CDB PROJECT 040-010-115

NEW NURSING HOME AND DOMICILIARY

FOR

THE ILLINOIS DEPARTMENT OF VETERANS' AFFAIRS ILLINOIS VETERANS' HOME AT QUINCY, ADAMS COUNTY

BRIDGING DOCUMENTS – VOLUME 02 November 11, 2019

1707 N. 12TH STREET QUINCY, IL 62301



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State of Illinois CAPITAL DEVELOPMENT BOARD

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PROJECT MANUAL FOR

CDB 040-010-115

New Nursing Home and Domiciliary Illinois Veterans' Home, Quincy Department of Veteran Affairs Quincy, Adams County, Illinois

DATE: November 11, 2019

The following listed documents comprise the project manual for the project listed above. Where numerical sequence of sections is interrupted, such interruptions are intentional.

The complete Project Manual for this project consists of the listed Volume(s), which must not be separated for any reason. The Architect and Owner disclaim any responsibility for any assumptions made by a contractor or subcontractor who does not receive a complete Project Manual, including all sections listed in the Table of Contents.

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SPECIFIER:	General:	Perkins Eastman 209 South LaSalle Street, Su Chicago, IL 60604	ite 400		

END 00 01 10.

SECTION 211000 – WATER-BASED FIRE-SUPRESSION SYSTEMS

1. GENERAL

1.1 SUMMARY

- A. Provide complete design, equipment, material, devices, labor, and supervision necessary to fabricate and erect hydraulically designed Wet Pipe Sprinkler and Sandpipe Fire Suppression Sprinkler Systems as required by the Drawings and this Section.
- B. Provide wet pipe fire suppression and sandpipe system in the Nursing Home.
- C. Provide wet pipe fire suppression system in the Domiciliary.
- D. Provide fire pump in each of the Nursing Home and Domiciliary.

1.2 CODES AND REGULATIONS

- A. Sprinkler system design, equipment, materials, devices, and installation shall conform to the following:
 - 1. NFPA National Fire Code pamphlets 13 (or 13R), 14, 101, and other applicable pamphlets.
 - 2. International Fire Code (NFPA National Fire Code pamphlet 101 shall take precedence where conflicts arise)
 - 3. Factory Mutual Global Approval Guide
 - 4. Underwriters Laboratory
 - 5. Fire Investigation Act. Part 41, Illinois Administrative Code Section 425, Section 25/6
 - 6. NFPA 99 : Healthcare Facilities Code, 2012

1.3 SEISMIC PROTECTION

- A. Seismic
 - 1. Risk Category (2018 IBC)
 - a. Nursing Home = 4
 - b. Domiciliary = 4
 - c. Nielson = 2
 - 2. Site class (ASCE/SEI 7-10)
 - a. Nursing Home = D
 - b. Domiciliary = D
 - 3. Seismic Importance Factor I_e (ASCE/SEI 7-10)

- a. Nursing Home = 1.5
- b. Domiciliary = 1.5
- 4. Component Importance Factor I_p
 - a. Follow ASCE/SEI 7-10, Chapter 13 Seismic Design Requirements for nonstructural components.
- B. Delegated Design
 - 1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic forces required to select seismic restraints.

1.4 SPRINKLER DESIGN

- A. Fire Hydrant Flow Test: Sprinkler system hydraulic calculations shall be based on a recent (within five calendar years or since the last major modification was made to the surrounding distribution system) fire hydrant flow test. Hydrants used should be immediately adjacent to water service connection building.
- B. Fire Service Line: The fire service line to the building is preferred to also provide domestic water service. Therefore, the fire protection contractor will start work at the backflow preventer

2. PRODUCTS

2.1 FIRE PUMPS

- A. Fire pumps shall be electric driven horizontal splitcase centrifugal type as manufactured by Aurora, Patterson, Peerless, and Xylem/ITT-AC.
- B. Fire Pump Controllers: Masters, Firetrol, and Cutler-Hammer/Eaton

2.2 FITTINGS

- A. Couplings: Grooved couplings shall be prelubricated type only. Any field lubrication is prohibited.
- B. Cast-Iron Threaded Flanges: ASME B16.1, Class 125, raised ground face, bolt holes spot faced.
- C. Cast-Iron Threaded Fittings: ASME B16.4, Class 125, and standard pattern, with threads according to ASME B1.20.1.

- D. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, and standard pattern, with threads according to ASME B1.20.1.
- E. Grooved-End Fittings for Ductile-Iron Pipe: ASTM A 536 ductile-iron or ASTM A 47 malleable-iron, AWWA pipe-size, designed to accept AWWA C606 grooved couplings. Include cement lining or Food and Drug Administration (FDA)-approved interior coating.
- F. Steel Fittings: ASTM A234, seamless or welded; ASME B16.9, buttwelding; or ASME B16.11, socket-welding type for welded joints.
- G. Steel Flanges and Flanged Fittings: ASME B16.5.
- H. Grooved-End Fittings for Steel Pipe: UL-listed and FM-approved, ASTM A 536, Grade 65-45-12 ductile iron or ASTM A 47 Grade 32510 malleable iron, with grooves or shoulders designed to accept grooved couplings.
- I. "Full-body style" mechanical tees are acceptable. "U-bolt style" mechanical tees are not allowed.

2.3 PIPE

- A. Use pipe, fittings, and joining methods according to the following applications. Piping may be joined with flanges instead of indicated joints. Use grooved end fittings with grooved couplings that are made by the same manufacturer and that comply with listing when used together for grooved-coupling joints.
- B. All sprinkler piping in fire pump room or where the fire service enters the building shall be painted to prevent external corrosion.
- C. Pipe between Backflow Preventer and Pump: Use galvanized steel for piping between the backflow preventer and pump.
- D. Drains and Pipe between Fire Department Connections and Check Valves: Use Galvanized steel pipe instead as specified below for dry pipe systems. Do not use welded joints.
- E. Sizes 2" and Smaller for Wet Pipe Systems: ASTM A 53 or A 135 Schedule 40 steel pipe with rolled-groove or cut-groove ends, grooved-end steel pipe fittings, and grooved-coupling joints. Threaded fittings and joints are also acceptable.
- F. Sizes 2 ¹/₂ and larger for Wet Pipe Systems: ASTM A 135 or A 795, Schedule 10 (minimum) steel pipe with rolled groove ends, grooved-end steel pipe fittings, and grooved-coupling joints.
- G. UL and FM approved flexible stainless steel piping drops to sprinkler heads are allowed only if there is not enough space for standard threaded fittings and pipe.
- H. CPVC may be used where listed and where pipe is concealed.

2.4 SPRINKLERS

- A. Components: O-rings shall not be used with any sprinkler.
- B. Response Rating: Automatic Sprinklers with quick-response element conforming to UL 199 for applications except residential.
- C. Sprinkler types and categories are as indicated and as required by application. Furnish automatic sprinklers with nominal ¹/₂-inch orifice and ¹/₂-inch NPT when available.
- D. Sprinkler types include:
 - 1. Coated or plated sprinklers
 - 2. Recessed sprinklers
 - 3. Sidewall sprinklers
 - 4. Upright sprinklers
 - 5. Concealed sprinklers
- E. Sprinkler Finishes: Painted, chrome, and bronze
- F. Sprinkler Escutcheons: Escutcheons for recessed-type sprinklers are specified with sprinklers.
- G. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.
- H. Sprinkler Cabinets: Finished steel cabinets and hinged cover, with space for minimum of 6 spare sprinklers plus sprinkler wrench, suitable for wall mounting. Include number of sprinklers required by NFPA 13 and 1 wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each style of sprinkler on project.
- I. Dry Sprinklers: Dry pendent and dry sidewall sprinklers shall be at least 24 inches long.

2.5 SPECIALTY VALVES

- A. Ball Drip Valves: UL 1726 automatic drain valve, ³/₄-inch size, spring loaded, ball check device with threaded ends.
- B. Backflow Preventer: Double check shall be Ames 2000ss, Wilkins, Watts.
- C. Dry Pipe Valve: Dry Pipe Valves shall be UL-listed and FM-approved, with 175-psig working pressure. Include trim sets for bypass, drain, electric sprinkler alarm switch, air pressure monitoring switch, pressure gauges, precision retarding chamber, air line, and fill line attachment with strainer.
 - 1. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
 - 2. Option: Grooved-end connections for use with grooved-end piping.
- D. Manual Air Vent: Require manual air vent at high point for each zone.

2.6 CONNECTIONS

- A. Freestanding Fire Department Connections: Freestanding Fire Department Connections supplying standpipe systems shall be polished brass with double clappers, plugs and chains, polished brass sleeve to cover standpipe and escutcheon lettered "Standpipe." The 2-1/2 inch by 2-1/2 inch by 4 inch Fire Department Connection shall be located on the street side of the building not less than 18 inches or more than 48 inches above grade or adjoining ground.
- B. Standpipe Hose Connections: Each standpipe hose connection shall be 2 ¹/₂ inches and shall be approximately 4 feet, 6 inches above the floor.

2.7 ALARM DEVICES

- A. Waterflow Indicators: UL 346, electrical-supervision type, vane-type Waterflow detector, rated to 250 psig, and designed for horizontal or vertical installation. Include 2 SPDT (single-pole, double-throw) circuit switches to provide isolated alarm and auxiliary contacts, 7 ampere, 125 volts AC and 0.25 ampere, 24 volts DC; complete with factory-set, field-adjustable retard element to prevent false signals, and tamper-proof cover that sends a signal when cover is removed.
- B. Supervisory Switches: UL 753 for valves, electrical-supervision type, SPDT (single-pole, double-throw), normally closed contacts, designed to signal controlled valve in other than full open position.
- C. Acceptable Manufacturers: Potter, System Sensor, and Notifier.

2.8 HYDRAULIC CALCULATIONS

A. Size system piping such that total required system pressure at demand flow (including hose streams) is at least 5 psi less than the available pressure at demand flow.

2.9 SPRINKLER APPLICATIONS

- A. Rooms without Ceilings: Upright sprinklers.
- B. Rooms with Ceilings: Recessed sprinklers.
- C. Beneath Overhead Doors: Sidewall sprinklers.
- D. Vestibules, stairwells, shipping, and other rooms with exterior doors: Dry pendent or dry sidewall sprinklers.
- E. Sprinkler Finishes: Use sprinklers with following finishes:
 - 1. Upright and Sidewall Sprinklers: Rough bronze.
 - 2. Recessed Sprinklers: White with white escutcheon.

- F. Sprinkler Temperature Ratings: Use sprinklers with the following temperature ratings in the applications listed unless noted otherwise on drawings:
 - 1. Ordinary Temperature Classification (165° F): Top of elevator hoistways where ambient temperatures cannot exceed 100° F, bottom of elevator hoistways for hydraulic elevators, elevator machine rooms, public areas, offices, custodial rooms, mechanical equipment rooms, alteration room.
 - 2. Intermediate Temperature Classification (212° F): Top of elevator hoistways where ambient temperatures can exceed 100° F, stock rooms, telephone/communication rooms.
 - 3. Thermal Response: Quick response sprinklers shall be used for light hazard and ordinary hazard occupancies.

2.10 CLEANING

A. Clean dirt and debris from sprinklers. Replace sprinklers having paint other than factory finish with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

2.11 COMMISSIONING

- A. Starting Procedures: Follow manufacturer's written procedures. If manufacturer prescribes no procedures, proceed as follows:
 - 1. Verify that valves, trim, fittings, controls, and accessories have been installed correctly and operate correctly.
 - 2. Verify that specified tests of piping are complete.
 - 3. Check that damaged sprinklers and sprinklers with paint or coating not specified have been replaced with new, correct type of sprinklers.
 - 4. Check that sprinklers are correct type, have correct finish and temperature ratings, and have guards where required for applications.
 - 5. Check that potable water supplies have correct type of backflow preventer.
 - 6. Check that fire department connections have threads compatible with local fire department equipment and have correct pressure rating.
 - 7. Fill wet pipe sprinkler systems with water and bleed air through vents.
 - 8. Fill dry pipe sprinkler systems with air and drain water from low points.
 - 9. Energize circuits to electrical equipment and devices.
 - 10. Adjust operating controls and pressure settings.
- B. Coordinate with fire alarm system tests. Operate systems as required.

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

1.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or ductile iron, with plain ends and integral waterstop collar.
- B. Steel Pipe Sleeves: Anticorrosion coated or zinc coated, with plain ends and integral waterstop collar.
- C. Galvanized-Steel Sheet Pipe Sleeves: Round tube closed with welded longitudinal joint.
- D. PVC Pipe Sleeves: Schedule 40.
- E. Molded-PE or -PP Sleeves: Removable, with nailing flange.

1.2 STACK SLEEVE FITTINGS

A. Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral cast flashing flange, with underdeck clamp.

1.3 SLEEVE-SEAL SYSTEMS

- A. Field-assembled, modular sealing-element unit for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM rubber.
 - 2. Pressure Plates: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel.

1.4 SLEEVE-SEAL FITTINGS

A. Manufactured, sleeve-type, plastic or rubber waterstop assembly made for imbedding in concrete slab or wall.

1.5 GROUT

A. Nonshrink, factory packaged.

1.6 SILICONE SEALANTS

A. Silicone Sealant: Type S, Grade NS, Class 25, Use NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

- B. Silicone Sealant: Type S, Grade P, Class 25, Use NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

1.7 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Exterior Concrete Walls above Grade:
 - 1. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - 2. Piping NPS 6 and Larger: Cast-iron pipe sleeves.
- B. Exterior Concrete Walls below Grade:
 - 1. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.
 - 2. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system.
- C. Concrete Slabs-on-Grade:
 - 1. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.
 - 2. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system.
- D. Concrete Slabs above Grade:
 - 1. Piping Smaller Than NPS 6: PVC pipe sleeves.
 - 2. Piping NPS 6 and Larger: Stack-sleeve fittings.
- E. Interior Partitions:
 - 1. Piping Smaller Than NPS 6: PVC pipe sleeves.
 - 2. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

1.1 PRODUCTS

A. Escutcheons for New Piping:

- 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece deep pattern.
- 2. Chrome-Plated Piping: one-piece cast brass with polished, chrome-plated finish.
- 3. Insulated Piping: One-piece stamped steel with polished or Split-plate, stamped steel with concealed hinge, with polished, chrome-plated finish.
- 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel with polished, chrome-plated finish or Split-plate, stamped steel with concealed hinge, with polished, chrome-plated finish.
- 5. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel with polished, chrome-plated finish or Split-plate, stamped steel with concealed hinge, with polished, chrome-plated finish.
- 6. Bare Piping in Unfinished Service Spaces: One-piece cast brass with rough-brass finish.
- 7. Bare Piping in Equipment Rooms: One-piece cast brass with rough brass finish.
- B. Escutcheons for Existing Piping to Remain:
 - 1. Chrome-Plated Piping: Split-plate, stamped steel with concealed hinge, with polished, chrome-plated finish.
 - 2. Insulated Piping: Split-plate, stamped steel with concealed hinge, with polished, chromeplated finish.
 - 3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge, with polished chrome-plated finish.
 - 4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge, with polished chrome-plated finish.
 - 5. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed hinge, with polished chrome-plated finish.
 - 6. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge, with polished, chrome-plated finish.
 - 7. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge, with polished, chrome-plated finish.
- C. Floor Plates: Split-plate, stamped steel with concealed hinge.

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SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

1.1 PRODUCTS

- A. Liquid-In-Glass Thermometers:
 - 1. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - a. Case: Cast aluminum; 9-inch size.
 - b. Case Form: Adjustable angle.
 - c. Tube: Glass with magnifying lens and blue or red organic liquid.
 - d. Tube Background: Nonreflective aluminum with etched scale in deg F and deg C.
 - e. Window: Glass.
 - f. Stem: Aluminum, brass, or stainless steel.
- B. Pressure Gages:
 - 1. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - a. Case: Liquid-filled Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch diameter.
 - b. Pressure-Element Assembly: Bourdon tube.
 - c. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - d. Dial: Nonreflective aluminum with etched scale in psi and kPa.
 - e. Window: Glass.
 - f. Ring: Metal.
 - g. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- C. Gage Attachments:
 - 1. Snubbers: Brass; with NPS 1/4 or NPS 1/2, and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
 - 2. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, pipe threads.
- D. Test Plugs: Test-station fitting made for insertion into piping tee fitting.

E. Test-Plug Kits: Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case.

SECTION 220523 - GENERAL DUTY VALVES FOR PLUMBING PIPING

- 1.1 QUALITY ASSURANCE
 - A. Quality Standards: NSF 14, NSF 61, and NSF 372.
- 1.2 PRODUCTS

A. DOMESTIC HOT- AND COLD-WATER VALVES

- 1. Ball Valves:
 - a. Bronze ball valves, lead free, two-piece with full port and stainless steel trim.
- 2. Butterfly Valves:
 - a. Ductile Iron, lead free, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, AND Aluminum-Bronze disc.
- 3. Check Valves:
 - a. Bronze Class 125, lead free, spring actuated.
 - b. Iron Swing, Class 125, lead free, metal seats with threaded or flanged end connections.

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SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

1.1 PERFORMANCE REQUIREMENTS

A. Pipe hangers and equipment supports designed and constructed by Design Build Contractor.

1.2 SUBMITTALS

A. Shop Drawings: Signed and sealed by a professional engineer as required.

1.3 PRODUCTS

- A. QUALITY ASSURANCE
 - 1. AWS D1.1/D1.1M.
 - 2. 2015 ASME Boiler and Pressure Vessel Code, Section IX.

B. COMPONENTS

- 1. Metal Pipe Hangers and Supports: Carbon steel stainless steel and copper.
- 2. Trapeze pipe hangers.
- 3. Metal Framing Systems: MFMA manufacturer.
- 4. Thermal hanger-shield inserts.
- 5. Fastener Systems: Powder-actuated fasteners and mechanical-expansion anchors.
- 6. Pipe-positioning systems.
- 7. Equipment supports.

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SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING

1.1 QUALITY ASSURANCE

- A. Seismic
 - 1. Risk Category (2018 IBC)
 - a. Nursing Home = 4
 - b. Domiciliary = 4
 - c. Nielson = 2
 - 2. Site class (ASCE/SEI 7-10)
 - a. Nursing Home = D
 - b. Domiciliary = D
 - 3. Seismic Importance Factor I_e (ASCE/SEI 7-10)
 - a. Nursing Home = 1.5
 - b. Domiciliary = 1.5
 - 4. Component Importance Factor I_p
 - a. Follow ASCE/SEI 7-10, Chapter 13 Seismic Design Requirements for nonstructural components.
- B. Wind
 - 1. Risk Category (2018 IBC)
 - a. Nursing Home = 4
 - b. Domiciliary = 4
 - c. Nielson = 2
 - 2. Basic wind speed V = 120 MPH
 - 3. Follow ASCE/SEI 7-10, Chapter 29 Wind Loads on other structures and building appurtenances MWFRS.
- C. Delegated Design
 - 1. Include design calculations and details for selecting seismic and wind restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic forces required to select seismic restraints.

1.2 COMPONENTS

- A. Vibration Isolators:
 - 1. Elastomeric Isolation Pads: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area. Material to be oil and water resistant with elastomeric properties.
 - a. Surface Pattern: Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.
 - c. Load-bearing metal plates adhered to pads.
 - 2. Double-Deflection, Elastomeric Isolation Mounts: Molded, oil-resistant rubber, neoprene, or other elastomeric material.
 - 3. Restrained Elastomeric Isolation Mounts: All-directional isolator with seismic restraints; molded, oil-resistant elastomeric material with cast-ductile-iron or welded-steel housing.
 - 4. Open-Spring Isolators: Freestanding, laterally stable.
 - 5. Housed-Spring Isolators: Freestanding, laterally stable, open-spring isolators in two-part telescoping housing.
 - 6. Restrained-Spring Isolators: Freestanding, laterally stable, open-spring isolators with vertical-limit stop restraint.
 - 7. Housed-Restrained-Spring Isolators: Freestanding, steel, open-spring isolators with vertical-limit stop restraint in two-part telescoping housing.
 - 8. Pipe-Riser Resilient Support: All-directional, acoustical pipe anchor.
 - 9. Resilient pipe guides.
 - 10. Air-Spring Isolators: Freestanding, single or multiple, compressed-air bellows.
 - 11. Restrained-Air-Spring Isolators: Freestanding, single or multiple, compressed-air bellows with vertical-limit stop restraint.
 - 12. Elastomeric hangers.
 - 13. Spring Hangers: Combination coil-spring and elastomeric-insert hangers with spring and insert in compression and with vertical-limit stop.

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

1.1 PRODUCTS

- A. Equipment Labels: Metal.
- B. Warning Signs and Labels: 1/8 inch thick with fasteners.
- C. Pipe Labels: Self-adhesive.
- D. Valve Tags: Brass, 0.032-inch minimum thickness.
- E. Warning Tags: 3 by 5-1/4 inches minimum; brass grommet and wire fasteners.

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SECTION 220719 - PLUMBING PIPING INSULATION

1.1 QUALITY ASSURANCE

A. Surface-Burning Characteristics: Flame-spread index of 25, and smoke-developed index of 50 for insulation installed indoors; according to ASTM E 84.

