL 8750.
- G. Metal Parts: Free of burrs and sharp corners and edges.
- H. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- I. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit maintenance without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during maintenance and when secured in operating position.
- J. USF campus standard LED fixtures (coordinate with USF-PM for the fixture appropriate for the project):
 1. 2'x4', equal to Lithonia 2ALL4 CTRF architectural LED troffer.
 2. 2'x2', equal to Lithonia 2ALL2 CTRF architectural LED troffer.
 3. Specification grade LED down lights for the application.
 4. Provide standard 1% (0-10 volt) dimming.
 5. Deviations require USF-FM approval via USF Design and Construction Guideline Change Form. Coordinate with USF-PM.
- K. Diffusers and Globes:
 1. Use of lay-in acrylic lens luminaires requires approval from USF-FM and FM-OPS prior to design.
 2. 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.
 - c. Glass: Annealed crystal glass unless otherwise indicated.
 - d. Polycarbonate lens are not permitted.
- L. Air-handling fluorescent fixtures shall not be used.

2.3 EMERGENCY POWER UNIT

- A. Internal Type, locations without life safety generator: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body. Comply with UL924.
 1. Emergency Connection: Operate as night light where not required to be switched.
 2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 3. Battery: Sealed, maintenance-free, nickel-cadmium type.
 4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 5. 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.
 6. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 7. Protection: Class P thermal cutout.
- B. Wall or ceiling mount dual head emergency lights with battery back-up are not approved. Provide self-contained, modular, battery inverter unit in LED fixtures in accordance with 2.5 A.

2.4 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. Self-Powered Exit Signs (Battery Type), locations without a life safety generator: Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.

- c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
- e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.5 LAMPS (EXISTING REPLACEMENT)

- A. USF campus standard T8 rapid-start lamps, rated 28 W maximum, nominal length of 48 inches 2800 initial lumens (minimum), CRI 85 (minimum), color temperature 3500K, and average rated life of 36,000 hours.
 - 1. Campus standard lamp is Sylvania Product Number 22178, F028/835/XP/SS/ECO with matching ballast: 1 lamp – QHE1x32 T8/UNV ISN-SC, 2 lamp – QHE 2x32 T8/UNV ISN-SC, and 3 lamp – QHE 3x32 T8/UNV ISN-SC. Or equivalent Phillips lamps and ballasts.
 - 2. College of Medicine buildings (CMS, CPH, MDA, MDC, MDH, MDL, MDN, and MDT) Kelvin temperature shall be 4100K.

2.6 KELVIN TEMPERATURE AND CRI STANDARDS

- A. USF campus standard:
 - 1. Color Index: CRI 80-85 (provide CR 95 minimum in galleries or other spaces requiring higher CRI – coordinate with USF-PM prior to design).
 - 2. Campus standard Kelvin temperature shall be 3500K.
 - 3. College of Health buildings (CMS, CPH, MDA, MDC, MDH, MDL, MDN, and MDT) Kelvin temperature shall be 4100K.

2.8 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with [Section 26 05 29, Hangers and Supports for Electrical Systems](#) for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2 inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2 inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 ga.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 ga.
- F. Rod Hangers: 3/16 inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

Part 3 -- EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Provide final aiming and focusing of luminaires under direction of USF-PM. All exterior lights final aiming and focusing shall be performed during non-daylight hours at the discretion of USF-PM.
- C. Comply with NFPA 70 for minimum fixture supports.
- 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.
- E. Adjust amiable lighting fixtures to provide required light intensities.
- F. Connect wiring according to [Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables](#).

- G. All fixtures LEDs boards and drivers shall be readily accessible from underneath the fixture, through the lens, door, open aperture, etc.
- I. Provide emergency lights in all restrooms.
- J. Facilities with life safety generator (Level 1): connect emergency egress lighting to the life safety generator.

3.2 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.

END OF SECTION 26 51 00

SECTION 26 56 00 EXTERIOR LIGHTING**PART 1 -- GENERAL****1.1 SUMMARY**

- A. Section Includes:
1. Exterior luminaires with LED illumination source and drivers.
 2. Poles and accessories.

1.2 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in the Florida Building Code. Poles and fixtures assemblies shall meet 145 mph.

1.3 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.
- B. Provide a fixture sample if directed by USF-PM.
- C. Submit photometric calculations superimposed onto the site plan or floor plan for all exterior lighting. The photometric levels shall be legible when plotted to scale. Provide separate photometric calculations for emergency egress lighting. Provide photometric calculations for all approved luminaires in section 2.1. Final design layout and quantities shall be based on the manufacturer requiring the greatest amount of luminaires to meet USF guidelines. Coordinate with USF PM to schedule a pre-design meeting with the USF FM EE to review design approach prior to proceeding.
- D. Design Light levels (Provide for USF-FM review and approval in the 50% Construction Document Phase or earlier submission):
1. Pedestrian Walkways/Sidewalks: 1.0 to 1.5 foot-candle average, 3:1 average to minimum ratio. 0.3 foot-candle minimum allowable level.
 2. Parking Areas: 1.0 to 1.5 foot-candle average, 3:1 average to minimum ratio. 0.5 foot-candle minimum allowable level.
 3. Roadways: 1.0 to 1.5 foot-candle average, 4:1 average to minimum ratio. 0.3 minimum allowable level.
 4. Emergency Egress lighting, required 50 feet from building at all emergency egress exits: 1.0 foot-candle average, no point less than 0.1 foot-candle, comply with NFPA 101 7.9.2. Coordinate with USF Building Code Administrator.
 5. Pedestrian Crosswalks: Provide roadway standard pole assembly at each entrance point from the sidewalk (e.g. both sidewalk to crosswalk entrances)
 6. Design light levels shall be maintained levels.
- E. Lighting fixture schedule indicating the fixture manufacturer, catalog number, voltage, input watts, CRI and Kelvin color identification, mounting, and description shall be included on the electrical documents in a "Fixture Schedule".

1.4 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 IEEE C2, "National Electrical Safety Code".
- C. Comply with NFPA 70.

1.5 WARRANTY

- A. LED fixtures, lighting emitting diodes, and drivers: Manufacturer shall provide five year warranty against defects in materials and workmanship for all products. Project contractor shall replace defective fixtures and components during the first year of warranty without additional compensation from USF.
- B. C. Warranty period shall begin on date of substantial completion.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers and products are subject to USF-FM review and approval.
 1. Provide electronic (PDF format) cutsheets of proposed fixtures at design development.
 2. Provide electronic (PDF format) cutsheets of specified fixtures at 100% Construction Documents.
- B. USF campus standard LED roadway fixture (verify project specific voltage).
 1. Cooper Lighting: NAV AF 03 E UNV T3 10K AP, or
 2. Phillips: RFL 145W64LED4K T R3M UNV DMG SP2 GY3
 3. Proposed substitutions require preapproval from USF Electrical Engineer.
- C. USF campus standard Parking Lot LED fixture (verify project specific voltage).
 1. Parking Lot Perimeter:
 - a. Cooper Lighting: NAV AF 03 E UNV T3 10K AP, or
 - b. Phillips: RFL 145W64LED4K T R3M UNV DMG SP2 GY3
 - c. Proposed substitutions require preapproval from USF Electrical Engineer.
 2. Parking Lot Interior (verify project specific voltage):
 - a. Cooper Lighting: NAV AF 03 E UNV SWQ 10K AP, or
 - b. Phillips: RFL 145W64LED4K T 5 DMG SP2 GY3
 - c. Proposed substitutions require preapproval from USF Electrical Engineer.
- D. USF campus standard post top pedestrian LED fixture (verify project specific voltage).
 1. Cooper Lighting: MPW AC-LED E U SYM GREY, or
 2. AEL: 245L 20LED70 4K MVOLT R5 GL NR SD SS
 3. Substitutions are not permitted.
- E. Roadway and parking lot fixture color shall be grey.
- F. Pedestrian/sidewalk fixture color shall be grey.
- G. Coordinate with USF-PM for building mounted fixture color. All building mounted and canopy luminaires shall be LED.