1.2 PIPING INSULATION SCHEDULE, GENERAL

- A. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Below-grade piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

1.3 PRODUCTS

A. INDOOR PIPING INSULATION SCHEDULE

- 1. Domestic Cold Water: Closed cell EPDM, preformed pipe insulation.
- 2. Domestic Hot and Recirculated Hot Water: Fiberglass, preformed pipe insulation.
- 3. Stormwater and Overflow: Closed cell EPDM, preformed pipe insulation.
- 4. Roof Drain and Overflow Drain Bodies: Closed cell EPDM.
- 5. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: ADA compliant covering.
- 6. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F: Closed cell EPDM, preformed pipe insulation.

B. INDOOR, FIELD-APPLIED JACKET SCHEDULE

- 1. Piping, Concealed: None required.
- 2. Piping, Exposed: PVC.

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SECTION 221116 - DOMESTIC WATER PIPING

1.1 PRODUCTS

A. UNDER-BUILDING SLAB DOMESTIC WATER, BUILDING-SERVICE PIPING

- 1. Pipe NPS 4 to NPS 12:
 - a. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.

B. UNDER-BUILDING-SLAB, DOMESTIC WATER PIPING

- 1. Pipe NPS 3 and Smaller:
 - a. Soft copper tube; Type K, wrought-copper, solder-joint fittings; and brazed joints.

C. ABOVEGROUND DOMESTIC WATER PIPING

- 1. Pipe NPS 2 and Smaller:
 - a. Hard copper tube; Type L, wrought-copper, solder-joint fittings; and soldered joints.
- 2. Pipe NPS 2-1/2 to NPS 4:
 - a. Hard copper tube; Type L, wrought-copper, solder-joint fittings; and brazed joints.

D. ABOVEGROUND DOMESTIC-WATER-SERVICE AND MAIN PIPING

- 1. Pipe NPS 6 to NPS 12:
 - a. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.
- E. MANUFACTURED UNITS
 - 1. Flexible Connectors: Bronze or Stainless-steel hose, as compatible with connected components.

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SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

1.1 QUALITY ASSURANCE

A. Quality Standards: NSF 14, NSF 61, and NSF 372.

1.2 PRODUCTS

- A. Vacuum Breakers:
 - 1. Pipe-Applied, Atmospheric-Type Vacuum Breakers: Rough-bronze finish.
 - 2. Hose-Connection Vacuum Breakers: Chrome- or nickel-plated finish.
 - 3. Pressure vacuum breakers.
- B. Backflow Preventers:
 - 1. Reduced-Pressure-Principle Backflow Preventers:
 - a. Body: Bronze for NPS 2 and smaller; stainless steel for NPS 2-1/2 and larger.
 - b. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - c. Configuration: Horizontal, straight through.
 - 2. Double-Check Backflow-Prevention Assemblies:
 - a. Body: Bronze for NPS 2 and smaller; stainless steel for NPS 2-1/2 and larger.
 - b. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - c. Configuration: Horizontal, straight through.
 - 3. Beverage-dispensing-equipment backflow preventers.
 - 4. Dual-check-valve backflow preventers.
 - 5. Carbonated-beverage-dispenser, dual-check-valve backflow preventers.
 - 6. Hose-connection backflow preventers.
 - 7. Backflow-preventer test kits.
- C. Water Pressure-Reducing Valves:
 - 1. Water Regulators:
 - a. Body: Bronze for NPS 2 and smaller; cast iron with interior for NPS 2-1/2 and NPS 3.
 - b. Valves for Booster Heater Water Supply: Include integral bypass.
 - c. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

- D. Balancing Valves:
 - 1. Copper-Alloy Calibrated Balancing Valves: Y-pattern, globe valve.
 - 2. Accessories: Meter kit.
- E. Temperature-Actuated Water Mixing Valves:
 - 1. Point-of-use, Thermostatic, Water Mixing Valves:
 - a. Type: Exposed mounted, below fixture.
 - b. Connections: Threaded union inlets and outlet.
 - c. Finish: Rough bronze.
 - d. Piping: Copper.
 - 2. Individual-fixture, water tempering valves, ASSE 1070 rated for sinks and lavatories ASSE 1016 T/P rated for showers.
- F. Strainers for Domestic Water Piping:
 - 1. Body: Bronze for NPS 2 and smaller; cast iron with interior lining and epoxy coating for NPS 2-1/2 and larger.
 - 2. Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 3. Screen: Stainless steel with round perforations unless otherwise indicated.
 - 4. Drain: Pipe plug.
- G. Hose Bibbs:
 - 1. Vacuum Breaker: Integral.
 - 2. Finish for Service Areas: Rough bronze.
 - 3. Operation for Service Areas: Wheel handle.
 - 4. Operation for Finished Rooms: Operating key.
- H. Wall Hydrants:
 - 1. Nonfreeze Wall Hydrants:
 - a. Outlet: Exposed.
 - b. Finish: Bronze.
- I. Drain Valves: Ball-valve type.
- J. Water Hammer Arresters: Copper tube with piston. Air chambers are not allowed.
- K. Air Vents: Bolted or Welded construction.

1.3 MANUFACTURED UNITS

A. Water Meters: Turbine or ultrasonic type with remote registration system.

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SECTION 221123 - FACILITY NATURAL-GAS PIPING

1.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig.
 - 2. Service Regulators: 100 psig.
 - 3. Service Meters: 65 psig.
- B. Natural-Gas System Pressures within Buildings:
 - 1. Two Pressure Ranges: More than 0.5 psig but not more than 2 psig, and 0.5 psig or less.
- C. Refer Section 220548 Vibration and Seismic Control for Plumbing.

1.2 MATERIALS

- A. Piping Specialties:
 - 1. Appliance flexible connectors.
 - 2. Quick-disconnect devices.
 - 3. Y-Pattern strainers.
 - 4. Weatherproof vent cap.
- B. Manual Gas Shutoff Valves:
 - 1. Two-piece, full-port bronze ball valves with bronze trim.
 - 2. Bronze plug valves.
 - 3. Valve boxes.
- C. Electrically operated motorized gas valves.
- D. Pressure Regulators:
 - 1. Service pressure regulators.
 - 2. Line pressure regulators.
 - 3. Appliance pressure regulators.
- E. Dielectric Fittings: Dielectric unions.
- F. Detectable warning tape for underground piping.

1.3 INDOOR PIPING SCHEDULE FOR PRESSURES LESS THAN 0.5 PSIG

A. Aboveground Branch Piping NPS 1 and Smaller: Steel pipe with threaded joints.

CDB 040-010-115	
New Nursing Home and Domiciliary	
Ouincy Veterans' Home, Adams County	

- B. Aboveground Distribution Piping: Steel pipe with threaded joints.
- C. Underground Piping: Steel pipe with welded joints, or engineering CSST system that is ULlisted and ANSI Z223.1 compliant with integral containment piping.
- D. Containment Conduit and Vent Piping: Steel pipe with welded joints.
- E. Aboveground concealed piping: Steel pipe with welded joints.
- 1.4 INDOOR PIPING SCHEDULE FOR PRESSURES MORE THAN 0.5 PSIG AND LESS THAN5 PSIG
 - A. Aboveground Branch Piping NPS 1 and Smaller: Steel pipe with threaded joints.
 - B. Aboveground Distribution Piping: Steel pipe with welded joints.
 - C. Underground Piping: Steel pipe with welded joints.
 - D. Containment Conduit and Vent Piping: Steel pipe with welded joints.
 - E. Aboveground concealed piping: Steel pipe with welded joints.02

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS

1.1 SUSTAINABILITY REQUIREMENTS

A. LEED v4:

1. Pump controls.

1.2 PRODUCTS

- A. Horizontally Mounted, In-Line, Close-Coupled Centrifugal Pumps:
 - 1. Casing Material: Bronze or cast iron.
 - 2. Impeller Material: Bronze or stainless steel.
 - 3. Shaft and Shaft Sleeve: Stainless steel shaft with deflector, with copper-alloy shaft sleeve.
 - 4. Seal: Mechanical.
 - 5. Bearings: Permanently lubricated ball type.
 - 6. Shaft Coupling: Flexible.
 - 7. Motor: Single speed with grease-lubricated ball bearings.
- B. Vertically Mounted, In-Line, Close-Coupled Centrifugal Pumps:
 - 1. Casing Material: Bronze, Cast or ductile iron.
 - 2. Impeller Material: Bronze or stainless steel.
 - 3. Shaft and Shaft Sleeve: Stainless steel shaft with copper-alloy shaft sleeve.
 - 4. Seal: Mechanical.
 - 5. Bearings: Oil-lubricated; bronze-journal or ball type.
 - 6. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
 - 7. Motor: Single speed, with grease-lubricated ball bearings; and rigidly mounted to pump casing.
- C. Controls:
 - 1. Thermostats: Electric; adjustable for control of hot-water circulation pump.
 - a. Type: Water-immersion temperature sensor, for installation in piping.
 - b. Operation of Pump: On or off.

- Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank. 2.
 - Type: Adjustable time-delay relay. Range: Up to five minutes. Operation of Pump: On or off. a.
 - b.
 - c.

END 221123.21

SECTION 221316 - SANITARY WASTE AND VENT PIPING

1.1 MATERIALS

- A. Hub-and-spigot, service-class, cast-iron soil pipe and fittings.
- B. Hubless, cast-iron soil pipe and CISPI, hubless piping couplings.
- C. Type DWV copper tube with solder-joint drainage fittings for indirect drains only.
- D. Solid-wall, Schedule 40 PVC pipe with PVC socket fittings.

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

1.1 QUALITY ASSURANCE

A. Quality Standard for Plastic Piping: NSF 14.

1.2 PRODUCTS

- A. Cleanouts: Cast-iron exposed, Nickel Bronze cover with Cast-iron body floor, Stainless Steel cover with Cast iron body wall.
- B. Roof Flashing Assemblies: Manufactured assembly of lead flashing collar and skirt extending at least from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
- C. Through-Penetration Firestop Assemblies: Listed and labeled assembly of sleeve and stack fitting with firestopping plug.
- D. Miscellaneous Sanitary Drainage Piping Specialties:
 - 1. Open drains, shop or field fabricated from Service class, hub-and-spigot, cast-iron, soilpipe fittings.
 - 2. Cast-iron deep-seal traps.
 - 3. Cleanouts vandal resistant.
 - 4. Floor drains vandal resistant.
 - 5. Floor sinks.
 - 6. Air-gap fittings.
 - 7. Sleeve flashing devices.
 - 8. Stack flashing fittings.
 - 9. Cast-iron body vent caps.
 - 10. Frost-resistant vent terminals.
 - 11. Expansion joints.

1.3 DRAINS

- A. Cast-Iron Floor Drains:
 - 1. Pattern: Floor.
 - 2. Top of Body and Strainer Finish: Nickel bronze.
 - 3. Top Shape: Round.
 - 4. Trap Pattern: Deep-seal P-trap.
 - 5. Top Loading Classification: Extra Heavy-Duty and Medium Duty.
 - 6. Vandal Resistant in all locations.
- B. Stainless-Steel Floor Drains:
 - 1. Outlet: Bottom.

- 2. Top or Strainer Material: Stainless steel.
- 3. Top Shape: Round.
- 4. Trap Material: Cast iron.
- 5. Trap Pattern: Deep-seal P-trap.
- C. Stainless-Steel Floor Sinks:
 - 1. Pattern: Floor drain.
 - 2. Body Material: Stainless steel.
 - 3. Outlet: Bottom, no-hub, connection.
 - 4. Sediment Bucket.
 - 5. Top of Body and Grate Finish: Stainless steel.
 - 6. Top Shape: Square.

1.4 MANUFACTURED UNITS

- A. Grease Interceptor:
 - 1. Standard: ASME A112.14.3 and PDI-G101, for intercepting and retaining fats, oils and greases from food preparation wastewater. Plumbing and Drainage Institute Seal required.
 - a. Gravity Grease Interceptor.
 - b. Body Material: Fiberglass or molded polyethylene.
 - c. Extension: As required.

SECTION 221413 - FACILITY STORM DRAINAGE PIPING

1.1 MATERIALS

- A. Hubless, cast-iron soil pipe and CISPI, hubless piping couplings.
- B. Solid-wall, Schedule 40 PVC pipe with PVC socket fittings.

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

1.1 PRODUCTS

- A. Metal Roof Drains:
 - 1. Cast-Iron Roof Drains and Overflow Drains:
 - a. Sump: Large.
 - b. Combination Flashing Ring and Gravel Stop: Not required.
 - c. Flow-Control Weirs: Not required.
 - d. Outlet: Bottom.
 - e. Outlet Type: No hub.
 - f. Extension Collars: Required.
 - g. Underdeck Clamp: Required.
 - h. Dome Material: Cast iron, galvanized.
 - i. Water Dam: 2 inches high on overflow drains.
- B. Miscellaneous Storm Drainage Piping Specialties: Conductor nozzles.
- C. Cleanouts: Cast-iron exposed, Nickel Bronze cover with Cast-iron body floor, Stainless Steel cover with Cast iron body wall.
- D. Overflow Outlet Nozzles
 - 1. Nickel bronze lambs-tongue.
 - 2. Stainless steel bird screen.

SECTION 221429 - SUMP PUMPS

- 1.1 PRODUCTS
 - A. Submersible Sump Pumps:
 - 1. Pump Casing: Cast iron.
 - 2. Impeller: Abrasion-resistant Cast iron, semi-open, non-clog design.
 - 3. Pump and Motor Shaft: Stainless steel.
 - 4. Seal: Mechanical.
 - 5. Motor: Hermetically sealed, capacitor-start type.
 - 6. Controls: Pedestal or Wall-mounted, mercury-float type.
 - 7. High-water alarm.
 - 8. Control-Interface Features:
 - a. Remote alarm contacts.
 - b. Building Automation System Interface:
 - 1) On-off status of pump.
 - 2) Alarm status.
 - B. Basin Covers:
 - 1. Cover Material: Cast iron or steel with bituminous coating.

SECTION 223200 - DOMESTIC WATER FILTRATION EQUIPMENT

1.1 QUALITY ASSURANCE

- A. Welding: ASME Boiler and Pressure Vessel Code: Section IX.
- B. Electrical Components, Devices, and Accessories: NFPA 70.
- C. Components in Contact with Potable Water: NSF 61 Annex.

1.2 PRODUCTS

- A. Service Entrance Cartridge Filter 2 Stage Filtration Requied
 - 1. Stage 1: 5 Micron cartridge filter
 - a. Type 304/304L, Stainless steel construction
 - b. NSF certified
 - c. Tangential inlet, centrifugal flow that induces pre-filtration by heavy particulate separation.
 - d. Replacement filter cartridges.
 - e. Housing to self purge air.
 - f. ASME rated.
 - g. Basis of Design is Harmsco Model HUR3X170FL-XP. Other approved manufacturers: Eaton Filtration and Siemens Water Technologies
- B. Stage 2: Ultrafiltration System
 - 1. Self-diagnostic, self-backwashing system skid.
 - 2. Filter down to 0.01 micron level.
 - 3. Basis of Design is Phoenix GT

1.3 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.

SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

1.1 QUALITY ASSURANCE

- A. Performance Efficiency: ASHRAE/IESNA 90.1 and ASHRAE 90.2.
- B. ASME Compliance: ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. NSF Compliance: NSF 61 Annex G, "Drinking Water System Components Health Effects."

1.2 WARRANTY

- A. Materials and Workmanship:
 - 1. Commercial, Gas-Fired, Domestic-Water Heaters: Three years.
 - 2. Compression Tanks: Five years.

1.3 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

- A. Commercial, Direct Vent, Gas-Fired, High Efficiency, Domestic-Water Heaters:
 - 1. Combustion Efficiency: 96 percent.
 - 2. Storage-Tank Construction: ASME-code steel.
 - 3. Pressure Rating: 150 psig.
 - 4. Burner: For natural-gas fuel.

1.4 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Compression Tanks: Steel tank with welded joints and butyl-rubber diaphragm; 150-psig pressure rating.
- B. Piping-type heat traps.
- C. Manifold kits.
- D. Gas shutoff valves.
- E. Gas pressure regulators.
- F. Automatic gas valves.
- G. Combination temperature-and-pressure relief valves.

H. Vacuum relief valves.

1.5 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.

SECTION 224000 – PLUMBING FIXTURES

1.1 WATER CLOSETS

- A. Water Closets, <u>WC-1</u>: Floor mounted, flush-tank, ADA commercial grade.
- B. Water Closets, <u>WC-2</u>: Floor mounted, top spud, accessible as noted.
 - 1. Material: Vitreous china.
 - 2. Type: Siphon jet.
 - 3. Style: Flushometer valve.
 - 4. Water Consumption: 1.28 gal. per flush.
 - 5. Flushometer Valve: Hard-wired solenoid activated.
 - 6. Toilet Seat: Heavy duty open front.

1.2 WALL-HUNG URINALS

- A. Urinals <u>UR-1</u>: Wall hung, back outlet, washout, accessible as noted.
 - 1. Material: Vitreous china.
 - 2. Type: Washout with extended shields.
 - 3. Water Consumption: .125 gal. per flush.
 - 4. Flushometer Valve: Hard-wired solenoid activated.
 - 5. Support: Carrier with waste-fitting assembly.

1.3 WALL-MOUNTED LAVATORIES

- A. Lavatory <u>LA-1</u>: Under mount, ADA
 - 1. Material: Vitreous china.
 - 2. Type: Under mount.
 - 3. Nominal Size: 17 by 14 inches.
 - 4. Faucet-Hole Punching: As required.
 - 5. Faucet-Hole Location: Top.
 - 6. Faucet: Hard wired, electronic sensor operated.

1.4 MOP BASINS

- A. Mop Basins (MB-1): Terrazzo, floor mounted.
 - 1. Shape: Square, with dropped, angled front.
 - 2. Nominal Size: 24 by 24 inches.
 - 3. Height: 12 inches with dropped front.
 - 4. Tiling Flange: Not required.
 - 5. Rim Guard: On front top surfaces.

- 6. Drain: Grid with NPS 3 outlet.
- 7. Mounting: On floor and flush to wall.
- 8. Faucet: Wall mounted, manual service sink faucet.

1.5 UTILITY SINKS

- A. Utility Sinks: (SK-1) Stainless steel, counter mounted Accessible.
 - 1. Type: Drop-in.
 - 2. Number of Compartments: One.
 - 3. Overall Dimensions: 22" x 19 1/2" x 5 1/2".
 - 4. Metal Thickness: 18 gauge.
 - 5. Single-Compartment Sinks:
 - a. Drain: NPS 1-1/2 tailpiece with stopper.
 - b. Drain Location: Center.
 - 6. Faucet(s): Single handle, counter mount.
 - a. Number Required: 4" Centers.
 - 7. Supply Fittings:
 - a. Supplies: Chrome-plated brass compression stop.
 - 1) Operation: Loose key.
 - 2) Risers: NPS 1/2, chrome-plated, soft-copper flexible tube.

8. Waste Fittings:

- a. Trap(s):
 - 1) Size: NPS 1-1/2.
 - 2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow.
- 9. Mounting: On counter with sealant.
- B. Utility Sinks: (SK-2) ABS Shampoo Sink.
 - 1. Type: Ledge back.
 - 2. Number of Compartments: One.
 - 3. Single-Compartment Sinks:
 - a. Drain: NPS 1-1/2 tailpiece with stopper.
 - b. Drain Location: Near back of compartment.
 - 4. Faucet(s): Deck mount, hand-spray.
 - a. Number Required: One.

- b. Mounting: On ledge.
- 5. Supply Fittings:
 - a. Supplies: Chrome-plated brass compression stop.
 - 1) Operation: Loose key.
 - 2) Risers: NPS 1/2, chrome-plated, soft-copper flexible tube.
- 6. Waste Fittings:
 - a. Trap(s):
 - 1) Size: NPS 1-1/2.
 - 2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow.
 - 3) Hair trap.
- C. Utility Sinks: (SK-3) Stainless steel, Scullery sink, with single drain board.
 - 1. Type: Ledge back.
 - 2. Number of Compartments: Two.
 - 3. Overall Dimensions: 19 1/2" x 19" x 6 1/2".
 - 4. Metal Thickness: 18 gauge.
 - 5. Compartment Sinks:
 - a. Drain: NPS 1-1/2 tailpiece with stopper.
 - b. Drain Location: Center.
 - 6. Faucet(s): Deck mount, gooseneck.
 - a. Number Required: One.
 - b. Mounting: On backsplash.
 - 7. Supply Fittings:
 - a. Supplies: Chrome-plated brass compression stop.
 - 1) Operation: Loose key.
 - 2) Risers: NPS 1/2, chrome-plated, soft-copper flexible tube.
 - 8. Waste Fittings:
 - a. Trap(s):
 - 1) Size: NPS 1-1/2.
 - 2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow.
 - 9. Mounting: On counter with sealant.

1.6 ELECTRIC WATER COOLERS

- A. Electric Water Cooler (EWC-1): Wall mounted, bi-level with bottle filler, accessible.
 - 1. Cabinet: Bi-level with two attached cabinets, all stainless steel, including bottle filler.
 - 2. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
 - 3. Control: Push button.
 - 4. Drain: Grid.
 - 5. Filter.
 - 6. Cooling System: Electric, with hermetically sealed compressor and adjustable thermostat.
 - 7. Capacities and Characteristics:
 - a. Cooled Water: 8 gph.
 - 8. Support: Water-cooler carrier.

1.7 EMERGENCY FIXTURES

- A. Quality assurance
 - 1. Quality Standard: ANSI Z358.1, NSF 61, and NSF 372.
- B. Emergency shower/face/eye wash (ESEW-1)
 - 1. Combination Units: Accessible, plumbed, emergency shower with eye/face wash.
 - 2. Water-Tempering Equipment: Hot and cold water emergency thermostatic mixing valve.