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. All exterior light fixtures including building mounted and canopy luminaires shall be full cutoff type, dark sky friendly, to reduce light pollution. USF standard pedestrian light fixture specified in 2.1 is exempt from the full cutoff requirement.
- 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 aluminum enclosures that will not warp, sag, or deform in use.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during servicing and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- 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: Aluminum baffles, or shields factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- K. Provide factory mounted in-line surge protection in all exterior roadway fixtures, parking lot fixtures, and pedestrian/sidewalk fixtures. Provide additional surge protector in each pole handhole equal to PQ Protection Series meeting Department of Transportation standards.
- L. All exterior fixtures shall be aluminum. Factory-applied finish for aluminum luminaires shall comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff

- complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
- M. Factory-Applied Labels: Comply with UL 1598. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles.
 - N. Exterior pedestrian, roadway, and parking lot lighting shall be fed from 60 ampere, 3 phase source via 60 ampere, 3 pole circuit breaker. Branch wiring shall be 4 # 6, 1 # 6 equipment ground in 1-1/2 inches conduit. Luminaires shall be 277 Volt. A 3 phase branch circuit shall be utilized, alternating between Phase A, B, and C for a balanced load. Extend all three Phases to end of conduit run unless directed otherwise by USF-PM and FM-OPS.

2.3 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with Florida Building Code.
 - 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.
- 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.
- D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 inches x 5 inches, with cover secured by stainless-steel captive screws. Provide ground lug with stainless steel screw inside of pole, adjacent to the handhole opening. Center line of handhole shall be 24 inches above finish grade for all poles. Handhole cover shall be flush to pole.

2.5 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
 - 1. Shape: Round, tapered.
 - 2. Direct Burial.
- B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- C. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, and then bolted together with stainless-steel bolts.
- D. Pole Finish – Brush satin natural aluminum finish.
- E. Poles Delivered to Site:
 - 1. Unwrap protective covering immediately and store so not to damage finish.
 - 2. Schedule inspection with USF-PM to ensure protective wrapping has been removed and the pole finish is acceptable to USF.
- F. USF standard poles: Substitution requires pre-approval from USF-FM prior to design.
 - 1. Roadway and Parking Lot Poles located in grass or landscape areas (direct burial type): Fixture mounting heights, 32 feet-6 inches above finish grade. Valmont 290845806TEA/1TA0832BSBF-HH 24 inches nominal 39 feet pole embedded 9 feet, or preapproved equal. Fixture Truss Arm shall be 8 feet arm.
 - 2. Parking Lot Poles (concrete base mounted): Fixture mounting heights, 32 feet-6 inches above finish grade. Valmont 270245805T4/1TA0832B45SBF nominal 27 feet-2 inch mounted on concrete base (nominal 2 feet-6 inches above ground and minimum 8 feet embedded), or preapproved equal. Fixture Truss Arm shall be 8 feet. Concrete pole base required for locations in asphalt or concrete areas without grass islands. Pole base shall be stained DOT yellow. Pole base detail shall be pre-approved by USF-FM at schematic design phase. Concrete base with pole assembly submittal including wind load calculations meeting USF campus wind load criteria shall be signed and sealed by a Florida Registered Structural Engineer.
 - 3. Post Top Pedestrian Lights Pole: Fixture mounting heights, top of pole 9 feet-8 inches to 10 feet-0 inches above finish grade. Valmont Structures 0908 30404TE TENON SBF, or preapproved equal.
 - 4. Burial (embedded) depths shall be as required by manufacturer to meet wind load requirement. Provide protective coating (Bitumastic) from pole bottom to line indicated for the embedded depth. The pole shall not be embedded no lower than the protective coating.

If pole is embedded beyond this line, the contractor shall replace pole at no additional compensation from USF.

PART 3 -- EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Provide final aiming and focusing of luminaires that require field adjustment or aiming under the direction of USF-PM. Aiming and focusing luminaires shall be performed during non-daylight hours.
- C. Provide adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.2 POLE INSTALLATION (Site Lighting - Pedestrian Light Poles, Roadway Light Poles, Parking Lot Light Poles, etc.)

- A. Alignment: Align poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Coordinate all pole locations with USF-PM prior to installation. All pole locations shall be staked for USF review and approval prior to excavating. Failure to verify proposed pole locations prior to excavating, the contractor shall bear all costs to relocate raceways, handholes, and poles as directed by USF. Maintain the following minimum horizontal distances from surface and underground features:
 1. Fire Hydrants: 7 feet-6 inches.
 2. Water, Gas, Electric, Communication, and Sewer Lines: 5 feet.
 3. Trees: Coordinate tree spacing with poles, locate pole at midpoint between trees.
 4. All roadway and parking lot light poles shall be located 4 feet from edge of parking or roadway curb to face of pole.
 5. All sidewalk light poles shall be located 3 feet from edge of sidewalk to face of pole.
- C. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated by the manufacturer to meet the wind load requirements.
 1. Dig holes large enough to permit use of tampers in the full depth of hole.
 2. Backfill in 6 inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
 3. Contractor shall re-tamp grade around pole 30 days after installation. Provide required fill and sod.
 4. Provide concrete collar at all roadway light poles. Obtain USF standard concrete collar detail from USF Electrical Engineer prior to design.
- D. Raise and set poles using web fabric slings (not chain or cable).
- E. Provide an in-ground handhole within 3 feet of each light pole for branch wiring connection to light pole. Minimum distance from pole shall be 1 feet-6 inches, but no closer that will affect the wind load rating for the pole assembly installation; consult with pole manufacturer performing the wind load structural analysis. In-ground handhole shall be located behind the pole, opposite of the sidewalk or roadway. The pole handhole shall face the in-ground handhole. "Electrical" label on in-ground handhole cover shall face the sidewalk or roadway. These may not be shown on plan view, but they are implied by the pole location.
- F. Branch wiring connection to light pole (between in-ground handhole and pole handhole) shall be 2 #10, 1 #10 equipment ground, and 1 #8 bare ground (bond between driven ground rod and pole ground lug) in 1 inch non-metallic flexible conduit.
- G. Connection to luminaires shall be #10 and #10 equipment ground. Provide slack at luminaire to allow removal from pole or mounting arm without disconnecting conductors and ground.
- H. Electrical connections in in-ground handholes shall be Raychem GHFC H Frame weatherproof closures UL listed for the application. Use weatherproof Blue Ideal wire nuts for end of single conductors.
- I. Provide luminaires fuses in pole handhole in accordance with [Section 26 28 13, Fuses](#).
- J. Provide identification tag on each light pole as directed by USF-PM and FM-OPS. Tag shall read top to bottom and face the roadway, parking lot, or sidewalk as directed by USF-PM and FM-OPS. The top of the tag for roadway and parking lot poles shall be located 10 feet above finish grade. The top of the tag for pedestrian poles shall be located 7 inches below the bottom of the luminaire housing base. The tags shall be Panduit nominal 3 feet x 1-3/4 inches with

black background and yellow reflective numbers: Panduit PRL250YB-1 with appropriate letter and number.

3.3 GROUND MOUNTED LUMINAIRES

- A. All landscape uplighting, building floodlighting, sign lighting, and flag uplighting shall be LED type floodlight mounted on concrete base. USF campus standard is RAB HBLEDD26NVG (verify project specific voltage). Use narrow beam for flag uplighting RAB HNLED26NG (verify project specific voltage). USF standard color shall be Verde Green (verify with USF-PM prior to ordering).
- B. Install on concrete base with top of concrete 6 inches above finish grade. Cast conduit or support into base, and finish by troweling and rubbing smooth.
- C. Concrete base diameter shall provide protection for the luminaire from lawn equipment, but in no case be smaller than 18 inches diameter, or less than 6 inches from furthest end of luminaire. Concrete base shall support Arlington Industries, Inc. GARD-N-POST GP26G 77094 Green for mounting floodlight.

3.4 GROUNDING

- A. Ground metal poles and support structures according to Section 26 05 26, Grounding & Bonding for Electrical System.
 - 1. Install grounding electrode for each pole in pole handhole.
 - 2. Provide #8 bare copper ground from grounding electrode to ground lug in pole. Bond the equipment grounds and pole ground to the driven grounding electrode via Acorn type connector. Ground pole to driven grounding electrode with #8 bare copper, looped through the Acorn connector at the electrode and connect to #6 and #10 equipment grounds in the in-ground handhole.