1.8 FLUSHOMETER VALVES

- A. Electronic-Actuator, Push-Button, Diaphragm Flushometer Valves:
 - 1. Style: Concealed.
 - 2. Consumption: 1.28 gal. per flush water closet; .125 gal. per flush urinal.
- B. Hard-Wired, Solenoid-Actuator, Piston Flushometer Valves:
 - 1. Style: Exposed.
 - 2. Consumption: 1.28 gal. per flush.

1.9 SECURITY FIXTURE FLUSHOMETER VALVES

- A. Flushometer Valves: Electronic Push button.
 - 1. Style: Concealed.
 - 2. Consumption: 1.5 gal. per flush.

1.10 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. Lavatory Faucets (LA-1, LA-2): Automatic-type, hard-wired, electronic-sensor-operated, mixing, solid-brass valve.
 - 1. Body Type: Single hole with trimplate.
 - 2. Body Material: Commercial, solid brass.
 - 3. Finish: Polished chrome plate.
 - 4. Maximum Flow Rate: 0.5 gpm.
 - 5. Mounting Type: Deck.
 - 6. Spout: Rigid type.
 - 7. Spout Outlet: Aerator.
 - 8. Programmable timed hygiene flush.

1.11 SINK FAUCETS

- A. NSF Standard: NSF 372 for faucet-spout materials in contact with potable water.
- B. Mop Sink Faucets: Manual, wall mount type, two-lever-handle mixing valve.
 - 1. Standard: ASME A112.18.1/CSA B125.1.
 - 2. Body Type: Widespread.
 - 3. Body Material: Commercial, solid brass.
 - 4. Finish: Rough chrome plated.
 - 5. Maximum Flow Rate: 2.2 gpm.
 - 6. Handle(s): Cross, four arm.
 - 7. Mounting Type: Back/wall, exposed.
 - 8. Spout Type: Rigid, solid brass with wall brace.
 - 9. Vacuum Breaker: Required for hose outlet.
 - 10. Spout Outlet: Hose thread.
- C. Utility Sink Faucets: Manual type, single-control mixing valve.
 - 1. Standard: ASME A112.18.1/CSA B125.1.
 - 2. Body Type: Single hole.
 - 3. Body Material: Commercial, solid brass.
 - 4. Finish: Polished chrome plate.
 - 5. Maximum Flow Rate: 2.2 gpm.
 - 6. Handle(s): Lever.
 - 7. Mounting Type: Deck, exposed.
 - 8. Spout Type: Swing, shaped tube.
 - 9. Vacuum Breaker: Not required.
 - 10. Spout Outlet: Aerator.
- D. Utility Sink Faucets: Manual type, two-lever-handle mixing valve.
 - 1. Standard: ASME A112.18.1/CSA B125.1.
 - 2. Body Type: Centerset.
 - 3. Body Material: Commercial, solid brass.

- 4. Finish: Polished chrome plate.
- 5. Maximum Flow Rate: 2.2 gpm.
- 6. Handle(s): Wrist blade, 4 inches.
- 7. Mounting Type: Deck, exposed.
- 8. Spout Type: Swivel gooseneck.
- 9. Vacuum Breaker: Not required.
- 10. Spout Outlet: Aerator.
- E. Utility Sink Faucets: Foot actuated type mixing valve.
 - 1. Standard: ASME A112.18.1/CSA B125.1.
 - 2. Body Type: Centerset.
 - 3. Body Material: Commercial, solid brass.
 - 4. Finish: Polished chrome plate.
 - 5. Maximum Flow Rate: 2.2 gpm.
 - 6. Handle(s): None required.
 - 7. Mounting Type: Deck, exposed.
 - 8. Spout Type: Swivel gooseneck.
 - 9. Vacuum Breaker: Not required.
 - 10. Spout Outlet: Aerator.

1.12 SHOWER FAUCETS

- A. Shower Faucets (SH-1, SH-2): Single-handle, thermostatic mixing valve with hot- and cold-water indicators; check stops; and shower head.
 - 1. Shower Head: Ball joint with arm and flange.
 - 2. Handheld Shower Head: 69" metal hose, hand held with non-positive shut-off <u>required</u> <u>at accessible fixtures (SH-2)</u> locations indicated on plans.
 - 3. Shower-Arm, Flow-Control Fitting: 1.5 gpm.
 - 4. ASSE 1016 Type T/P rated.

1.13 <u>BATH TUBS</u>

A. <u>Bath Tub (BT-1): Walk-in bathtub to be selected by Using Agency</u>

1. <u>Provide with mixing valve to temper water</u>, ASSE 1016 Type T/P rated.

SECTION – 226113 MEDICAL COMPRESSED AIR PIPING FOR HEALTHCARE FACILITIES

1.1 PIPES, TUBES, AND FITTINGS

- Copper Medical Gas Tube for Medical Air: ASTM B 819, Type L, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.
 - 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
 - 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
 - 3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

1.2 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for generalduty brazing unless otherwise indicated.
- C. Threaded-Joint Tape: PTFE.

1.3 VALVES

- A. General Requirements for Medical Compressed Air Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
 - 1. Note: Valves for non-medical compressed air are not required to be cleaned and bagged.
- B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. BeaconMedaes.
 - c. NIBCO INC.
 - d. Conbraco Industries, Inc.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Ball: Full-port, chrome-plated brass.
 - 4. Seats: PTFE or TFE.

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- 5. Handle: Lever.
- 6. Stem: Blowout proof with PTFE or TFE seal.
- 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Check Valves: In-line pattern, bronze.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. BeaconMedaes.
 - c. Nibco Inc.
 - d. Conbraco Industries, Inc.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Operation: Spring loaded.
 - 4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Ball: Full-port, chrome-plated brass.
 - 4. Seats: PTFE or TFE.
 - 5. Handle: Lever.
 - 6. Stem: Blowout proof with PTFE or TFE seal.
 - 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - 2. Interior Finish: Factory-applied white enamel.
 - 3. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.

- 4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
- G. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.
- H. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

1.4 MEDICAL COMPRESSED-AIR SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Healthcare Products, Inc.; Chemetron Div.
 - 2. BeaconMedaes.
 - 3. Amico Corporation
- B. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
 - 1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.
 - b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
 - c. Double seals that will prevent air leakage.
 - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
 - e. Plastic boxes and cover plates are not acceptable.
 - 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Double seals that will prevent air leakage.
 - c. Cover plate with gas-service label.
 - d. Plastic cover plates are not acceptable.
 - 3. Quick-Coupler Service Connections: Pressure outlet with non-interchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

4. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

1.5 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Healthcare Products, Inc.; Chemetron Div.
 - 2. BeaconMedaes.
 - 3. Amico Corporation
- B. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.
- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39°F at 55 psig.
 - 1. Operation: Hygrometer moisture analyzer with sensor probe.
- E. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Low-Pressure Operating Range: 0- to 100-psig.
 - 2. High-Pressure Operating Range: Up to 250-psig.
- F. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.
- G. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Recessed installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05-inch- thick aluminum, with knockouts for electrical and piping connections.
- H. Master Alarm Panels: Separate trouble alarm signals, and indicators for medical compressedair piping systems.
 - 1. Include alarm signals when the following conditions exist:

- a. Medical Air: Pressure drops below 40 psig or rises above 60 psig, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above 39°F at 55 psig, carbon monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.
- I. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
 - 1. Include alarm signals when the following condition exists:
 - a. Medical Air: Pressure drops below 40 psig or rises above 60 psig.
- J. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
 - 1. NPS 3 and Smaller: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- 1.6 RELATED REQUIREMENTS: NFPA 55 COMPRESSED GASES AND CRYOGENIC FLUIDS CODE.

SECTION 226119 – COMPRESSED-AIR EQUIPMENT FOR HEALTHCARE FACILITIES

1.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design compressed-air equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

1.2 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS

- A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
- B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
 - 2. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 - 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 - 4. Motor Overload Protection: Overload relay in each phase.
 - 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
 - 6. Automatic control switches to alternate lead-lag air compressors for duplex air compressors.
 - 7. Instrumentation: Include discharge-air and air-filter maintenance indicator, hour meter, and control transformer.
 - 8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.
- C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 1. Pressure Rating: At least as high as highest discharge pressure of connected air compressors and bearing appropriate code symbols.
 - 2. Interior Finish: Corrosion-resistant coating.
 - 3. Accessories: Include safety valve, pressure gage, automatic drain, and pressure regulator.

D. Mounting Frame: Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

1.3 OILLESS, SCROLL TYPE AIR COMPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings Beacon Medaes or comparable product by the following:
 - 1. Beacon Medaes
 - 2. Allied Healthcare Products, Inc.; Chemetron Div.
 - 3. Allied Healthcare Products, Inc.; Oxequip Health Industries.
 - 4. Squire-Cogswell/Aeros Instruments, Inc.
- C. Description: Packaged unit.
- D. Air Compressor(s): Single stage, oilless (nonlubricated), scroll type, that will deliver air of quality equal to intake air.
 - 1. Single point connection.
 - 2. High discharge-air temperature switch.
 - 3. Belt guard totally enclosing pulleys and belts.
 - 4. Duplex desiccant drying system with purge control, systems with purge control are not acceptable.
- E. Capacities and Characteristics:
 - 1. Compressed-Air Service: Medical air.
 - 2. Air Compressor(s): Two.
 - 3. Actual-Air Capacity of Each Air Compressor: to be calculated.
 - 4. Discharge-Air Pressure: 50 60 psig.
 - 5. Intake-Air Temperature: 80 deg F.
 - 6. Discharge-Air Temperature: 50 deg. F.
 - 7. Mounting: Freestanding.
 - 8. Motor (Each Air Compressor): TBD.
 - a. Speed:3600 rpm.
 - 9. Unit Electrical Characteristics:
 - a. Volts: 460.
 - b. Phase(s): Three.
 - c. Hertz: 60 Hz.
 - 10. Receiver: ASME construction steel tank.

1.4 INLET-AIR FILTERS

- A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
 - 1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
 - 2. Capacity: Match capacity of air compressor, with collection efficiency of 99 percent retention of particles larger than 10 micrometers.
- B. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.
 - 1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
 - 2. Capacity: Match total capacity of connected air compressors, with collection efficiency of 99 percent retention of particles larger than 10 micrometers.

1.5 DESICCANT COMPRESSED-AIR DRYERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
 - 1. BeaconMedaes.
 - 2. Ingersoll-Rand; Air Solutions Group.
 - 3. Wilkerson Operations; Pneumatic Division.
- B. Description: Twin-tower unit with purge control system, mufflers, and capability to deliver plus 10 deg F, pressure dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

1.6 MEDICAL COMPRESSED-AIR EQUIPMENT ALARM SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Allied Healthcare Products, Inc.; Chemetron Div.
 - 2. Allied Healthcare Products, Inc.; Oxequip Health Industries.
 - 3. Amico Corporation.
 - 4. BeaconMedaes.
- B. General Requirements for Medical Compressed-Air Equipment Alarm System: Compatible alarm panels, remote sensing devices, and other related components as required by NFPA 99 for Level 1 alarm systems. Refer to Division 22 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities" for medical compressed-air piping and alarm systems. Power wiring is specified in Division 26 Sections.

- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.
 - 1. Operation: Hygrometer moisture analyzer with sensor probe.
- E. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Low-Pressure Switches: 0- to 100-psig operating range.
 - 2. High-Pressure Switches: Up to 250-psig operating range.
- F. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.
- G. General Requirements for Medical Compressed-Air Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Exposed, surface, recessed installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.
- H. Local and Master Alarm Panels: Separate trouble alarm signals and pressure gages to indicate function of medical compressed-air equipment when the following conditions exist:
 - 1. Medical Air, Compressed-Air Equipment: Pressure drops below 40 psig or rises above 60 psig, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above 39 deg F at 55 psig, carbon monoxide level rises above 10 ppm, and the following:
 - a. Oil-Free Air-Compressor Equipment: High discharge-air temperature and high water level in receiver.

1.7 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.
 - 1. Motor Sizes: Minimum size shall be large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections per NFPA 70 and NFPA 99.

1.8 PREPARATION

- A. Clean compressed-air equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for medical air applications, according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
- B. Medical Compressed-Air Equipment Installation:
 - 1. Install according to ASSE 6010 and NFPA 99.
 - 2. Install compressed-air equipment, except wall-mounting equipment, on concrete bases. Install units anchored to substrate in locations indicated. Maintain manufacturers' recommended clearances. Orient equipment so controls and devices are accessible for servicing.
 - a. Anchor equipment to concrete bases according to manufacturer's written instructions and seismic criteria applicable to Project.
 - 1) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 2) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 3) Install anchor bolts to elevations required for proper attachment to supported equipment.
 - b. Vibration Isolation: Install spring isolators with a minimum deflection.

1.9 MEDICAL COMPRESSED-AIR EQUIPMENT ALARM SYSTEM INSTALLATION

- A. Alarm panels for medical compressed-air equipment may be combined in single panels with medical vacuum equipment and medical gas piping systems.
- B. Install medical compressed-air equipment alarm system components in locations required by and according to NFPA 99.
- C. Install medical compressed-air equipment local and master alarm panels where required by NFPA 99.

1.10 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.
SECTION 226213 – VACUUM PIPING FOR HEALTHCARE FACILITIES

1.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 88 and ASTM B 819, Type L, seamless, drawn temper copper tube.
 - 1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or ASME B16.50, with dimensions for brazed joints.
 - 2. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper.
 - 3. Copper alloy fittings are not permitted.

1.2 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for generalduty brazing unless otherwise indicated.
- C. Threaded-Joint Tape: PTFE.
- D. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
- E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

1.3 VALVES

- A. General Requirements for Valves: Exception: Factory cleaning and bagging are not required for valves for vacuum service.
- B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. BeaconMedaes.
 - c. Conbraco Industries, Inc.
 - d. NIBCO INC.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Ball: Full-port, chrome-plated brass.
 - 4. Seats: PTFE or TFE.
 - 5. Handle: Lever.

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- 6. Stem: Blowout proof with PTFE or TFE seal.
- 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- 8. All valves shall be from the same manufacturer.
- C. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. BeaconMedaes.
 - c. Squire-Cogswell/Aeros Instruments, Inc.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Ball: Full-port, chrome-plated brass.
 - 4. Seats: PTFE or TFE.
 - 5. Handle: Lever.
 - 6. Stem: Blowout proof with PTFE or TFE seal.
 - 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
 - 8. Vacuum Gage: Manufacturer installed on one copper-tube extension.
 - 9. All zone valves shall be from the same manufacturer.
- D. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. BeaconMedaes.
 - 2. Interior Finish: Factory-applied white enamel.
 - 3. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
 - 4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
 - 5. All zone valve boxes shall be from the same manufacturer.
- E. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.
- F. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

1.4 MEDICAL VACUUM SERVICE CONNECTIONS

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

- 1. Allied Healthcare Products, Inc.; Chemetron Div.
- 2. BeaconMedaes.
- 3. All service connections shall be from the same manufacturer.
- B. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
 - 1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.
 - b. Brass-body inlet block.
 - c. Seals that will prevent vacuum leakage.
 - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
 - 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Seals that will prevent vacuum leakage.
 - c. Cover plate with gas-service label.
 - 3. Quick-Coupler Service Connections: Suction inlets for medical vacuum evacuation service outlets with non-interchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
 - 4. Service Connection: Ohmeda type.
 - 5. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
 - 6. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

1.5 MEDICAL VACUUM PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Healthcare Products, Inc.; Chemetron Div.
 - 2. BeaconMedaes.
- B. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.
- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical

connections for alarm system.

- 1. Vacuum Operating Range: 0- to 30-in. Hg.
- E. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Recessed installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.
- F. Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for medical vacuum piping systems.
 - 1. Include alarm signals when the following conditions exist:
 - a. Medical Vacuum: Vacuum drops below 12-in. Hg and backup vacuum pump is in operation.
- G. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
 - 1. Include alarm signals when the following condition exists:
 - a. Medical Vacuum: Vacuum drops below 12-in. Hg.

END 226213

SECTION 226219 – VACUUM EQUIPMENT FOR HEALTHCARE FACILITIES

1.1 GENERAL REQUIREMENTS FOR PACKAGED VACUUM PUMPS

- A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty vacuum pumps and receivers.
- B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
 - 2. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 - 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 - 4. Motor Overload Protection: Overload relay in each phase.
 - 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
 - 6. Automatic control switches to sequence lead-lag vacuum pumps for multiplex vacuum pumps.
 - 7. Instrumentation: Include vacuum pump inlet and receiver vacuum gages, hour meter, vacuum pump discharge-air and coolant temperature gages, and control transformer.
 - 8. Alarm Signal Device: For connection to alarm system to indicate when backup vacuum pump is operating.
- C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; bearing appropriate code symbols.
 - 1. Interior Finish: Corrosion-resistant coating.
 - 2. Accessories: Include vacuum relief valve, vacuum gage, and drain.
- D. Mounting Frame: Fabricate base and attachment to pressure vessel with reinforcement of adequate strength to resist packaged equipment movement during a seismic event when base is anchored to building structure.

1.2 CLAW TYPE VACUUM PUMPS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - 1. BeaconMedaes.
 - 2. Ohio Medical Healthcare.
 - 3. Allied Healthcare Products, Inc.; Oxequip Health Industries.
 - 4. Squire-Cogswell/Aeros Instruments, Inc.
- B. Description: Packaged unit.

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- C. Vacuum Pump(s): "Oilless", base mounted, claw type.
 - 1. Construction: Cast-iron body with bronze rotor.
 - 2. Coupling: Non-lubricated, flexible type.
 - 3. Sealing Fluid: Building Chilled water supply and return.
 - 4. Outlet silencers and water-vapor separators on discharge connections.
- D. Capacities and Characteristics:
 - 1. Vacuum Service: Healthcare vacuum.
 - 2. Vacuum Pump(s): Two.
 - 3. Vacuum Required: 19-in. Hg vacuum.
 - 4. Mounting: Freestanding.
 - 5. Motor HP (Each Vacuum Pump): TBD.
 - 6. Unit Electrical Characteristics:
 - a. Volts: 460 V.
 - b. Phase(s): Three.
 - c. Hertz: 60 Hz.
 - 7. Receiver: ASME construction steel tank.
 - 8. Interior Finish: Corrosion resistant.
 - 9. Drain: Automatic valve.
 - 10. TAE control and VSD Drive.

1.3 MEDICAL VACUUM EQUIPMENT ALARM SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - 1. BeaconMedaes
 - 2. Allied Healthcare Products, Inc.; Oxequip Health Industries.
 - 3. Squire-Cogswell/Aeros Instruments, Inc.
- B. General Requirements for Medical Vacuum Equipment Alarm System: Compatible alarm panels, remote sensing devices, and other related components as required by NFPA 99 for alarm systems. Refer to Division 22 Section "Vacuum Piping for Healthcare Facilities" for medical vacuum piping and alarm systems. Power wiring as specified in Division 26 Sections and NFPA 70.
- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Vacuum Switches or Transducer Sensors: Continuous equipment monitoring with electrical connections for alarm system.
 - 1. Vacuum Switches: 0- to 30-in. Hg vacuum operating range.

- E. General Requirements for Medical Vacuum Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Exposed, surface installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch thick steel or minimum 0.05-inchthick aluminum, with knockouts for electrical and piping connections.
- F. Local and Master Alarm Panels: Separate trouble alarm signals and pressure gages to indicate function of medical vacuum equipment when the following conditions exist:
 - 1. Medical Vacuum Equipment: Drops below 12-in. Hg vacuum, backup vacuum producer is in operation, and high water level is in receiver.

1.4 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.
 - 1. Motor Sizes: Minimum size shall be large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections and NFPA 70.

1.5 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.

END 226219

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SECTION – 226313 MEDICAL GAS PIPING FOR HEALTHCARE FACILITIES

1.1 SYSTEM DESCRIPTION

A. Medical oxygen operating at 50 to 55 psig.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design medical gas piping systems including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria to meet NFPA 99.
- B. Seismic Performance: Medical gas manifolds and bulk medical gas storage tanks shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the medical gas manifolds and bulk medical gas storage tanks will remain in place without separation of any parts when subjected to the seismic forces specified and the manifolds and tanks will be fully operational after the seismic event."

1.3 PIPES, TUBES, AND FITTINGS

- A. Comply with NFPA 99 for medical gas piping materials.
- B. Copper Medical Gas Tube: ASTM B 819, Type K and Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service; or according to CGA G-4.1 for oxygen service. Include standard color marking in green for Type K tube and blue for Type L tube.
- C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
- D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
- E. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
 - 1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, full-face type.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

1.4 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.

1.5 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.
 - 1. Zone-Valve Boxes:
 - a. Basis-Of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
 - 1) Allied Healthcare Products Inc.; Chemetron Division.
 - 2) BeaconMedaes.
 - b. Description: Formed steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves. Oxygen, medical air and medical vacuum tubing, valves, and gages may be incorporated in zone valve boxes for medical gases.
 - 1) Interior Finish: Factory-applied white enamel.
 - 2) Cover Plate: Stainless steel with frangible or removable windows.
 - 3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- C. Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products Inc.; Chemetron Division.
 - b. BeaconMedaes.
 - c. NIBCO INC.
 - 2. Standard: MSS SP-110.
 - 3. Description: Three-piece body, bronze.
 - 4. Pressure Rating: 300 psig minimum.
 - 5. Ball: Full-port, chrome-plated brass.
 - 6. Seats: PTFE or TFE.
 - 7. Handle: Lever type with locking device.
 - 8. Stem: Blowout proof with PTFE or TFE seal.
 - 9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions and manufacturerinstalled ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.
- D. Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Allied Healthcare Products Inc.; Chemetron Division.
- b. BeaconMedaes.
- c. Nibco, Inc.
- 2. Description: In-line pattern, bronze.
- 3. Pressure Rating: 300 psig minimum.
- 4. Operation: Spring loaded.
- 5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- E. Emergency Oxygen Supply Connection: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
 - 1. Basis of Design: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products Inc.; Chemetron Division.
 - b. BeaconMedaes.
 - 2. Enclosure: Powder-coated steel, weather tight hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
 - 3. Inlet: Manufacturer-installed, NPS 1, ASTM B 819, copper tubing with NPS 1 minimum ball valve.
 - 4. Safety Valve: Bronze-body pressure relief valve set at 75 psig.
 - 5. Instrumentation: Pressure gage.

Note: Furnish and install keyed padlock with 4 keys. Keys shall be keyed identically to gate lock at bulk oxygen farm to expedite entry during emergency event. Turn all keys over to Using Agency's representative.

- F. Safety Valves:
 - 1. Bronze body.
 - 2. ASME-construction, poppet, pressure-relief type.
 - 3. Settings to match system requirements.
- G. Pressure Regulators:
 - 1. Stainless-steel body and trim.
 - 2. Spring-loaded, diaphragm-operated, relieving type.
 - 3. Manual pressure-setting adjustment.
 - 4. Rated for 250-psig minimum inlet pressure.
 - 5. Capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

1.6 MEDICAL GAS SERVICE CONNECTIONS

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

- 1. Allied Healthcare Products Inc.; Chemetron Division.
- 2. BeaconMedaes.
- 3. Oxequip Health Industries; a division of Allied Healthcare Products Inc.
- B. General Requirements for Medical Gas Service Connections:
 - 1. Suitable for specific medical gas pressure and suction service listed.
 - 2. Include roughing-in assemblies, finishing assemblies, and cover plates.
 - 3. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate.
 - 4. Recessed-type units made for concealed piping unless otherwise indicated.
 - 5. Plastic not acceptable.
- C. Roughing-in Assembly:
 - 1. Steel outlet box for recessed mounting and concealed piping.
 - 2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
 - 3. Double seals that will prevent gas leakage.
 - 4. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tubeend dust cap.
 - 5. Plastic not acceptable.
- D. Finishing Assembly:
 - 1. Brass housing with primary check valve.
 - 2. Double seals that will prevent gas leakage.
 - 3. Cover plate with gas-service label.
 - 4. Plastic not acceptable.
- E. Quick-Coupler Pressure Service Connections: Outlets for nitrous oxide and oxygen with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
- F. Quick-Coupler Pressure Service Connections: Outlets for medical air with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
- G. Quick-Coupler Suction Service Connections: Inlets for vacuum with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
- H. Service Connections: Ohmeda type.
- I. Cover Plates: One piece, stainless steel and permanent, color-coded, identifying label matching corresponding service. Plastic not acceptable.

1.7 PATIENT-SERVICE

- A. Patient-Service: Inlets and outlets recessed mounted.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products inc.; Chemetron Dividion
 - b. BeaconMedaes.
 - 2. Standard: UL 60601.
 - 3. 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.
 - 4. General Requirements for Patient-Service Consoles: Wall units with service connections. Include labels indicating services, and the following:
 - a. Steel console box or mounting bracket.
 - b. Concealed supplies.
 - c. Cover: One piece, stainless steel and permanent identifying label.
 - d. Medical gas service connections as specified in "Medical Gas Service Connections" Article.
 - 1) Medical Oxygen: One quick-coupler pressure outlet.
 - 2) Medical Air: One quick-coupler, quick-coupler pressure outlet.
 - 3) Medical Vacuum: Quick coupler suction inlet.
 - 4) Medical Vacuum Bottle Bracket: One
 - e. Electrical Service Connections:
 - 1) General Requirements for Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 PIPING SCHEDULE

A. Medical Gas Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type L, copper tube; wrought-copper fittings; and brazed joints.

1.9 VALVE SCHEDULE

- A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.
- B. Zone Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

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SECTION 226400 - MEDICAL GAS ALARMS

1.1 SYSTEM DESCRIPTION

- A. Gas and Vacuum Systems Monitored:
 - 1. Medical compressed air, designated "medical air."
 - 2. Medical vacuum, designated "medical vacuum."
 - 3. Oxygen, designated "medical oxygen."

1.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Allied Healthcare Products, Inc.; Chemetron Division.
 - 2. Amico Corporation.
 - 3. BeaconMedaes.
- C. Source Limitations: Obtain medical alarm systems and components from single manufacturer.

1.3 GENERAL REQUIREMENTS FOR ALARM PANELS

- A. Description: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Recessed installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch thick steel or minimum 0.05-inch thick aluminum, with knockouts for electrical and piping connections.
- B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- C. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F (4 deg C) at 55 psig (380 kPa).
 - 1. Operation: Hygrometer moisture analyzer with sensor probe.

- D. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Low-Pressure Operating Range: 0 to 100 psig.
 - 2. High-Pressure Operating Range: Up to 250 psig.
- E. Carbon-Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon-monoxide level rises above 10 ppm.
- F. Vacuum Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Vacuum Operating Range: 0 to 30 in. Hg.

1.4 MASTER ALARM PANELS

- A. Master Alarm Panels: Separate trouble alarm signals and indicators for each system.
 - 1. Standards: Comply with NFPA 99 and UL 544.
 - 2. 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.
 - 3. Include alarm signals when the following conditions exist:
 - a. Medical Air: Pressure drops below 40 psig or rises above 60 psig, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above 39 deg F at 55 psig, carbon-monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.
 - b. Medical Vacuum: Vacuum drops below 12 in. Hg and backup vacuum pump is in operation.
 - c. Medical Oxygen: Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig, changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
 - d. Medical Oxygen: Pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.

1.5 AREA ALARM PANELS

- A. Area Alarm Panels: Separate trouble alarm signals and indicators for each system.
 - 1. Standards: Comply with NFPA 99 and UL 544.
 - 2. 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.
 - 3. Include alarm signals when the following condition exists:

- a.
- b.
- Medical Air: Pressure drops below 40 psig or rises above 60 psig. Medical Vacuum: Vacuum drops below 12 in. Hg. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig. c.

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SECTION 228010 – ELECTRONIC WATER MONITORING SYSTEM

1. GENERAL

1.1 System Description:

- A. Contractor shall provide,
 - 1. PLC Controller, including Processor ("CPU") and associated system power supply.
 - 2. Remote Input and Output ("RIO") Modules with communications and storage, power supplies and enclosures (nodes).
 - 3. Sensors with Associated Transmitters and power supplies.
 - 4. Integration between transmitters and RIO modules.
 - 5. All wiring and terminations.
 - 6. All necessary / required power supplies.
 - 7. Uninterruptible power supplies (UPS) units.
 - 8. Interface from communications port at RIO modules to Using Agency's communications and networking equipment, both wired (predominantly) and wireless.
 - 9. Integration between PLC system and State's email server.
 - 10. Full and transparent integration between SCADA/PLC and /HMI systems see section 280020 for further information.
 - 11. Testing and labeling of all equipment and wiring.
 - 12. Programming, Configuration and Commissioning services.
 - 13. Warranty.

1.2 REFERENCES and REGULATORY REQUIREMENTS

- A. NFPA 70 National Electrical Code (NEC), 2017.
- B. Federal Communications Commission (FCC), specifically part 15.
- C. System shall be NRTL-listed.

1.3 SUBMITTALS

- A. Provide project-specific product data, including data sheets, shop drawings including equipment layouts at all including buildings, and wiring diagrams for both the buildings and the campus network. Equipment layouts shall include: POWER DISTRIBUTION, TERMINALS LAYOUT, CONTROL and REMOTE PANEL layouts, and COMMUNICATION SYSTEM DISTRIBUTION. All layouts shall include part listing (BOM) for reference.
- B. Qualification data to demonstrate their capabilities and experience: Include list of completed projects with project names, addresses, names of engineers and Owners, and other information specified.

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1.4 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Specification 01 78 39 "Project Record Documents".
- B. Include plans, diagrams and details including locations of all specified and installed equipment.
- C. Record Documents shall be furnished to A/E for delivery to Owner in both print and electronic format. Electronic format includes CAD drawings (AutoCAD version 2012 or later) on compact disc. A/E will furnish Contractor and/or their integrator with all electronic files for preparation.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit data under provisions of Section 01 78 23 "Operating and Maintenance Data."
- B. Include operating instructions, and maintenance and repair procedures and Project Record Drawings with manual.
- C. Include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual.
- D. Provide manufacturer's standard literature, covering all equipment included in the system. The maintenance manuals shall contain specifications, adjustment procedures, circuit schematics, component location diagrams, and replacement parts identification. All references to equipment not supplied on this project shall be crossed out.
- E. Functional Block Diagram: Provide an overall block diagrams showing the major interconnections between subsystems components.
- F. Wiring Diagrams: Provide wiring diagrams showing all interconnecting wiring. Wire identification on the diagrams shall agree with the wire markers installed on the equipment.
- G. Submit list of manufacturer's replacement parts to maintain the complete system with a minimum of down time. This list shall include part names, part numbers, and source for additional purchase. The parts list shall be cross-referenced to the functional block diagrams and the product data.
- H. Include manufacturer representative's letter stating that system is fully operational.

1.6 SUMMARY

A. The water monitoring system shall be comprised of a primary programmable controller (PLC) with system processor and server (CPU), multiple remote nodes with input and output capability, communications and storage modules (RIOs), the communications network, the operator interface (HMI/GUI), and the Historian storage. This system shall provide the necessary remote input and output modules, power supplies, interface to the State's communications equipment and any other required equipment to provide a fully functional system. The system will receive discrete inputs, and through the use of an internal control logic program, control output relay operations, and record/log/chart via the Historian system and display via the video graphic (HMI)

user interfaces. Automation, or controlled processes based upon input parameters, is a requirement with this system – this system will monitor, display and record all inputs, and control automated processes as indicated.

- B. Allen-Bradley shall manufacture the necessary programmable controllers. No other systems are approved. All components that comprise the PLC system shall be from the same manufacturer.
- C. Provide labor, equipment, materials and supervision to install, program, calibrate, adjust, document, and test the total system as required herein, as shown on the drawings and required for the complete integration of the monitoring system.
- D. The Electronic Water Monitoring System is composed of five (5) primary subsystems, each of which may have its own subsystems:
 - 1. SCADA (supervisory control and data acquisition) system with PLC peripheral devices.
 - 2. HMI (human machine interface) system, including the GUI.
 - 3. Historian.
 - 4. Management system.
 - 5. Notification platform.

1.7 CONTROL MONITORING AND ANNUNCIATION

A. The electronic water monitoring system shall monitor and supervise all electronic transmitters connected to sensor networks in each identified building on IVHQ's campus as indicated on the drawings. As part of graphic user interface system (specified by 28 0020), provide an integral management system that shall record to media, paper or screen all occurrences of the system. System shall include a rack-mounted workstation for configuration, programming and troubleshooting; all display shall be through a web-enabled and accessible page accessible via standard credentials.

1.8 WARRANTY

- A. Warranty shall meet all requirements of section 01 7836, "Extended Warranties & Bonds".
- B. General. The contractor warrants that all work provided under the contract will be in conformance with the contract and free from defects in workmanship, materials and equipment for a period of two (2) years or such longer periods may be specified in the contract documents, except as provided below. Warranty time periods shall commence from the date of Owner acceptance of the whole, or any part of the project.
- C. Latent Defects. On demand by the Owner, at any time within <u>the two (2) year period</u> following substantial completion or final acceptance, if applicable, the Contractor shall promptly repair or replace all defective or non-conforming work resulting from, or constituting, latent defects, fraud, fraudulent concealment or gross negligence. The Owner and/or A/E will give timely notice of such defects.
- D. Prompt Repair. Upon notice from Owner of such defects or non-conforming work, the Contractor shall promptly visit the site within <u>48 hours</u> in the company of a building representative, and shall

provide all labor, material and equipment to promptly repair or replace the defective or non-conforming work. The repair shall include all adjacent work not necessarily provided by the Contractor but damaged as a result of such defects or non-conforming work, Owner may repair or replace such work and charge the cost thereof to the Contractor. Work which is repaired or replaced by the Contractor shall be inspected and shall be warranted by the Contractor in accordance with this Article. The warranties set forth herein are in addition to all warranties or guarantees expressed or implied by operation of law, statute or ordinance.

E. Commercial Warranties. The Contractor shall deliver all commercial warranties received from manufacturers to the A/E prior to final completion but this shall not reduce Contractor's obligations under this article.

2. PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Provide a complete and fully functional water monitoring system using materials and equipment of types, sizes and rating, as required to meet performance requirements. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.
- B. All assemblies and sub-assemblies performing similar functions in separate controllers purchased under this specification shall be interchangeable. Components of the PLC system shall be by the same manufacturer, no mixing of multiple manufacturers shall be considered.
- C. All components shall be housed in structurally sound and finished metal cabinets. All switches and other operator-controlled devices shall be of the size and durability for their intended use as is normally offered for industrial applications.
- D. Modular components of the system shall be listed or recognized by a nationally recognized testing laboratory (NRTL).
- E. Each identified location shall be a networked PLC system including PLC processors, power supplies, input and output modules.
- F. The field (remote) input and output modules shall be housed in NEMA-rated lockable enclosures hereafter referred to as remote input/output ("RIO") modules. The equipment cabinets shall house the following items.
 - 1. Input modules related to the monitoring of all sensor networks via their associated/attached transmitters.
 - 2. Output modules related to the automatic control of specified field devices (e.g. automatic/electronic flush valves).
 - 3. Communications (Ethernet) port.
 - 4. Storage of all monitored data using the sampling rates / scan times in specification section 28 0020, using "Store and Forward" function upon compromise of communications

network, remote I/O node shall continue storing data locally until communications are restored, and then shall forward all stored data to PLC system Historian and auto-adjust that module's data logging to reflect new data.

NOTE that this requirement will most likely require this equipment to be a smallformat industrial computer, examples included Allen-Bradley VersaView5000 non-display or Schneider Electric / Wonderware Intouch Machine Edition.

- 5. Regulated power supplies.
- 6. Terminal strips and fusing. Fuse holders shall be manufactured by Phoenix Contacts, Entrelec, or Square D and shall provide indication when the fuse has blown. Fuses shall be rated for the specific load.
- 7. The programmable controller, or where applicable, transmitting and receiving modules to communicate with the PLC or remote input and output modules.
- G. All Inputs and Outputs of the integrated system shall go through the I/O modules of the PLC. Direct connection to LED's, relays or other devices will not be acceptable.
- H. System includes a single primary PLC (at the Stone Administration building) and multiple remote PLC input and output modules with both communications and power supplies. <u>The system shall</u> be Ethernet-based, and shall rely upon the State of Illinois's LAN/WAN network at the campus – all proposed and submitted-upon PLC equipment shall be certified to work with the existing network communications equipment.

2.2 PLC EQUIPMENT AND MATERIALS

- A. SCADA/PLC Manufacturers:
 - 1. Allen-Bradley to match and integrate to existing system on campus.
- B. Input cards shall be optically isolated and designed to accept an input signal of 4-20mA, 24VDC. These modules shall be din-rail mounted at the interior of the identified enclosures. Each input point shall have a corresponding red LED indicator on the upper front of the module, which illuminates when the input is read as on by the microprocessor. These modules shall be configured in 8 or 16 inputs.
- C. Output cards shall be reed relay outputs with isolated commons. These devices shall be rack mounted. Each output shall be fused and be accompanied by a red LED indicator on the upper front of the module, which illuminates when the on-board processor issues a command to energize the output. These cards shall be configured in 16 or 32 outputs.
- D. Delays between any field device input and the graphic user interface shall not exceed sixty (60) seconds.
- E. DipSwitch Programming is not acceptable.
- F. No proprietary PLC system shall be acceptable. Each PLC shall be a standard industrial grade product designed for high reliability. The PLC shall be manufactured by a company that has produced a product line of compatible PLCs for at least fifteen years and has a minimum of two

Illinois distributors with annual sales over one hundred thousand dollars. Additionally, the PLC manufacturer must have a minimum of five Illinois system integrators proficient in the programming, integration and maintenance of the manufacturer PLC equipment.

- G. System (via Historian) shall include sufficient memory to record/log all received data at intervals specified in section 28 0020 for a period of (60) days. Both the system (headend) PLC and RIO shall include local memory to store received information, with the latter needing only to store (buffer) data no less than (48) hours, in case of a communications (LAN/WAN) interruption.
- H. System (via Historian) shall be able to produce graphical data of all received data values, both instantaneous and historical, in both continuous and trending formats.
- I. System (via Notification Platform) shall be able to communicate to designated personnel and devices via Smartphone App, SMS text messaging, and Text-to-Speech messaging. System shall include Win-911 Advanced software.
- J. PLC shall be password protected against unauthorized entry to software.

2.3 NETWORK SWITCHES

A. <u>All</u> network switches or other network electronics (e.g. wireless bridges) to be furnished and installed by State's IT department. Contractor shall provide IT services in coordination with the State of Illinois's personnel and per their requirements. Significant coordination shall be conducted between Contractor and State.

2.4 SYSTEM POWER SUPPLIES

- A. Output Rating (Amperage): due to the variances between manufacturers and their products, the Electrical Contractor shall be responsible for sizing the power supply based upon the total connected load and providing for a spare 20% capacity for possible future use.
- B. Voltage Input: 120VAC, 60Hz (protected by internal fuse rated at 3.0A). Electrical Contractor shall be responsible for providing power between power supplies and indicated electrical circuit (on electrical power sheets). Provide all equipment necessary to facilitate routing and connection.
- C. Voltage Output: 24VDC via multiple (8/16) class 2 rated (power-limited) and protected outputs. Outputs shall also be filtered and electronically rated, and have short circuit and thermal overload protection.
- D. Features: power supply shall have a built-in charger and (2) 12VDC / 7Ah sealed (leakproof) lead-acid batteries, minimum.
- E. Display: AC input and DC output LED indicators.
- F. Supervision: power supply shall have both low-battery and AC power supervision via form C contacts.
- G. Physical: wall-mounted, lockable enclosure properly labeled "ACS Power Supply".

- H. Physical Connection: Screw-type via terminal block.
- I. Warranty: three (3) years minimum.
- J. Agency Approvals: Complies with UL 294 / 603.
- K. Manufacturers:
 - 1. Puls
 - 2. Altronix
 - 3. AlarmSaf

2.5 COMPONENT PROTECTION

- A. Surge protection: Protect components from voltage surges originating external to equipment housings and entering through power, communication, signal, control, and sensing leads. Include surge protection for external wiring of each conductor entry connecting to components.
 - 1. Minimum Protection for AC Power Circuits 120V (minimum): Multistage surge suppressors, listed under UL 1449, using a combination of inductors and silicon avalanche diodes or equivalent, and with 300-V minimum suppression level and 5-nanosecond maximum response time.
 - a. Silicon Avalanche Diodes: bipolar, grade A, +/-5% tolerance.
 - b. Discrete SPD units external to protected equipment: enclosed modules with indicating lights labeled "power on" and "failure".
- B. Interference Protection: Component function shall be unaffected by radiated radio-frequency interference and electrical induction of 15V/m over a frequency range of 10 to 10,000MHz, or by conducted interference signals up to 0.25VRMS injected into power supply lines at 10 to 10,000MHz.

2.6 AUXILIARY CONTROL SYSTEMS

- A. Provide interconnection / integration to the following systems for total control by the PLC-based system via output points and interposing relays as necessary:
 - 1. Remote control of automatic/electronic flush valves.
- B. All control systems shall be a subsystem within the PLC. Reference division 26 specifications for manufacturers of contactors.

2.7 BATTERY BACKUP SYSTEM

A. An uninterruptible power supply (UPS) shall be provided at each system enclosure (DIN-rail mountable) or rack, as indicated.

- B. Provide a means to monitor alarm/trouble signals from each UPS through the PLC system software.
- C. Size: 1000VA (minimum), unless noted otherwise Contractor shall be responsible for calculating this size depending upon connected equipment and sizing power supply per manufacturer's recommendations.
- D. Type: Line-interactive.
- E. Battery Type: Maintenance-free, sealed (leakproof) lead-acid battery with suspended electrolyte.
- F. Runtime: Approximately 15min. at <u>full</u> load capacity.
- G. Input Voltage: 120VAC, 60Hz.
- H. Output Voltage: 120VAC, 60Hz. Distortion shall be less than 5% at full load capacity.
- I. Display: LED indicators for On-Line, On-Battery, Replace Battery and Overload status.
- J. Audible Alarm: Low battery or configurable delay status.
- K. Communications: LAN (Ethernet) port.
- L. Physical Connection:
 - 1. Input: flexible cord with either NEMA 5-20P plug or conduit whip for connection to power wiring at junction box.
 - 2. Output: Six (6) NEMA 5-15R receptacles.
- M. Finish: Black.
- N. Warranty. 2 years minimum.
- O. Manufacturer: APC, Liebert, Emerson or Approved Equivalent.