3.5 USF EMERGENCY PHONES BLUE LIGHTS

- A. The emergency safety light and phone towers (Blue Lights) shall be "Talk-a-phone" Model ETP-MTE. Pole tower shall be painted USF standard Pantone Green color PMS 342 with reflective white lettering. Coordinate with USF-PM, USF-IT, and FM-OPS for most current specification.
 - 1. Talk-A-Phone ETP-MTE
 - 2. Talk-A-Phone ETP-500E: Hands Free Help Phone.
 - 3. Talk-A-Phone Blue Light shall be LED top light ETP-EL and LED faceplate light.
- B. Provide concrete base per manufacturer installation instructions.
- C. Power via dedicated 120 Volt branch circuit from the nearest building. Provide a lock-on handle on the branch circuit breaker. 120 Volt branch circuit shall be via standby generator backed up panel if available.
- D. Provide 3/4 inch conduit with CAT 6E wire from the nearest building IDF room. Coordinate with USF-IT.
- E. Coordinate Blue Lights locations with USF-PM, FM-OPS, USF-IT, and USF-UPD prior to conduit rough-in.
- F. Project FM-PM shall identify and provide funding source chart field for a monthly billing entity through USF-IT Communications for the phone service and/or purchase of the Blue Light assembly prior to design or construction.

3.6 EXTERIOR POLE MOUNTED LIGHTING CONTROL

- A. Provide 24 inches x 24 inches x 8 inches deep NEMA 3R Hoffman enclosure. Locate on exterior of building as directed by USF-PM and FM-OPS.
- B. Provide backboard in Hoffman enclosure for mounting equipment. Backboard shall be manufactured with fire resistant materials.
- C. Provide 60 ampere, 3 pole circuit breaker for local means to disconnect power. Locate circuit breaker on the left side of the enclosure. The line side conduit shall enter the enclosure on the left side.
- D. Provide 60 ampere, 3 pole lighting contactor. Locate contactor on top right side of the enclosure. The load side conduit shall exit the enclosure on the right side.
- E. Provide on/off/auto selector switch for lighting contactor override control. Selector switch shall be located inside the enclosure, lower left hand corner. Selector switch shall not be integral to the lighting contactor and shall not be able to be controlled by the public while the enclosure is

- closed. Label the selector switch control positions: ON / OFF / AUTO.
- F. Provide lightning arrester, leads connected to load side of lighting contactor. The lightning arrester shall be located at the lower right bottom of enclosure.
 - G. Provide Tork 2007A photocell on Hoffman enclosure for lighting control. Face photocell away from light sources. Locate photocell at the right top of enclosure.
 - H. Provide the same exterior lighting control apparatus listed in [Subparagraph 3.6 A thru G](#) above for the emergency egress pole mounted lighting. Emergency egress lighting branch circuit breaker can be sized to the load, but no smaller than 30 amperes. All items on the load side of the contactor shall meet USF site lighting standards, such as 3 phase branch circuit, minimum conductor size #6 AWG, and minimum conduit size 1-1/2 inches. The emergency lighting branch circuit, circuit breaker, and contactor can be located in the same Hoffman enclosure as the normal exterior lighting branch circuit apparatus provided there is a separation barrier and there is NEC code required space in the Hoffman enclosure. Contractor shall provide layout for USF approval prior to ordering, include in project submittals.

3.7 USF FM OPERATIONS COORDINATION

- A. Coordinate with USF-PM and FM-OPS prior to working on any existing branch circuit.
- B. All roadway, parking lot, walkway, and area lighting circuits shall remain operational during modifications or relocations.
- C. Removed concrete poles, fiberglass poles, concrete base poles and concrete bases that are not re-used shall be removed from the campus for disposal by the contractor. FM-OPS approval is required before re-using any removed pole.
- D. Removed fixtures arms shall be removed from the campus for disposal by the contractor. Removed fixtures shall be delivered to FM-OPS approved storage area if requested by FM-OPS. Coordinate with USF-PM and FM-OPS prior to construction.

END OF SECTION 26 56 00