2.8 SENSOR and TRANSMITTER SYSTEMS

- A. TEMPERATURE (RTD) plan mark "T"
 - 1. Type: Platinum Resistance; housed in stainless steel thermo-well.
 - 2. Potable water in line flow; threaded; various pipe sizes, NSF 61 rated if possible.
 - 3. Range: 0°C (32°F) to 100°C (212°F); center weighted for the temperature of medium, either hot or cold domestic water; minimum accuracy per IEC 60751, B standard; monitor both cold and hot domestic water.
 - 4. Flow pressure: varies from 30PSI 80PSI; should withstand pressure/flow above the highest range to allow for system flushing at up to 100PSI.
 - 5. Hygienic: must be hygienic and non-biologic active (3A if available); resistant to elevated levels of active chlorine, chloramines, and chlorine dioxide (CIO2).
 - 6. External Protection Class: IP 65 minimum

- 7. Signal: HART 4-20mA via transmitter and power supply.
- 8. Acceptable Manufacturers:
 - a. Endress+Hauser (BOD)
 - b. ABB
 - c. Omega Engineering
- B. pH plan mark "pH"
 - 1. Type: Glass or glass with stainless steel housing.
 - 2. Potable water; threaded mounting; mounted in sampling well.
 - 3. Range: 0-14; center weighted for 6.0 9.0; accuracy to ± 0.1 ; pre-calibrated with traceable report.
 - 4. Must withstand up to 100PSI (8 bar abs) to allow for system flushing.
 - 5. Operating Environment Temperature: 32°F 180°F; indirect sampling will require a sampling well.
 - 6. Potable water in sampling flow; resistant to elevated levels of active chlorine, chloramines, and chlorine dioxide (CIO2).
 - 7. Other Features: Provide integral temperature sensing for compensation; provide necessary accessories for ease of removal or retraction for cleaning/calibration without draining the main water system piping via a sampling bypass; bypass sampling system shall include check, drain and test sample valves; consolidate with Chlorine Monitor as a single sample system with bypass panel mounted in NEMA 4 enclosure.
 - 8. External Protection Class: IP65 minimum.
 - 9. Signal: HART 4-20mA via digital transmitter with power supply.
 - 10. Acceptable Manufacturers:
 - a. Endress+Hauser (BOD)
 - 1) Mettler Toledo
 - 2) Hach
 - 3) Omega Engineering (Spectris)
 - 4) Sensorex
 - 5) Grundfos
 - 6) DeNora
 - 7) ABB
- C. FREE RESIDUAL CHLORINE (Cl₂) and CHLORINE DIOXIDE (ClO₂) plan mark "CL"
 - 1. Type: diaphragm for free residual chlorine dioxide (CIO2) in mg/L (ppm).
 - 2. Potable water in line flow or sample; threaded mounting; various pipe sizes.
 - 3. Range: 0.1 10mg/l; accuracy to ± 0.1 ; can be calibrated per EPA accepted DPD colorimetric method; pre-calibrated with traceable report to meet system parameters.
 - 4. Must withstand up to 100PSI (8 bar abs) to allow for system flushing.
 - 5. Operating Environment Temperature: direct contact rated 32°F 180°F; indirect sampling will require a flow well.
 - 6. Hygienic: must be hygienic and non-biologic active.
 - 7. Other Features: Provide necessary accessories for ease of removal or retraction for cleaning/calibration without draining the main water system via a sampling bypass; bypass

sampling system shall include check, drain and test sample valves; consolidate with pH Monitor as a single sample with bypass, panel mounted in NEMA 4 enclosure.

- 8. External Protection Class: IP 65 minimum.
- 9. Signal: HART 4-20mA via digital transmitter and power supply.
- 10. Acceptable Manufacturers:
 - a. Endress+Hauser (BOD)
 - b. Mettler Toledo
 - c. Hach
 - d. Grundfos
 - e. DeNora
 - f. ABB
- D. ORP (Oxidation Reduction Potential) --plan mark "ORP
 - 1. Type: platinum electrodes; highly polished to reduce maintenance and assure longer reliable data.
 - 2. Potable water in line flow or sample; threaded mounting; various pipe sizes; NSF 61 if inserted in main flow stream (non-bypass or sampling).
 - 3. Range: -1500mV to +1500mV.
 - 4. Must withstand up to 100PSI (8 bar abs) to allow for system flushing.
 - 5. Operating Environment Temperature: 32°F 212°F; must be direct contact rated to a minimum of 180°F; indirect sampling will require a flow well.
 - 6. Hygienic: must be hygienic and non-biologic active; resistant to elevated levels of active chlorine, chloramines, and chlorine dioxide (CIO2).
 - 7. Other Features: Provide integral pH/temperature sensing for compensation; provide necessary accessories for ease of removal or retraction for cleaning/calibration without draining the main water system piping via a sampling bypass; bypass sampling system shall include check, drain and test sample valves.
 - 8. External Protection Class: IP65 minimum.
 - 9. Signal: HART 4-20mA via digital transmitter with power supply.
 - 10. Acceptable Manufacturers:
 - a. Endress+Hauser (BOD)
 - b. Mettler Toledo
 - c. Hach
 - d. Sensorex
 - e. Grundfos
 - f. DeNora
 - g. ABB

E. TOTAL DISSOLVED SOLIDS (Conductivity) – plan mark "TDS"

- 1. Type: Total dissolved solids (TDS); toroidal inductive sensor, non-corroding material.
- 2. Potable water in line flow; threaded mounting; various pipe sizes, NSF 61 rated if possible.
- 3. Hygienic: must be hygienic and non-biologic active (3A if available); resistant to elevated levels of active chlorine, chloramines, and chlorine dioxide (CIO2).
- 4. Range: Correlates conductivity μ S/cm² to ppm for dissolved solids.

- 5. Operating Environment Temperature: 32°F 180°F.
- 6. Operating Environment Pressure: up to 100PSI.
- 7. Other Features: Local display and interface control for setup; provide necessary accessories for ease of removal or retraction for cleaning/calibration without draining the main water system via a piping bypass.
- 8. External Protection Class: IP 65 minimum.
- 9. Signal: HART 4-20mA via digital transmitter/translator with power supply; provide signal for correlated ppm TDS from conductivity.
- 10. Acceptable Manufacturers:
 - a. Endress + Hauser (BOD)
 - b. Mettler Toledo
 - c. Hach
 - d. Omega Engineering
 - e. Sensorex
- F. FLOW METER plan mark "FM"
 - 1. Type: Electro-magnetic flow measurement.
 - 2. MAXIMUM PRESSURE DROP ACROSS ASSEMBLY IS <u>LIMITED TO 2 PSI AT</u> <u>FULL FLOW</u>.
 - 3. Potable water in line flow; threaded or flange mounting; various pipe sizes, FDA approved for use in potable water systems; NSF rated if possible.
 - 4. Operating Environment Pressure: maximum 150PSI.
 - 5. Operating Environment Temperature: 32°F 180°F.
 - 6. Construction: 316 stainless steel tube with stainless steel probes.
 - 7. Accuracy: $\pm 1\%$ or better.
 - 8. Remote Output: HART 4-20mA via integral transmitter; provide power supply as needed.
 - 9. External Protection Class: IP 65 minimum.
 - 10. Installation Limits: Maximum of five (5) pipe diameters for in-flow piping length and maximum three (3) pipe diameters for out-flow length.
 - 11. Other Features: Local direct reading display; provide accessories and fittings for piping bypass to allow cleaning and maintenance without disruption of the main water system.
 - 12. Acceptable Manufacturers:
 - a. Endress+Hauser (BOD)
 - b. Omega Engineering
 - c. Honeywell
 - d. Badger
 - e. ABB

G. WATER PRESSURE – plan mark "P"

- 1. Type: Solid State direct output; stainless steel diaphragm with sealed SS sensor.
- 2. Potable water in line flow; threaded for insertion in various size piping; FDA approved for use in potable water systems.
- 3. Range: 0-100PSI (gage), temperature compensated.
- 4. Operating Environment Temperature: 0 60°C (32 140°F).
- 5. Accuracy: $\pm 0.5\%$.

- 6. External Protection Class: IP 65 minimum.
- 7. Other Features: Provide accessories and fittings for piping bypass to allow cleaning and maintenance without disruption of the main water system.
- 8. Signal: HART 4-20mA via integral transmitter; provide power supply as needed.
- 9. Acceptable Manufacturers:
 - a. Endress+Hauser (BOD)
 - b. Omega Engineering
 - c. Ametek
 - d. ABB
- H. WATER TURBIDITY plan mark "TB"
 - 1. Type: Photometric Light Scattering; ISO 7027 standard; digital; housed in stainless steel tube or well.
 - 2. Potable water in line flow; various pipe sizes.
 - 3. Range: 0-5 NTU (FNU); pre-calibrated with traceable report; drinking water standard.
 - 4. Sensitivity: ≤ 0.1 NTU.
 - 5. Continuous Output; repeatable within 0.5% of value measured.
 - 6. Must withstand up to 100PSI to allow for system flushing.
 - 7. Operating Environment Temperature: 0°C (32°F) 85°C (185°F)).
 - 8. Other Features: Ease of maintenance; provide necessary accessories for ease of maintenance or provide method to bypass for maintenance without draining or interrupting the delivery and monitoring systems; include calibration tools.
 - 9. External Protection Class: IP 65 minimum.
 - 10. Signal: HART 4-20mA via digital transmitter with power supply.
 - 11. Acceptable Manufacturers:
 - a. Endress+Hauser (BOD)
 - b. Mettler- Toledo
 - c. Hach

I. COMBINED MONITORING STATIONS

- 1. Combined stations for sampling of pH, chlorine dioxide and ORP (Oxidation Reduction Potential) sensors shall be combined where all sensors are required at a single location. Similarly other sensors and for non-sampling can be combined as a unit with a single multi-channel transmitter.
- 2. Combined pH, chlorine dioxide, ORP stations shall include pressure reducer, dirt trap, check valve, 2.5" pressure gauge, tubing/piping, fittings, multi-channel transmitters, sensor wells, sensor probes and manual sample port with valve on a single back panel in a NEMA 4 enclosure. All devices and accessories will meet the respective performance to match the sensor probes listed above.
- 3. Stations located with other required probes, sensors and transducers where indicated on plans shall include additional transmitters or multi-channel transmitters in the same enclosure for those data points. A single enclosure station shall be provided where multiple sensors, probes and transducers are indicated.
- 4. Transmitter power shall be housed within the enclosure and included one or more TVSS type NEMA 5-20R, 20A, 125V duplex receptacles in electrical boxes. Boxes and

receptacles shall be located to allow ease of conduit/wiring entry or shall provide an external, single point connection in a minimum 4" square box with cover. All devices, boxes and wiring shall be NRTL listed and meet Division 26 specifications for individual devices or materials.

- 5. Equipment and devices shall be clearly labeled for function or for interconnection to exterior piping or wiring e.g. 'DPD Test' for manual sample port/valve.
- 6. Non-metallic finger duct or other wire management shall be provided for internal routing of input/output wiring to sensor, probes, transducers and data acquisition equipment.
- 7. Combined stations shall be either manufacturer's or authorized fabricator custom preassembled and tested with complete set of plans, material lists, diagrams and data for each device used in the assembly. Stations will be calibrated and tested to meet the system parameters for data acquisition including programming of each station to output the data points, trends, trouble notification and alarm points outlined in the system specification.

J. ENCLOSED TRANSMITTERS

- Transmitter power shall be housed within a NEMA 4 type enclosure and included one or more TVSS type NEMA 5-20R, 20A, 125V duplex receptacles in electrical boxes. Boxes and receptacles shall be located to allow ease of conduit/wiring entry or shall provide an external, single point connection in a minimum 4" square box with cover. All devices, boxes and wiring shall be NRTL listed and meet Division 26 specifications for individual devices or materials.
- 2. Non-metallic finger duct or other wire management shall be provided for internal routing of input/output wiring to sensor, probes, transducers and data acquisition equipment.

2.9 SYSTEM WIRING

- A. LAN (between PLC RIO and networking equipment): CAT-6 (unless noted otherwise) see specification section 271000.
- B. Analog communications, i.e. 4-20mA (between PLC RIO and sensor transmitters): #16/2STP (copper, shielded, twisted pair) designed for instrumentation and process control applications (NEMA WC55), 300VAC jacket rating, shield shall be overlapped aluminum (100% coverage) with #20AWG tinned copper drain.

3. EXECUTION

3.1 WIRING INSTALLATION

A. Wiring Method: Install wiring in accordance with Section 260519 – Low Voltage Electrical Power Conductors and Cables. Low-voltage cabling may be installed open above accessible ceilings; where rooms or areas do not contain any ceiling ("exposed structure") and cables are not subject to physical damage, cables may be installed open; otherwise in exposed structure areas such as crawl spaces, where indicated on plans and where inaccessible ("hard") ceilings exist without adequate access, **cabling shall be installed in conduit**.

- B. Wiring Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- C. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where any circuit tap is made.
- D. Alarm Wiring: For the low-voltage portion of the system, install 75-deg C insulation in wet, damp, or dry locations. Provide wiring operating at line voltage having similar insulation.
- E. Color Coding: Color code all fire alarm conductors differently from the normal building power wiring.
- F. Do not bend cable, in handling or installation, to smaller radii than minimum recommended by manufacturer. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

3.2 GROUNDING

A. Ground equipment and conductor and cable shields. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.3 TESTING, CALIBRATION AND MAINTENANCE

- A. Contractor will include the manufacturers' or manufacturer trained and certified services to perform start-up on instruments and combined stations to include basic operational training and certification of performance of the instrument.
- B. Contractor shall include all services per the manufacturer's recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to end user acceptance / plant turnover and the first (24) months of end-user operation post turnover (to coincide with the specified warranties for the system).
- C. Items A and B are to be performed by manufacturers' or manufacturer trained and certified service personnel.
- D. Provide all service parts and reagents necessary for calibration and maintenance per the manufacturer's recommendations. Third-party parts and reagents are not approved for use.
- E. Minimum maintenance services to be included are:
 - 1. Turbidity clean, test & calibrate quarter annually (every 3 months after startup).
 - 2. pH, Chlorine, ORP and Conductivity clean, test & calibrate semi-annually (every 6 mo. after startup).
 - 3. Flow and Pressure test & calibrate annually (once a year after startup); clean as required.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative for the pretesting, testing, and adjustment of the system.
- B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results. Each device shall be tested during the pretest. Verify the absence of unwanted voltages between circuit conductors and ground. Megger test all conductors other than those intentionally and permanently grounded with electronic components disconnected. Test for resistance to ground. Report readings less than 1-megohm for evaluation. Test all conductors for short circuits utilizing an insulation testing device. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter.
- C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable. The letter shall include the names and titles of the witnesses to the preliminary tests.
- D. Final Test Notice: Provide 10 days minimum notice in writing when the system is ready for final acceptance testing.

3.5 CORRECTION OF DEFECTS

- A. When the tests disclose any unsatisfactory workmanship or equipment furnished under this Contract, correct defects and retest. Repeat tests until satisfactory results are obtained.
- B. When any wiring or equipment is damaged by tests, repair or replace such wiring or equipment. Test repaired items to ensure satisfactory operation.

3.6 COMMISSIONING

- A. Provide the services of a factory-authorized service representative to demonstrate and train the Using Agency's personnel as specified below.
 - 1. Train maintenance personnel in the procedures and schedules involved in installing, operating, troubleshooting, servicing, and preventive maintaining of the system. Allot (8) hours for this training.
 - 2. Provide (8) hours of additional training for the appointed responding personnel regarding the operation of the specific systems installed on this project. This phase of training shall not include installing, troubleshooting, servicing or preventive maintenance.
 - 3. Operation and Maintenance Manuals shall be submitted to the Engineer and approved prior to Training. Utilize the O&M manual as reference material during all training sessions.
 - 4. Schedule training at least two weeks in advance. Notify both A/E and Using Agency of training dates.

B. Provide the services of a factory-authorized and trained service representative to provide adjustments to the system within the two (2) year warranty period – allot (40) hours for this work.

END 228010.

SECTION 228020 - GRAPHIC USER INTERFACES and MANAGEMENT SYSTEM

- 1. GENERAL
- 1.1 System Description:
 - A. Contractor shall provide,
 - 1. Software and programming services to include graphical user interface (HMI) and management system for PLC system described in section 28 0010.

1.2 REFERENCES and REGULATORY REQUIREMENTS

- A. NFPA 70 National Electrical Code (NEC), 2017.
- B. Federal Communications Commission (FCC), specifically part 15.
- C. System shall be NRTL-listed.

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Specification 01 3323 "Shop Drawings, Product Data & Samples Schedule".
- B. Submit renderings of all GUI screens that the User will be able to view, as well as a sample of the logging record(s).
- C. Submit manufacturer's installation instructions under provisions of Division One Specifications.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Section 01 78 23 "Operating and Maintenance Data."

1.5 SUMMARY

- A. System shall include a HMI (Human Machine Interface) in associated with the PLC system, and shall include a graphical user interface (GUI) allowing for monitoring of the water monitoring systems. GUI / HMI shall indicate real-time levels of all sensors at all buildings (included in specification section 280010), as well as historical and trending data.
- B. Contractor shall provide a dynamic webpage that provides all of the same graphical information (levels, both real-time and historical) and system integrity (heartbeat of PLC, communications and power systems), as well as an export utility to translate historical data into a file format

(PDF, XLS, etc.) easily saved and/or printed.

- C. System shall be capable of sending both SMS (text) and SMTP (email) messages to multiple phone numbers and email addresses, respectively, to communicate system survivability (power and/or communication), supervisory alerts and alarms reference paragraph 1.7 ("SENSOR RANGES") for additional information.
- D. System shall include a management system (server), which shall provide all administrative functions and management of database information data included in the later shall be in Window-compatible format for easy exportation and report generation.

1.6 OPERATION DESCRIPTION

- A. GUI display shall be arranged into two primary sections: SITE display and the UTILITY section. The graphical display shall consist of screens based upon the actual building/site plans icon titles, size, etc. shall be confirmed with the Owner prior to software development. Time duration to generate any screen within the GUI shall not exceed 0.5s.
 - 1. SITE display: Main section of display with a 2D view of the overall campus with the capability of zooming in on a specific building. "VIEW"s shall be tabulated on the screen for quick reference, and shall include designated viewports of the campus. VIEWs shall include graphic icons representing all monitored devices, at the approximate locations of the physical devices. Graphics shall optimize monitor size, resolution and color to enhance and simplify the information displayed, as well of selection of that information by the operator.
 - UTILITY, i.e. SYSTEM STATUS: shall be included on the operator control panel to communicate the status of all PLC modules, both at the PLC and the remote I/O modules disconnection (no power) or offline (no communications) modules shall be visually indicated separately from the other normal/on-line modules. A "popup" message shall also be initiated to notify all logged-in operators of a failure

1.7 SENSOR RANGES

- A. In coordination with specification section 280010, specifically the applicable paragraphs of part II that include the individual water monitoring sensors, the following ranges shall be programmed to output data to the system log, as well as send alert/alarm messages based upon the following ranges:
 - 1. SUPPLY WATER TEMPERATURE (HOT)
 - a. Normal: >150deg F.
 - b. Supervisory (Alert): 140-150deg F.
 - c. Alarm: <140deg F.
 - 2. RETURN WATER TEMPERATURE (HOT)
 - a. Normal: >150deg F.
- b. Supervisory (Alert): 140-150deg F.
- c. Alarm: <140deg F.

3. COLD WATER TEMPERATURE

- a. Normal: 35 to 85deg F.
- b. Supervisory 1 (Alert): 85deg F and above.
- c. Supervisory 2 (Alert): 35deg F and below.
- 4. pH
 - a. Normal: <8.5.
 - b. Supervisory (Alert): 8.5 and above.

5. FREE RESIDUAL CHLORINE

- a. Normal: >2.0 ppm (mg/L).
- b. Supervisory (Alert): 1.0 to 2.0ppm (mg/L).
- c. Alarm: <1.0 ppm (mg/L).

6. CHLORINE DIOXIDE

- a. Normal: >0.2ppm (mg/L).
- b. Supervisory (Alert): 0.1 to 0.2ppm (mg/L).
- c. Alarm: <0.1 ppm (mg/L).

7. OXIDATION REDUCTION POTENTIAL

- a. Normal: >+300mV.
- b. Supervisory (Alert): +200mV to +300mV.
- c. Alarm: <+200mV.

8. TOTAL DISSOLVED SOLID

- a. Normal: <200mg/L.
- b. Supervisory 200mg/L and above.
- 9. PRESSURE
 - a. Normal: >50psi.
 - b. Supervisory (Alert): 35 to 50psi.
 - c. Alarm: <35psi.

10. TURBIDITY

- a. Normal: <1NTU.
- b. Alarm: 1NTU and above.
- 11. FLOW

- a. N/A (system shall continually display/record data, but never alert/alarm.
- B. All of the above values shall be able to be adjusted via the software by the Owner/User with the proper credentials include training on entering and augmenting these values, in conjunction with paragraph 3.4 (commissioning).
- C. All non-sample measurements (flow, temperature, pressure, turbidity, TDS) shall be recorded every one second (1s); all sample measurements (free chlorine and chlorine dioxide, pH, ORP) shall be recorded every 15 minutes. Upon power or communications failure, the former measurement may be extended to every one minute; the latter, every 30 minutes (maximum).

1.8 SURVIVABILITY PARAMETERS

- 1.9 Full system, from the headend equipment at the Stone/Security building, to each and every building, shall be monitored for both power, communications and signal failures:
 - 1. POWER at MDF Headend location and each building's RIO location, both via UPS units.
 - 2. COMMUNICATIONS between each building's RIO location and network switch at IDF, and network switch MDF and system headend location; between system headend location (servers) and Intranet (to State's email server) and Internet (to webpage). Intercommunications between each SCADA device at headend location (system server, system workstation, HMI server, Historian storage system, and/or PLC system) shall all be monitored for communications status.
 - 3. SIGNAL between each building's set of transmitter panels and building's RIO location.

1.10 EVENT SUMMARY

- A. Event-based display schemes shall be implemented in the development of the GUI screens. Background color (all normal) shall be neutral gray, with events highlighted using contrasting color – the following are suggestions that shall be communicated to and confirmed by the Owner prior to final programming:
 - 1. GREEN: All levels normal.
 - 2. YELLOW: Supervisory (Alert).
 - 3. RED: Alarm.
- B. Systems shall also include audible tones (beeps, etc.) to announce actions, system warnings, emergencies, and other important information to the operator. These announcements shall be displayed until they are acknowledged, regardless of display.
- C. System shall communicate both supervisory and alarm messages via email (to State's SMTP server).

1.11 ALARM PRIORITIES

- A. Prioritization of alarms shall be limited to four layers, total. The following includes suggested priority levels; however, once again, the integrator / contractor shall confirm all alarm levels with the Owner prior to final programming:
 - 1. LEVEL ONE: Survivability parameters included in paragraph 1.8.
 - 2. LEVEL TWO: Free Residual Chlorine, Chlorine Dioxide and ORP.
 - 3. LEVEL THREE: Temperature (Hot and cold systems), Pressure and Turbidity.
 - 4. LEVEL FOUR: All other minus flow.
- B. If necessary, additional level(s) of priority shall be assigned by the Owner.

1.12 DEVICE ICONS

- A. MAP display shall include the following icons included on the floorplans:
 - 1. SENSOR icon (with levels), on a building-by-building basis
 - 2. SYSTEM HEALTH (HEARTBEAT) for power, communications, and signaling systems.
- B. GLOBAL FUNCTION CONTROL display shall include the following icons:
 - 1. ACKNOWLEDGE icon
 - 2. SILENCE icon
 - 3. RESET icon

1.13 MANAGEMENT SYSTEM

- A. System shall record (log) <u>all</u> operations and operator requests included in all of the previous sections. This log shall be stored on both primary and backup servers provided by the Contractor and shall include an operating system to simply sorting, searching and request generation by ALL or specific subsystems. Archived information shall include the time, date, function and associated activity.
- B. System shall store, process, and report logged data using an approved software package designed for that purpose.
- C. Events to be logged:
 - 1. Operator log-on, log-off (including user name, date and time).
 - 2. Status of all inputs.
 - 3. All output actions.
 - 4. Alarms and alarm responses (acknowledge, silence, clear).
- D. System shall include a DIAGNOSTIC function for troubleshooting monitored inputs and controlled outputs.
- E. System configuration software shall be an industry-recognized and standard software package

from United States distributors located in the continental US. Software shall be 64-bit format and must operate on Windows 7 or 10 (8 is prohibited) only.

- F. All monitoring and login logic shall be programmed within the management system. System software and Input / Output / Data Access servers shall be the product of a single manufacturer. No proprietary DLL, EXE or other form of encrypted software shall be considered. Failure to provide such a non-proprietary system shall result in breach of contract, forcing either the contractor / integrator to be release from said contract or to re-program and re-develop all software with non-proprietary programmed methods at their own expense and not the Owner's.
- G. Contractor / integrator shall provide all programming passwords, source code and programming schedules to Owner during closeout procedures.

1.14 WARRANTY

- A. Warranty shall meet all requirements of section 01 7836, "Extended Warranties & Bonds".
- B. General. The contractor warrants that all work provided under the contract will be in conformance with the contract and free from defects in workmanship, materials and equipment for a period of two (2) years or such longer periods may be specified in the contract documents, except as provided below. Warranty time periods shall commence from the date of Owner acceptance of the whole, or any part of the project.
- C. Latent Defects. On demand by the Owner, at any time within the <u>two (2) year</u> period following substantial completion or final acceptance, if applicable, the Contractor shall promptly repair or replace all defective or non-conforming work resulting from, or constituting, latent defects, fraud, fraudulent concealment or gross negligence. The Owner and/or A/E will give timely notice of such defects.
- D. Prompt Repair. Upon notice from Owner of such defects or non-conforming work, the Contractor shall promptly visit the site within <u>48 hours</u> in the company of a building representative, and shall provide all labor, material and equipment to promptly repair or replace the defective or non-conforming work. The repair shall include all adjacent work not necessarily provided by the Contractor but damaged as a result of such defects or non-conforming work, Owner may repair or replace such work and charge the cost thereof to the Contractor. Work which is repaired or replaced by the Contractor shall be inspected and shall be warranted by the Contractor in accordance with this Article. The warranties set forth herein are in addition to all warranties or guarantees expressed or implied by operation of law, statute or ordinance.
- E. Commercial Warranties. The Contractor shall deliver all commercial warranties received from manufacturers to the A/E prior to final completion but this shall not reduce Contractor's obligations under this article.

2. PRODUCTS

2.1 SYSTEM WORKSTATIONS

- A. General: Workstations shall be provided at the Stone (Security) building, and shall include both graphical user interface (GUI) and management system software as described in this specification section contractor shall provide any peripheral equipment, wiring and programming for connection between these workstations, PLC-based control system and microcomputer controllers.
- B. Processor: manufactured by Intel (i5/i7 series), dual- or quad-core operating at 3.0GHz, minimum. Other processors shall be considered given minimum requirements by manufacturer (AMD is not acceptable).
- C. System Bus: 1200MHz front-side bus (FSB), minimum.
- D. RAM: 8Gb DDR400 SDRAM.
- E. Hard Drive: 1TB eSATA.
- F. Video Card: 2Gb SGRAM (minimum) by Nvidia or ATI.
- G. Sound Card: 32-bit multimedia sound card.
- H. Drive: 8x DVD-R/RW, 16x/10x/40x CD-R/RW.
- I. Network Card: (2) 10/100/1000Mbps Ethernet network interface card (NIC) or function directly on motherboard.
- J. Case: rack-mounted.
- K. Operating System: Microsoft Windows 7 or 10 Professional, 64-bit with latest service package and all security updates.
- L. Monitor: rack-mounted 22" Flat Panel Display (LCD technology) with 1920x1080 (HD, 1080p) resolution. Manufacturers include: NEC, HP, Sony and Panasonic.
- M. Peripherals: Speakers, keyboard, 2-button optical mouse with scroll wheel. Include rackmounted sliding tray for peripherals.
- N. Backup and Recovery: Back-up software and additional hardware to back-up system once a day. Provide either segmented internal disk drive or external disk drive (500Gb, minimum) for backup files.
- O. Reporting Printer (where required): Ink- or Laser-Jet printer with (1) set of both black and color replacement printer cartridges (in addition to installed set).
- P. Warranty and Service: Three-year on-site manufacturer's warranty (part and labor).
- Q. Manufacturers:
 - 1. Dell.
 - 2. HP.
 - 3. IBM / Lenovo.

2.2 GRAPHIC USER INTERFACE and MANAGEMENT SYSTEM SOFTWARE

- A. Software shall be commercial Supervisory Control and Data Acquisition (SCADA) system available from United States distributors for security types of automation systems. Manufacturer shall have produced SCADA software for a minimum of ten (10) years and offer both live telephone and Internet support, including both technical support and on-line upgrade packages.
- B. Software shall include data acquisition, control, data storage, data analysis and HMI in one package. All components of this system shall be by a single manufacturer components by multiple companies is not permitted.
- C. Software shall operate on the Microsoft Windows professional platforms specified elsewhere within this specification and fully comply with Microsoft Windows' Open System Architecture standards.
- D. All configuration changes shall be capable of being executed dynamically, while the system is operating, and not require shutdown or other types of interrupted processes.
- E. System shall provide user documentation in electronic format, as well as include on-line technical assistance based upon Windows-standard hypertext language.
- F. Workstation shall be provided with a tagging software package to extend to total quantity of input and output points plus 10% contingency. All control and monitoring, as well as login logic, shall be programmed within this application. The GUI, management system, and input / output / data access (I/O/DA) servers shall be a product of this same manufacturer.
- G. All I/O addresses from the software tag environment shall have continuous communication with the PLC, and no programming tag PLC addresses shall be changed in runtime.
- H. Contractor / integrator shall provide all programming passwords, source code and programming schedules to Owner during closeout procedures. All software licenses shall be registered to the Owner and the Owner only.
- I. SCADA/HMI Manufacturers:
 - 1. Wonderware (Schneider Electric) to match existing.
- 3. EXECUTION

3.1 SOFTWARE REVIEW, TESTING and DELIVERY

- A. A preliminary GUI operations schedule shall be submitted for review during the shop drawing and product data submittal of this project. Owner shall determine the exact and final layout and operations of the software based upon a working demonstration of the proposed operation.
- B. Contractor's cost shall include two (2) meetings with the Owner to discuss and determine final layout and appearance of the GUI software. After the initial meeting and prior to the second,

the Contractor and integrator shall provide a partially functioning system, with all monitoring and control functions for manipulating and supervising all field devices to demonstrate the overall operation of the system at the second meeting. After the final meeting, the integrator shall then completely and fully test and certify the software with the actual headend equipment prior to delivery of any said equipment to the project site for installation.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative for the pretesting, testing, and adjustment of the system.
- B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results. Each device shall be tested during the pretest. Verify the absence of unwanted voltages between circuit conductors and ground. Megger test all conductors other than those intentionally and permanently grounded with electronic components disconnected. Test for resistance to ground. Report readings less than 1-megohm for evaluation. Test all conductors for short circuits utilizing an insulation testing device. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter.
- C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable. The letter shall include the names and titles of the witnesses to the preliminary tests.
- D. Final Test Notice: Provide 10 days' minimum notice in writing when the system is ready for final acceptance testing.

3.3 CORRECTION OF DEFECTS

- A. When the tests disclose any unsatisfactory workmanship or equipment furnished under this Contract, correct defects and retest. Repeat tests until satisfactory results are obtained.
- B. When any wiring or equipment is damaged by tests, repair or replace such wiring or equipment. Test repaired items to ensure satisfactory operation.

3.4 COMMISSIONING

- A. Provide the services of a factory-authorized service representative to demonstrate and train the Owner's personnel as specified below.
 - 1. Train maintenance and operating personnel in the procedures and schedules involved in installing, operating, troubleshooting, servicing, and preventive maintaining of the system. Allot (8) hours for this training.

- 2. Provide (8) hours of additional training for the Owner's appointed responding personnel regarding the operation of the specific systems installed on this project. This phase of training shall not include installing, troubleshooting, servicing or preventive maintenance.
- 3. Operation and Maintenance Manuals shall be submitted to the Engineer and approved prior to Training. Utilize the O&M manual as reference material during all training sessions.
- 4. Schedule training at least two weeks in advance. Notify both A/E and Owner of training dates.

END 228020.

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

1.1 SUMMARY

- A. Packed Expansion Joints:
 - 1. Flexible-Hose Packless Expansion Joints, Suitable for Service:
 - a. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - b. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded or flanged end connections.
 - c. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - d. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged or welded end connections.
 - e. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with flanged or welded end connections.
 - 2. Externally Pressurized Metal-Bellows Packless Expansion Joints, Suitable for Service: Totally enclosed, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
 - a. Carbon-steel housing.
 - b. Drain plugs and lifting lug for the NPS 3 and larger.
 - c. Joint Axial Movement: 4 inches of compression and 2 inches of extension.
 - d. Permanent locking bolts.
 - e. End Connection Configuration: Flanged; one raised, fixed and one floating flange.
- B. Alignment Guides and Anchors:
 - 1. Alignment Guides: Steel, factory fabricated.
 - 2. Anchor Materials:
 - a. Steel shapes, plates, bolts, nuts, and washers.
 - b. Wedge-type mechanical anchor fasteners.

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

1.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast iron or ductile iron, with plain ends and integral waterstop collar.
- B. Steel Pipe Sleeves: Anti-corrosion coated or Zinc-coated, with plain ends and integral waterstop collar.
- C. Galvanized-Steel Sheet Pipe Sleeves: Round tube closed with welded longitudinal joint.
- D. PVC Pipe Sleeves: Schedule 40.
- E. Molded-PVC Sleeves: With nailing flange.
- F. Molded-PE or -PP Sleeves: Removable, with nailing flange.

1.2 SLEEVE-SEAL SYSTEMS

- A. Field-assembled, modular sealing-element unit for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM rubber.
 - 2. Pressure Plates: Composite plastic.
 - 3. Connecting Bolts and Nuts: Stainless steel.

1.3 SLEEVE-SEAL FITTINGS

A. Manufactured plastic, sleeve-type, plastic or rubber waterstop assembly, made for imbedding in concrete slab or wall.

1.4 GROUT

A. Nonshrink, factory packaged.

1.5 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, non-sag, plus 25 percent and minus 25 percent movement capability, non-traffic-use, neutral-curing silicone joint sealant.
- B. Silicone, S, P, 25, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

1.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

1.7 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Exterior Concrete Walls above Grade:
 - 1. Piping Smaller Than NPS 10: Cast-iron wall sleeves.
- B. Exterior Concrete Walls below Grade:
 - 1. Piping Smaller Than NPS 10: Cast-iron wall sleeves with sleeve-seal system.
- C. Concrete Slabs-on-Grade:
 - 1. Piping Smaller Than NPS 10: Cast-iron wall sleeves with sleeve-seal system Galvanized-steel wall sleeves with sleeve-seal system.

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

1.1 PRODUCTS

- A. Escutcheons for New Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece deep pattern.
 - 2. Insulated Piping: One-piece steel with polished chrome-plated finish or Split-plate stamped steel, concealed hinge, with polished, chrome-plated finish.
 - 3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished chrome-plated finish or Split-plate stamped steel, concealed hinge, with polished, chrome-plated finish.
 - 4. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish or Split-plate stamped steel, concealed hinge, with polished, chrome-plated finish.
 - 5. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish or Split-plate stamped steel, concealed hinge, with polished, chrome-plated finish.
 - 6. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish Split-plate, stamped steel, concealed hinge, with polished, chrome-plated finish.
- B. Escutcheons for Existing Piping to Remain:
 - 1. Insulated Piping: Split-plate, stamped steel, concealed hinge, polished, chrome-plated finish.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel, concealed hinge, with polished chrome-plated finish.
 - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel, concealed hinge, with polished chrome-plated finish.
 - 4. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel, concealed hinge, with polished chrome-plated finish.
 - 5. Bare Piping in Equipment Rooms: Split-plate, stamped steel, concealed hinge, with polished, chrome-plated finish.
 - 6. Bare Piping in Equipment Rooms: Split-plate, stamped steel, concealed hinge, with polished, chrome-plated finish.
- C. Floor Plates: Split-plate stamped steel with concealed hinge.

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

1.1 SUMMARY

- A. Liquid-in-Glass Thermometers:
 - 1. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - a. Case: Cast aluminum; 9-inch size unless otherwise indicated.
 - b. Case Form: Adjustable angle unless otherwise indicated.
 - c. Tube: Glass with magnifying lens and blue or red organic liquid.
 - d. Tube Background: Nonreflective aluminum with etched scale in deg F.
 - e. Window: Glass.
 - f. Stem: Aluminum.
- B. Duct-Thermometer Mounting Brackets: Flanged bracket, for attachment to air duct.
- C. Thermowells:
 - 1. Material for Use with Copper Tubing: CNR.
 - 2. Material for Use with Steel Piping: CRES.
 - 3. Type: Stepped shank unless straight or tapered shank is indicated.
 - 4. Heat-Transfer Medium: Mixture of graphite and glycerin.
- D. Pressure Gages:
 - 1. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - a. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch diameter.
 - b. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - c. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - d. Dial: Nonreflective aluminum with etched scale in psi.
 - e. Window: Glass or plastic.
 - f. Ring: Stainless steel.
 - g. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- E. Gage Attachments:
 - 1. Snubbers: Brass; with NPS 1/4 or NPS 1/2, and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
 - 2. Valves: Brass ball, with NPS 1/4 or NPS 1/2 pipe threads.
- F. Test Plugs: Test-station fitting made for insertion in piping tee fitting.
- G. Test-Plug Kits: Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case.

- H. Sight Flow Indicators:
 - 1. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator.
 - 2. Minimum Pressure Rating: 125 psig.
 - 3. Minimum Temperature Rating: 200 deg F.
- I. Flowmeters:
 - 1. Turbine Flowmeters:
 - a. Sensor: Impeller turbine; for inserting in pipe fitting or for installing in piping and measuring flow directly in gallons per minute.
 - 1) Minimum Pressure Rating: 150 psig.
 - 2) Minimum Temperature Rating: 180 deg F.
 - b. Display: Shows rate of flow, with register to indicate total volume in gallons.
- J. Thermal-Energy Meters:
 - 1. Impeller-Turbine, Thermal-Energy Meters:
 - a. Flow Sensor:
 - 1) Minimum Pressure Rating: 150 psig.
 - 2) Minimum Temperature Range: 40 to 250 deg F.
 - b. Indicator: Solid-state, integrating-type meter; for wall mounting.
 - c. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
 - 2. Ultrasonic, Thermal-Energy Meters:
 - a. Indicator: Solid-state, integrating-type meter.
 - b. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

1.1 CHILLED-WATER VALVES

- A. Pipe NPS 2 and Smaller:
 - 1. Ball Valves: Brass, two piece, with stainless-steel trim, and full port.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Ball Valves: Class 125.
 - 2. Steel Ball Valves: Class 150.

1.2 HEATING-WATER VALVES

- A. Pipe NPS 2 and Smaller:
- B. Brass, two piece with stainless-steel trim, and full port.
- C. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Ball Valves: Class 125.
 - 2. Steel Ball Valves: Class 150.

END 230523.12

SECTION 230523.13 - BUTTERFLY VALVES FOR HVAC PIPING

1.1 CHILLED-WATER VALVES

- A. Pipe NPS 2-1/2to NPS 12:
 - 1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.
 - 2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Aluminum-bronze disc, 150 CWP, and EPDM seat.
 - 3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 175 CWP.
 - 4. High-Performance Butterfly Valves: Single flange, Class 150.

1.2 HEATING-WATER VALVES

- A. Pipe NPS 2-1/2 and Larger:
 - 1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.
 - 2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Aluminum-bronze disc, 150 CWP, and EPDM seat.
 - 3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 175 CWP.
 - 4. High-Performance Butterfly Valves: Single flange, Class 150.

END 230523.13

SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

1.1 CHILLED-WATER VALVES

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze swing check valves with bronze disc, Class 125.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.
 - 2. Iron swing check valves with metal seats, Class 125.
 - 3. Iron, dual-plate check valves with metal seat, Class 125.

1.2 HEATING-WATER VALVES

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze swing check valves with bronze disc, Class 125.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. NPS 3 to NPS 12: Iron, grooved-end check valves, 300 CWP.
 - 2. Iron swing check valves with metal seats, Class 125.
 - 3. Iron, dual-plate check valves with metal seat, Class 125.

END 230523.14

SECTION 230523.15 - GATE VALVES FOR HVAC PIPING

1.1 CHILLED-WATER VALVES

- A. Pipe NPS 2 and Smaller: Bronze valves, RS, Class 125, with soldered or threaded ends.
- B. Pipe NPS 2-1/2 and Larger: Iron gate valves, OS&Y, Class 125.

1.2 HEATING-WATER VALVES

- A. Pipe NPS 2 and Smaller: Bronze valves, RS, Class 125, with soldered or threaded ends.
- B. Pipe NPS 2-1/2 and Larger: Iron gate valves, OS&Y, Class 125.

END 230523.15

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

1.1 PERFORMANCE REQUIREMENTS

A. Pipe hangers and equipment supports designed and constructed by Design Build Contractor.

1.2 SUBMITTALS

A. Shop Drawings: Signed and sealed by a professional engineer.

1.3 QUALITY ASSURANCE

- A. AWS D1.1/D1.1M, "Structural Welding Code Steel."
- B. ASME Boiler and Pressure Vessel Code, Section IX.

1.4 COMPONENTS

- A. Metal Pipe Hangers and Supports: Carbon steel and copper.
- B. Trapeze pipe hangers.
- C. Metal Framing Systems:
 - 1. Manufacturer: MFMA.
 - 2. Material: Carbon steel.
 - 3. Coating: Hot dipped galvanized.
- D. Thermal-Hanger Shield Inserts:
 - 1. For Cold Piping: Cellular glass.
 - 2. For Hot Piping: Cellular glass.
- E. Fastener Systems: Powder-actuated fasteners and mechanical-expansion anchors.
- F. Pipe Stands: Compact.
- G. Equipment supports.

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

1.1 PERFORMANCE REQUIREMENTS

- A. Seismic
 - 1. Risk Category (2018 IBC)
 - a. Nursing Home = 4
 - b. Domiciliary = 4
 - c. Nielson = 2
 - 2. Site class (ASCE/SEI 7-10)
 - a. Nursing Home = D
 - b. Domiciliary = D
 - 3. Seismic Importance Factor I_e (ASCE/SEI 7-10)
 - a. Nursing Home = 1.5
 - b. Domiciliary = 1.5
 - 4. Component Importance Factor I_p
 - a. Follow ASCE/SEI 7-10, Chapter 13 Seismic Design Requirements for nonstructural components.
- B. Wind
 - 1. Risk Category (2018 IBC)
 - a. Nursing Home = 4
 - b. Domiciliary = 4
 - c. Nielson = 2
 - 2. Basic wind speed V = 120 MPH
 - 3. Follow ASCE/SEI 7-10, Chapter 29 Wind Loads on other structures and building appurtenances MWFRS.
- C. Delegated Design
 - 1. Include design calculations and details for selecting seismic and wind restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic forces required to select seismic restraints.

1.2 COMPONENTS

- A. Vibration Isolators:
 - 1. Elastomeric Isolation Pads: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area. Material to be oil and water resistant with elastomeric properties.
 - a. Surface Pattern: Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.
 - c. Load-bearing metal plates adhered to pads.
 - 2. Double-Deflection, Elastomeric Isolation Mounts: Molded, oil-resistant rubber, neoprene, or other elastomeric material.
 - 3. Restrained Elastomeric Isolation Mounts: All-directional isolator with seismic restraints; molded, oil-resistant elastomeric material with cast-ductile-iron or welded-steel housing.
 - 4. Open-Spring Isolators: Freestanding, laterally stable.
 - 5. Housed-Spring Isolators: Freestanding, laterally stable, open-spring isolators in two-part telescoping housing.
 - 6. Restrained-Spring Isolators: Freestanding, laterally stable, open-spring isolators with vertical-limit stop restraint.
 - 7. Housed-Restrained-Spring Isolators: Freestanding, steel, open-spring isolators with vertical-limit stop restraint in two-part telescoping housing.
 - 8. Pipe-Riser Resilient Support: All-directional, acoustical pipe anchor.
 - 9. Resilient pipe guides.
 - 10. Air-Spring Isolators: Freestanding, single or multiple, compressed-air bellows.
 - 11. Restrained-Air-Spring Isolators: Freestanding, single or multiple, compressed-air bellows with vertical-limit stop restraint.
 - 12. Elastomeric hangers.
 - 13. Spring Hangers: Combination coil-spring and elastomeric-insert hangers with spring and insert in compression and with vertical-limit stop.

1.3 FIELD QUALITY CONTROL

A. Testing: By Owner-engaged agency.

<u>DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING</u> Section 230553 – Identification for HVAC Piping and Equipment

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

1.1 QUALITY ASSURANCE

A. Quality Standard for Piping Identification: ASME A13.1.

1.2 PRODUCTS

- A. Equipment Labels: Plastic.
- B. Warning Signs and Labels: 1/8 inch thick with fasteners.
- C. Pipe Labels: Self-adhesive.
- D. Valve Tags: Brass, 0.032-inch minimum thickness.

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

1.1 SUMMARY

- A. TAB for the following:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - c. Primary-secondary hydronic systems.

3. TAB Equipment:

- a. Heat exchangers.
- b. Motors.
- c. Chillers.
- d. Condensing units.
- e. Boilers.
- f. Heat-transfer coils.
- 4. Sound tests.
- 5. Vibration tests.
- 6. Duct leakage tests.
- 7. Control system verification.

1.2 QUALITY ASSURANCE

A. TAB Agent Qualifications: AABC or NEBB certified.

1.3 EXECUTION

- A. Tolerances: Plus or minus 10 percent of design values.
- B. Inspections: Random checks by Using Agency to verify final TAB report.
- C. Additional Tests: Random tests within 90 days of completing TAB to verify balance conditions and seasonal tests.

SECTION 230713 - DUCT INSULATION

1.1 QUALITY ASSURANCE

A. Surface-Burning Characteristics: Flame-spread index of 25, and smoke-developed index of 50 for insulation installed indoors; according to ASTM E 84.

1.2 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
 - 5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
 - 6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
 - 7. Indoor, concealed warewash exhaust.
 - 8. Indoor, exposed warewash exhaust.
 - 9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
- B. Items Not Insulated:
 - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums and casings.
 - 4. Flexible connectors.
 - 5. Vibration-control devices.
 - 6. Factory-insulated access panels and doors.

1.3 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, Round and Flat-Oval, Supply-Air Duct Insulation: Flexible elastomeric or mineralfiber blanket.
- B. Concealed, Round and Flat-Oval, Return-Air Duct Insulation: Flexible elastomeric or mineralfiber blanket.
- C. Concealed, Round and Flat-Oval, Outdoor-Air Duct Insulation: Flexible elastomeric or mineral-fiber blanket.
- D. Concealed, Round and Flat-Oval, Exhaust-Air Duct Insulation: Flexible elastomeric or mineral-fiber blanket.

- E. Concealed, Rectangular, Supply-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket, or mineral-fiber board.
- F. Concealed, Rectangular, Return-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber board.
- G. Concealed, Rectangular, Outdoor-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber board.
- H. Concealed, Rectangular, Exhaust-Air Duct Insulation between Isolation Damper and Penetration of Building Exterior: Flexible elastomeric, mineral-fiber blanket or mineral-fiber board.
- I. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.
- J. Concealed, Supply-Air Plenum Insulation: Flexible elastomeric mineral-fiber blanket or mineral-fiber board.
- K. Concealed, Return-Air Plenum Insulation: Flexible elastomeric mineral-fiber blanket or mineral-fiber board.
- L. Concealed, Outdoor-Air Plenum Insulation: Mineral-fiber blanket or mineral-fiber board.
- M. Concealed, Exhaust-Air Plenum Insulation: Mineral-fiber blanket or mineral-fiber board.
- N. Exposed, Round and Flat-Oval, Supply-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket, or mineral-fiber pipe and tank.
- O. Exposed, Round and Flat-Oval, Return-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber pipe and tank.
- P. Exposed, Round and Flat-Oval, Outdoor-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber pipe and tank.
- Q. Exposed, Round and Flat-Oval, Exhaust-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber pipe and tank.
- R. Exposed, Rectangular, Supply-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber board.
- S. Exposed, Rectangular, Return-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber board.
- T. Exposed, Rectangular, Outdoor-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber board.
- U. Exposed, Rectangular, Exhaust-Air Duct Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber board.

- V. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.
- W. Exposed, Supply-Air Plenum Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber board.
- X. Exposed, Return-Air Plenum Insulation: Flexible elastomeric, mineral-fiber blanket or mineral-fiber board.
- Y. Exposed, Outdoor-Air Plenum Insulation: Mineral-fiber blanket or mineral-fiber board.
- Z. Exposed, Exhaust-Air Plenum Insulation: Mineral-fiber blanket or mineral-fiber board.
SECTION 230716 - HVAC EQUIPMENT INSULATION

1.1 QUALITY ASSURANCE

A. Surface-Burning Characteristics: Flame-spread index of 25, and smoke-developed index of 50 for insulation installed indoors 75, and smoke-developed index of 150 for insulation installed outdoors; according to ASTM E 84.

1.2 FIELD QUALITY CONTROL

A. Field Inspections: By Owner-engaged agency.

1.3 EQUIPMENT INSULATION SCHEDULE

- A. Chillers: flexible elastomeric.
- B. Heat-Exchanger (Water-to-Water for Cooling Service) Insulation: flexible elastomeric.
- C. Chilled-Water Pump Insulation: Flexible elastomeric.
- D. Heating-Hot-Water Pump Insulation: cellular glass or mineral-fiber board.
- E. Chilled-Water Expansion/Compression Tank Insulation: flexible elastomeric.
- F. Heating-Hot-Water Expansion/Compression Tank Insulation: mineral-fiber board or mineral-fiber pipe and tank.
- G. Chilled-Water Air-Separator Insulation: flexible elastomeric.
- H. Heating-Hot-Water Air-Separator Insulation: mineral-fiber board or mineral-fiber pipe and tank.

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230719 - HVAC PIPING INSULATION

1.1 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: Flame-spread index of 25, and smoke-developed index of 50 for insulation installed indoors 75, and smoke-developed index of 150 for insulation installed outdoors; according to ASTM E 84.
- B. Mockup of each type of pipe insulation and finish.

1.2 FIELD QUALITY CONTROL

- A. Field Inspections: By Owner-engaged agency.
- 1.3 PIPING INSULATION SCHEDULE, GENERAL
 - A. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.

1.4 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F: flexible elastomeric.
- B. Chilled Water, above 40 Deg F: flexible elastomeric, EPDM.
- C. Heating-Hot-Water Supply and Return, 200 Deg F and Below: mineral-fiber, preformed pipe, Type I or mineral-fiber, pipe and tank insulation.
- D. Refrigerant Suction Piping: flexible elastomeric, EPDM.

1.5 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water: flexible elastomeric, EPDM.
- B. Heating-Hot-Water Supply and Return, 200 Deg F and Below: mineral-fiber, preformed pipe insulation, Type I.
- C. Refrigerant Suction Piping: flexible elastomeric, EPDM.

1.6 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Piping, Exposed: Aluminum, Painted aluminum or Stainless steel.

230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

1.1 SYSTEM DESCRIPTION

- A. System Description: Microprocessor-based monitoring and control including analog/digital conversion and program logic.
- B. DDC System: Web based or Web compatible.
- C. Delegated Design: Engage a qualified professional engineer to design DDC system.
 - 1. Available Manufacturers':
 - a. Environmental Solutions Inc.
 - b. Alerton
 - c. Johnson Controls
 - d. Schneider Electric
 - e. Trane
- D. DDC System Speed:
 - 1. Response Time of Connected I/O:
 - a. AI Point Values: Five seconds.
 - b. BI Point Values: Five seconds.
 - c. AO Points: Two second(s).
 - d. BO Point Values: Two second(s).
 - 2. Display of Connected I/O:
 - a. Analog Point COV: 10 seconds.
 - b. Binary Point COV: 10 seconds.
 - c. Alarms of Analog and Digital Points: 45 seconds.
 - d. Graphic Display Refresh: Eight seconds.
 - e. Point Change of Values and Alarms Displayed from Workstation to Workstation: Graphic refresh rate indicated.
- E. Network Bandwidth: 30 percent available spare bandwidth.
- F. DDC System Data Storage: Server(s): 48 consecutive months of historical data for all I/O points connected to system.
- G. Future Expandability: Three times total I/O points.
- H. Input Point Displayed Accuracy:
 - 1. Energy:

- a. Thermal: Within 3 percent of reading.
- b. Electric Power: Within 1 percent of reading.
- 2. Flow:
 - a. Air: Within 2 percent of design flow rate.
 - b. Air (Terminal Units): Within 5 percent of design flow rate.
 - c. Water: Within 2 percent of design flow rate.
- 3. Gas:
 - a. Carbon Dioxide: Within 50 ppm.
 - b. Carbon Monoxide: Within 5 percent of reading.
 - c. Oxygen: Within 5 percent of reading.
- 4. Moisture (Relative Humidity):
 - a. Air: Within 2 percent RH.
 - b. Space: Within 2 percent RH.
 - c. Outdoor: Within 2 percent RH.
- 5. Pressure:
 - a. Air, Ducts and Equipment: 1 percent of instrument range.
 - b. Space: Within 1 percent of instrument range.
 - c. Water: Within 1 percent of instrument range.
- 6. Temperature, Dew Point:
 - a. Air: Within 0.5 deg F.
 - b. Space: Within 0.5 deg F.
 - c. Outdoor: Within 2 deg F.
- 7. Temperature, Dry Bulb:
 - a. Air: Within 0.5 deg F.
 - b. Space: Within 0.5 deg F.
 - c. Outdoor: Within 1 deg F.
 - d. Chilled Water: Within 0.5 deg F.
 - e. Heating Hot Water: Within 0.5 deg F.
 - f. Temperature Difference: Within 0.25 deg F.
 - g. Other Temperatures Not Indicated: Within 0.5 deg F.
- 8. Temperature, Wet Bulb:
 - a. Air: Within 0.5 deg F.
 - b. Space: Within 0.25 deg F.
 - c. Outdoor: Within 1 deg F.
- I. Precision of I/O Reported Values:

- 1. Current:
 - a. Milliamperes: Nearest 1/100th of a milliampere.
 - b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.
- 2. Energy:
 - a. Electric Power:
 - 1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
 - 2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
 - 3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.
 - b. Thermal, Rate:
 - Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh.
 - 2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.
 - c. Thermal, Usage:
 - 1) Heating: For Btu, nearest Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu.
 - 2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.
- 3. Flow:
 - a. Air: Nearest 1/10th of a cfm through 100 cfm; nearest cfm between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
 - b. Water: Nearest 1/10th gpm through 100 gpm; nearest gpm between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.
 - c. Steam: Nearest 1/10th lb/hr through 100 lbs/hr; nearest lbs/hr between 100 and 1000 lbs/hr; nearest 10 lbs/hr above 1000 lbs/hr.
- 4. Gas:
 - a. Carbon Dioxide (ppm): Nearest ppm.

- b. Carbon Monoxide (ppm): Nearest ppm.
- c. Oxygen (Percentage): Nearest 1/10th of 1 percent.
- d. Refrigerant (ppm): Nearest ppm.
- 5. Moisture (Relative Humidity):
 - a. Relative Humidity (Percentage): Nearest 1 percent.
- 6. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches.
- 7. Speed:
 - a. Rotation (rpm): Nearest 1 rpm.
 - b. Velocity: Nearest 1/10th fpm through 100 fpm; nearest fpm between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.
- 8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
- 9. Pressure:
 - a. Air, Ducts and Equipment: Nearest 1/10th in. w.c..
 - b. Space: Nearest 1/100th in. w.c..
 - c. Steam: Nearest 1/10th psig through 100 psig; nearest psig above 100 psig.
 - d. Water: Nearest 1/10 psig through 100 psig; nearest psig above 100 psig.
- 10. Temperature:
 - a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
 - b. Outdoor: Nearest degree.
 - c. Space: Nearest 1/10th of a degree.
 - d. Chilled Water: Nearest 1/10th of a degree.
 - e. Condenser Water: Nearest 1/10th of a degree.
 - f. Heating Hot Water: Nearest degree.
 - g. Heat Recovery Runaround: Nearest 1/10th of a degree.
 - h. Steam: Nearest degree.
- 11. Vibration: Nearest 1/10th in/s.
- 12. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.
- J. Control Stability:
 - 1. Flow:
 - a. Air, Ducts and Equipment, except Terminal Units: Within 2 percent of design flow rate.
 - b. Air, Terminal Units: Within 5 percent of design flow rate.
 - c. Water: Within 2 percent of design flow rate.
 - 2. Gas:
 - a. Carbon Dioxide: Within 50 ppm.

- b. Carbon Monoxide: Within 5 percent of reading.
- c. Oxygen: Within 5 percent of reading.
- 3. Moisture (Relative Humidity):
 - a. Air: Within 2 percent RH.
 - b. Space: Within 2 percent RH.
 - c. Outdoor: Within 2 percent RH.
- 4. Pressure:
 - a. Air, Ducts and Equipment: 1 percent of instrument range.
 - b. Space: Within 1 percent of instrument range.
 - c. Water: Within 1 percent of instrument range.
- 5. Temperature, Dew Point:
 - a. Air: Within 0.5 deg F.
 - b. Space: Within 0.5 deg F.
- 6. Temperature, Dry Bulb:
 - a. Air: Within 0.5 deg F.
 - b. Space: Within 0.5 deg F.
 - c. Chilled Water: Within 0.5 deg F.
 - d. Heating Hot Water: Within 1 deg F.
- 7. Temperature, Wet Bulb:
 - a. Air: Within 0.5 deg F.
 - b. Space: Within 0.5 deg F.
- K. Environmental Conditions for Controllers, Gateways, and Routers:
 - 1. Outdoors, Protected: Type 3.
 - 2. Outdoors, Unprotected: Type 4.
 - 3. Indoors, Heated with Filtered Ventilation: Type 1.
 - 4. Indoors, Heated with Non-Filtered Ventilation: Type 2.
 - 5. Indoors, Heated and Air Conditioned: Type 1.
 - 6. Mechanical Equipment Rooms:
 - a. Chiller and Boiler Rooms: Type 12.
 - b. Air-Moving Equipment Rooms: Type 1.
 - 7. Localized Areas Exposed to Washdown: Type 4.
 - 8. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.
 - 9. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
- L. Environmental Conditions for Instruments and Actuators:

- 1. Outdoors, Protected: Type 3.
- 2. Outdoors, Unprotected: Type 4.
- 3. Indoors, Heated with Filtered Ventilation: Type 1.
- 4. Indoors, Heated with Non-Filtered Ventilation: Type 2.
- 5. Indoors, Heated and Air-conditioned: Type 1.
- 6. Mechanical Equipment Rooms:
 - a. Chiller and Boiler Rooms: Type 12.
 - b. Air-Moving Equipment Rooms: Type 1.
- 7. Localized Areas Exposed to Washdown: Type 4.
- 8. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.
- 9. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
- M. DDC System Reliability: DDC controllers, gateways, routers,: 40,000 hours.
- N. Electric Power Quality:
 - 1. Power-Line Surges:
 - a. Protect susceptible DDC system products connected to ac power circuits from power-line surges.
 - b. No fuses for surge protection.
 - c. Two waveforms:
 - 1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
 - 2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.
 - 2. Power Conditioning: Susceptible DDC system products.
 - 3. Ground Fault: Protect products.
- O. Backup power source.
- P. DDC System Products Powered by UPS:
 - 1. Desktop operator workstations.
 - 2. Printers.
 - 3. Servers.
 - 4. Gateways.
 - 5. DDC controllers, except application-specific controllers.
- Q. Continuity of operation after electric power interruption for applications with systems and equipment connected to backup power systems.

1.2 SYSTEM COMPONENTS

- A. Panel-Mounted, Manual Override Switches:
 - 1. Manual override of control dampers.
 - 2. Manual override of control valves.

1.3 SYSTEM ARCHITECTURE

- A. Extend System to Nursing House, Domiciliary, Nielson, and new small boiler in Boiler House.
- B. Minimum Data Transfer and Communication Speed:
 - 1. LAN Connecting Operator Workstations and Network Controllers: 100 Mbps.
 - 2. LAN Connecting Programmable Application Controllers: 1000 kbps.
 - 3. LAN Connecting Application-Specific Controllers: 76,800 bps.
- C. Dedicated and separated LANs.
- D. Modular and able to expand to not less than three times system size.
- E. Perform modifications without having to remove and replace existing network equipment.
- F. Number of LANs and associated communication transparent to operator.
- G. Independence of any single device for system alarm reporting and control execution.

1.4 DDC SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access:
 - 1. Desktop and portable operator workstation with hardwired connection.
 - 2. Portable operator terminal with hardwired connection through LAN port.
 - 3. Portable operator workstation with wireless connection through LAN router.
 - 4. Mobile device with wireless connection through LAN router.
 - 5. Remote connection using outside of system personal computer or mobile device through web access.
 - 6. Remote connection using portable operator workstation and telephone dial-up modem.
- B. Operator transparent access to system, regardless of operator means used.
- C. Hardwired Network Ports:
 - 1. Each mechanical equipment room.
 - 2. Each boiler room.
 - 3. Each chiller room or outdoor chiller yard.
 - 4. Each different roof level with roof-mounted air-handling units or rooftop units.
 - 5. Security system command center.

- 6. Fire-alarm system command center.
- D. Desktop Workstations:
 - 1. Connect to Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
 - 2. Able to communicate with any device located on any DDC system LAN.
 - 3. Able to communicate, with modems, remotely with any device connected to any DDC system LAN.
- E. Portable Workstations:
 - 1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
 - 2. Able to communicate with any device located on any DDC system LAN.
 - 3. Connect to DDC system Level two or Level three LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
 - 4. Connect to system through a wireless router connected to Level one LAN.
 - 5. Able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
 - 6. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
 - 7. Have dynamic graphic displays that are identical to desktop workstations.
- F. POT:
 - 1. Connect DDC controller through a communications port local to controller.
 - 2. Able to communicate with any DDC system controller that is directly connected or connected to DDC system.
- G. Mobile Device:
 - 1. Connect to system through a wireless router connected to LAN.
 - 2. Able to communicate with any DDC controller connected to DDC system.
- H. Telephone Communications:
 - 1. Through use of a standard modem to communicate with any device connected to any system LAN.
 - 2. Have auto-dial and auto-answer communications.
 - 3. Desktop and Portable Operator Workstation Computers with Modems:
 - a. Operators able to perform control functions, report functions, and database generation and modification functions.
 - b. Automatically answer calls, and either file or display information sent remotely.
 - c. Communications transparent to operator.
 - 4. DDC Controllers: No modems.
 - 5. DDC Controllers with Modems:

- a. Automatically place calls to report critical alarms, or to upload trend and historical information for archiving.
- b. Analyze and prioritize alarms to minimize initiation of calls.
- c. Buffer noncritical alarms in memory and report them as a group of alarms, or until an operator manually requests an upload.
- d. Make provisions for handling busy signals, no-answers, and incomplete data transfers.
- e. Call default devices when communications cannot be established with primary devices.
- I. Critical Alarm Reporting:
 - 1. Operator-selected critical alarms sent by DDC system.
 - 2. Send alarm notification to multiple recipients.
 - 3. Notify recipients by any or all means, including e-mail, text message, and prerecorded phone message to mobile and landline phone numbers.
- J. Simultaneous Operator Use: Five simultaneous operators.

1.5 NETWORKS

- A. Acceptable Networks for Connecting Operator Workstations and Network Controllers:
 - 1. ATA 878.1, ARCNET.
 - 2. CEA-709.1-C.
 - 3. IP.
 - 4. IEEE 8802-3, Ethernet.
- B. Acceptable Networks for Connecting Programmable Application Controllers:
 - 1. ATA 878.1, ARCNET.
 - 2. CEA-709.1-C.
 - 3. IP.
 - 4. IEEE 8802-3, Ethernet.
- C. Acceptable Networks for Connecting Application-Specific Controllers:
 - 1. ATA 878.1, ARCNET.
 - 2. CEA-709.1-C.
 - 3. EIA-485A.
 - 4. IP.
 - 5. IEEE 8802-3, Ethernet.

1.6 NETWORK COMMUNICATION PROTCOL

- A. Industry Standard Protocols:
 - 1. ASHRAE 135.

1.7 DESKTOP WORKSTATIONS

- A. Personal computer.
- B. Keyboard.
- C. Pointing device.
- D. Flat panel display monitor.
- E. Speakers.
- F. I/O cabling.

1.8 PORTABLE WORKSTATIONS

- A. Network interface card.
- B. Digital video disc rewrite recorder (DVD+/-RW).
- C. Leather carrying case.
- D. Docking station.
- E. Wireless-N communication card.
- F. Bluetooth module with 2.1 standard technologies.
- G. Mobile broadband card.
- H. Wireless optical mouse.
- I. 500 GB portable hard drive.
- J. Cable with network jackets on each end. Minimum cable length shall be 25 feet.

1.9 POT

- A. Capability:
 - 1. Display and monitor BI point status.
 - 2. Change BO point set point (on or off, open or closed).
 - 3. Display and monitor analog point values.
 - 4. Change analog control set points.
 - 5. Command a setting of AO point.
 - 6. Display and monitor I/O point in alarm.
 - 7. Add a new or delete an existing I/O point.
 - 8. Enable and disable I/O points, initiators, and programs.

- 9. Display and change time and date.
- 10. Display and change time schedules.
- 11. Display and change run-time counters and run-time limits.
- 12. Display and change time and event initiation.
- 13. Display and change control application and DDC parameters.
- 14. Display and change programmable offset values.
- 15. Access DDC controller initialization routines and diagnostics.

1.10 SERVERS

- A. Performance Requirements:
 - 1. Energy Star compliant.
 - 2. Minimum Processor Speed: 3.2 gigahertz.
 - 3. RAM:
 - a. Capacity: 16 GB.
 - b. Speed and Type: 2666 MGz,DDR4.
 - c. Expandable Capacity: 64 GB.
 - 4. Drive Bays: Eight at 2.5 inches or eight at 3.5 inches.
 - 5. Hard-Drive Storage: Two drives each with 1 TB storage and nominal rotational speed of 7200 rpm.
 - 6. Network Interface: Dual port Ethernet.
 - 7. DVD +RW Drive.
 - 8. Color, flat-screen display with 21 diagonal viewable area.
 - 9. Keyboard and mouse.
 - 10. Next-day on-site warranty for two-year period following Substantial Completion.

1.11 PRINTERS

- A. Black and white laser printer.
- B. Color laser printer.
- C. Color inkjet printer.
- D. Dot matrix printer.

1.12 SYSTEM SOFTWARE

- A. System Software Minimum Requirements:
 - 1. Enterprise Application Software.
 - 2. Real-time multitasking and multiuser 32- or 64-bit operating system.
 - 3. Capable of operating DOS and Microsoft Windows applications.
 - 4. Database management software.

- 5. Network communications software manages and controls multiple network communications.
- 6. Operator interface software includes day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
- 7. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.
- B. Operator Interface Software:
 - 1. English language.
 - 2. Minimize use of a typewriter-style keyboard.
 - 3. Manual operator sign-off.
 - 4. Programmable automatic sign-off period.
 - 5. Recorded and printed operator sign-on and sign-off activity.
 - 6. Security access.
 - 7. Data segregation.
 - 8. Operators Commands:
 - a. Start or stop selected equipment.
 - b. Adjust set points.
 - c. Add, modify, and delete time programming.
 - d. Enable and disable process execution.
 - e. Lock and unlock alarm reporting for each point.
 - f. Enable and disable totalization for each point.
 - g. Enable and disable trending for each point.
 - h. Override control loop set points.
 - i. Enter temporary override schedules.
 - j. Define holiday schedules.
 - k. Change time and date.
 - 1. Enter and modify analog alarm limits.
 - m. Enter and modify analog warning limits.
 - n. View limits.
 - o. Enable and disable demand limiting.
 - p. Enable and disable duty cycle.
 - q. Display logic programming for each control sequence.
 - 9. Reporting:
 - a. General listing of points.
 - b. List points currently in alarm.
 - c. List of off-line points.
 - d. List points currently in override status.
 - e. List of disabled points.
 - f. List points currently locked out.
 - g. List of items defined in a "Follow-Up" file.
 - h. List weekly schedules.
 - i. List holiday programming.
 - j. List of limits and deadbands.

- 10. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.
- C. Graphic interface software.
- D. Project-specific graphics.
- E. Customizing software.
- F. Alarm handling software.
- G. Reports and logs.
- H. Standard Reports:
 - 1. All I/O: With current status and values.
 - 2. Alarm: All current alarms, except those in alarm lockout.
 - 3. Disabled I/O: All I/O points that are disabled.
 - 4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
 - 5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
 - 6. Logs:
 - a. Alarm history.
 - b. System messages.
 - c. System events.
 - d. Trends.
- I. Custom reports.
- J. Tenant override reports.
- K. HVAC equipment reports.
- L. Project-specific utility reports.
- M. Project-specific daily, weekly, monthly and annual energy reports.
- N. Project-specific daily, weekly, monthly, and annual HVAC system efficiency reports.
- O. Weather reports.
- P. Standard trends.
- Q. Custom trends.
- R. Programing software shall be as follows:
 - 1. Graphic based.
 - 2. Menu based.
 - 3. Line by line and text based.

S. Database management software.

1.13 OFFICE APPLICATION SOFTWARE

- A. Multiple separate applications using a common platform for all applications and including the following:
 - 1. Database.
 - 2. E-mail.
 - 3. Presentation.
 - 4. Publisher.
 - 5. Spreadsheet.
 - 6. Word processing.

1.14 ASHRAE 135 (BACnet) GATEWAYS

- A. Gateway Minimum Requirements:
 - 1. Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.
 - 2. Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.
 - 3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.
 - 4. Includes data sharing read property, data sharing write property, device management dynamic device binding, and device management communication control.
 - 5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
 - 6. Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

1.15 ASHRAE 135 (BACnet) PROTOCOL ANALYZER

- A. Analyzer minimum capabilities:
 - 1. Capture and store to a file data traffic on all network levels.
 - 2. Measure bandwidth usage.
 - 3. Filtering options with ability to ignore select traffic.

1.16 WIRELESS ROUTERS FOR OPERATOR INTERFACE

- A. Single-band wireless routers.
- B. Dual-band wireless routers.

1.17 DDC CONTROLLERS

- A. DDC Controller Spare Processing Capacity:
 - 1. Network Controllers: 50 percent.
 - 2. Programmable Application Controllers: Not less than 60 percent.
 - 3. Application-Specific Controllers: Not less than 70 percent.
- B. DDC Controller Spare I/O Point Capacity:
 - 1. Network Controllers: 20 percent of each AI, AO, BI, and BO point connected to controller.
 - 2. Programmable Application Controllers: 10 percent of each AI, AO, BI, and BO point connected to controller.
 - 3. Application-Specific Controllers: 10 percent of each AI, AO, BI, and BO point connected to controller.
- C. Input and Output Point Interface:
 - 1. Controller AIs perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
 - 2. Controller AOs perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
 - 3. BIs include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
 - 4. Controller BOs include relay contact closures or triac outputs for momentary and maintained operation of output devices.

1.18 NETWORK CONTROLLERS

- A. Communication: Communicate with other devices on DDC system Level one network.
- B. Operator Interface: Equipped with a service communications port for connection to a portable operator's workstation or mobile device.
- C. Local keypad and display.

1.19 PROGRAMMABLE APPLICATION CONTROLLERS

- A. Communication: Communicate with other devices on network.
- B. Operator Interface: Equipped with a service communications port for connection to a portable operator's workstation or mobile device.
- C. Local keypad and display.

1.20 APPLICATION-SPECIFIC CONTROLLERS

- A. Microprocessor-based controllers.
- B. Operator interface with a service communications port for connection to a portable operator's workstation.

1.21 CONTROLLER SOFTWARE

- A. General Controller Software Requirements: I/O points shall be identified by up to 30-character point name and up to 16-character point descriptor. Same names shall be used at operator workstations.
- B. Security: Individual security passwords and user names.
- C. Scheduling:
 - 1. Weekly Schedule: Include separate schedules for each day of week.
 - 2. Exception Schedules: Operator able to designate any day of the year as an exception schedule.
 - 3. Holiday Schedules: Operator able to define up to 99 special or holiday schedules.
- D. System Coordination: Operator able to group equipment based on function and location.
- E. Binary Alarms: Alarm based on operator-specified state.
- F. Analog Alarms: Both high and low alarm limits and able to be automatically and manually disabled.
- G. Alarm Reporting: Able to determine action to be taken in event of an alarm, routed to appropriate operator workstations based on time and other conditions, and able to start programs, print, be logged in event log, generate custom messages, and display graphics.
- H. Remote Communication: Able to dial out in the event of an alarm.
- I. Electric power demand limiting.
- J. Maintenance Management: Monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.
- K. Sequencing: Application software to properly sequence chillers, boilers, and other applicable HVAC equipment.
- L. Control Loops
 - 1. Support Control Loops:
 - a. Two-position (on/off, open/close, slow/fast) control.
 - b. Proportional control.

- c. Proportional plus integral (PI) control.
- d. Proportional plus integral plus derivative (PID) control.
- e. Adaptive (automatic tuning).
- M. Staggered-start applications.
- N. Energy calculations.
- O. Anti-short cycling.
- P. On and off control with differential.
- Q. Run-time totalization.

1.22 RELAYS

- A. General-purpose relays.
- B. Multifunction time-delay relays.
- C. Latching relays.
- D. Current sensing relay.
- E. Combination on-off status sensor and on-off relay.

1.23 ELECTRICAL POWER DEVICES

- A. Transformers.
- B. Power-line conditioner.
- C. Transient voltage suppression and high-frequency noise filter unit.
- D. DC power supply.

1.24 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

- A. 250 through 1000 VA.
- B. 1000 through 3000 VA.

1.25 PIPING AND TUBING

A. Pneumatic, and Pressure Instrument Signal Air, Tubing and Piping:

- 1. Copper tubing.
- 2. Copper tubing connectors and fittings.
- 3. Galvanized-steel piping.
- 4. Polyethylene tubing.
- 5. Polyethylene tubing connectors and fittings.
- B. Process Tubing:
 - 1. Copper tubing.
 - 2. Copper tubing connectors and fittings.
 - 3. Stainless-steel tubing.
 - 4. Stainless-steel tubing connectors and fittings.

1.26 CONTROL WIRE AND CABLE

- A. Wire: Single conductor control wiring above 24 V.
- B. Single Twisted Shielded Instrumentation Cable above 24 V.
- C. Single Twisted Shielded Instrumentation Cable 24 V and Less.
- D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1.27 ACCESSORIES

- A. Pneumatic pressure gages.
- B. Pressure electric switches.
- C. Damper blade limit switches.
- D. I/P and E/P transducers.
- E. E/P switches.
- F. Instrument enclosures.
- G. Manual valves.
 - 1. Needle type.
 - 2. Ball type.
- H. Wall-mounted portable operator's workstation cabinet.

1.28 IDENTIFICATION

- A. Instrument Air Pipe and Tubing: Engraved tags with the service and pressure range.
- B. Control Equipment, Instruments, and Control Devices: Engraved tags.
- C. Valve tags: Brass tags and brass chains attached to valve.
- D. Raceway and Boxes: Painted labels on cover plates.
- E. Equipment Warning Labels: Acrylic label with pressure-sensitive adhesive back and peel-off protective jacket.

1.29 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.

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SECTION 232113 - HYDRONIC PIPING

1.1 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressures and Temperatures:
 - 1. Hot-Water Heating Piping: 100 psig at 200 deg F.
 - 2. Chilled-Water Piping: 100 psig at 200 deg F.
 - 3. Makeup-Water Piping: 80 psig at 150 deg F.
 - 4. Condensate-Drain Piping: 150 deg F.
 - 5. Blowdown-Drain Piping: 200 deg F.
 - 6. Air-Vent Piping: 200 deg F.
 - 7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.2 QUALITY ASSURANCE

A. Quality Standard: ASME B31.9.

1.3 PRODUCTS

A. Bypass chemical feeder and chemicals and glycol for first year of operation.

1.4 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
 - 1. Copper tubing and brazed joints.
 - 2. Steel pipe, cast-iron fittings, and threaded joints.
- B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
 - 1. Copper tubing and brazed joints.
 - 2. Steel pipe and welded and flanged joints.
 - 3. Steel pipe and grooved, mechanical-coupled joints.
- C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
 - 1. Copper tubing and brazed joints.
 - 2. Steel pipe; cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
 - 1. Copper tubing and brazed joints.

- 2. Steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- 3. Steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- E. Makeup-water piping installed aboveground shall be the following:
 - 1. Copper tubing, wrought-copper fittings, and soldered or brazed joints.
- F. Condensate From Cooled Air Systems Drain Piping: Copper tubing, wrought-copper fittings, and soldered joints.
- G. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- H. Air-Vent Piping:
 - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 - 2. Outlet: Copper tubing with soldered or flared joints.
- I. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

1.5 CHEMICAL TREATMENT

- A. Chemical Treatment: Water analysis by Contractor.
- B. Glycol solutions for hot and chilled-water piping for freeze protection.

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

1.1 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressures and Temperatures:
 - 1. Hot-Water Heating Piping: 100 psig at 200 deg F.
 - 2. Chilled-Water Piping: 100 psig at 200 deg F.
 - 3. Makeup-Water Piping: 80 psig at 150 deg F.
 - 4. Condensate-Drain Piping: 150 deg F.
 - 5. Blowdown-Drain Piping: 200 deg F.
 - 6. Air-Vent Piping: 200 deg F.
 - 7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.2 PRODUCTS

- A. Valves:
 - 1. Bronze, Calibrated-Orifice, Balancing Valves: Ball or plug type with calibrated orifice or venturi.
 - 2. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves: Ball, plug, or globe pattern with calibrated orifice or venturi.
 - 3. Pressure-Reducing Valves: ASME labeled bronze or brass, with glass and carbon-filled PTFE disc and brass seat.
 - 4. Safety Valves: ASME labeled bronze or brass, with glass and carbon-filled PTFE disc and brass seat.
 - 5. Automatic Flow-Control Valves: Brass or ferrous metal body; stainless-steel piston and spring assembly or elastomeric diaphragm and polyphenylsulfone orifice plate; combination assemblies include bronze or brass-alloy ball valve.
- B. Air Control Devices:
 - 1. Air Vents: Manual and automatic.
 - 2. Expansion Tanks: ASME labeled with bladder.
 - 3. Air Separators: Tangential type.
- C. Hydronic Piping Specialties:
 - 1. Strainers: Y-pattern, basket, and T-pattern.
 - 2. Flexible Connectors: Stainless-steel bellows with woven-wire jacket.

1.3 VALVE APPLICATIONS

A. Shutoff-duty valves for branch connection to supply mains, and at supply connection to each piece of equipment.

- B. Calibrated-orifice, balancing valves for branch connection to return main.
- C. Calibrated-orifice, balancing valves for return pipe of each heating or cooling terminal.
- D. Check valves for each pump discharge and elsewhere as required to control flow direction.
- E. Safety valves for hot-water generators.
- F. Pressure-reducing valves for makeup-water connection to regulate system fill pressure.

SECTION 232123 - HYDRONIC PUMPS

1.1 PRODUCTS

- A. Close-Coupled, In-Line Centrifugal Pumps:
 - 1. Casing: Radially split, cast iron.
 - 2. Impeller: Cast bronze.
 - 3. Pump Shaft: Stainless steel.
 - 4. Seal: Mechanical.
 - 5. Pump Bearings: Permanently lubricated ball bearings.
- B. Separately Coupled, Base-Mounted, End-Suction Centrifugal Pumps:
 - 1. Casing: Radially split, cast iron. Integral mount on volute to support the casing and attached piping.
 - 2. Impeller: Cast bronze.
 - 3. Pump Shaft: Steel, with stainless steel shaft sleeve.
 - 4. Seal: Mechanical.
 - 5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing.
 - 6. Shaft Coupling: Drop-out type molded-rubber insert and interlocking spider with EPDM coupling sleeve for variable-speed applications.
 - 7. Coupling Guard: Dual rated, steel, removable, attached to mounting frame.
 - 8. Mounting Frame: Welded-steel frame and cross members.
- C. Automatic Condensate Pump Units: Package units with corrosion-resistant pump, plastic tank with cover, and automatic controls.
- D. Specialty Fittings:
 - 1. Suction diffuser.
 - 2. Triple-duty valves.

1.2 Startup services

A. Startup service by a factory-authorized service representative.

1.3 DEMONSTRATION

A. By a factory-authorized service representative.

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SECTION 232213 - STEAM AND CONDENSATE PIPING

1.1 REFERENCES – QUALITY AND PERFORMANCE REQUIREMENTS

- A. ASME-B31.9 Building Services Piping
- B. *ASME-B31.1 Power Piping*
- C. Applicable ASME-B16 Standards for valves and fittings
- D. Illinois Steel Products Procurement Act
- E. International Mechanical Code

1.2 QUALITY ASSURANCE

- A. Products and execution shall be in compliance with applicable codes and standards including those referenced above in paragraph entitled *REFERENCES*.
- B. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and installation, operations, and maintenance manuals.

1.3 SUBMITTALS

- A. Pipe and tubing: Type, material, ASTM number, schedule/wall thickness
- B. Pipe certification, indication of domestic manufacture
- C. Fittings: Type, material, pressure class, ASME number
- D. Flanges: Type, material, pressure class, ASME number
- E. Unions: Type, pressure class, ASME number, material
- F. Flange gaskets: Material, construction, temperature/pressure rating
- G. Valves: Type, pressure class, leakage class, pressure/temperature rating, materials of construction, construction details
- H. Welder Certifications
- I. Leak test report

1.4 PIPE AND FITTINGS FOR STEAM AND CONDENSATE SYSTEMS

- A. High Pressure Steam and Condensate Normal Operation: <165-PSIG, <400-degrees-F Worst Case: Verify Boiler House relief valve setting.
 - 1. Pipe and Fittings
 - a. Size 2" and Smaller
 - 1) Pipe: Carbon Steel, ASTM-A106 Grade B Seamless, Schedule Standard
 - 2) Fittings: Forged Steel, ASTM-A105, 3000-Lb.
 - 3) Unions: Forged Steel, ASTM-A105, 3000-Lb.
 - a) Unions at final connections only
 - b. Size 2-1/2" and Larger
 - 1) Pipe: Carbon Steel, ASTM-A106 Grade B Seamless, Schedule Standard
 - 2) Fittings: Carbon Steel, ASTM-A234 WPB, Seamless, Schedule Standard, Long Radius, Welding
 - 3) Flanges: Forged Steel, Class 300, ASTM-A105, ASME/ANSI-B16.5, Weld Neck, Raised Face
 - a) Flanges at final connections only, otherwise welded joints
- B. Medium Pressure Steam and Condensate Normal Operation: <60- PSIG, <350-degrees-F Worst Case: Verify Boiler House relief valve setting.
 - 1. Pipe and Fittings
 - a. Size 2" and Smaller
 - 1) Pipe: Carbon Steel, ASTM-A53 Grade B E or S, Schedule Standard
 - 2) Fittings: Cast Iron, Class 125, NPT
 - 3) Unions: Cast Iron, Class 250, NPT
 - b. Size 2-1/2" and Larger
 - 1) Pipe: Carbon Steel, ASTM-A53 Grade B E or S, Schedule Standard
 - 2) Fittings: Carbon Steel, ASTM-A234 WPB Seamless, Schedule Standard, Long Radius, Welding
 - Flanges: Forged Steel, Class 150, ASTM-A105, ASME/ANSI-B16.5, Weld Neck, Raised Face
- C. Low Pressure Steam and Condensate Normal Operation: <15-PSIG, < 300-degrees-F Worst Case: Verify Boiler House relief valve setting.

- 1. Pipe and Fittings
 - a. Size 2" and Smaller
 - 1) Pipe: Carbon Steel, ASTM-A53 Grade B E or S, Schedule Standard
 - 2) Fittings: Cast Iron, Class 125, NPT
 - 3) Unions: Cast Iron, Class 250, NPT
 - b. Size 2-1/2" and Larger
 - 1) Pipe: Carbon Steel, ASTM-A53 Grade B E or S, Schedule Standard
 - 2) Fittings: Carbon Steel, ASTM-A234 WPB Seamless, Schedule Standard, Long Radius, Welding
 - Flanges: Forged Steel, Class 150, ASTM-A105, ASME/ANSI-B16.5, Weld Neck, Raised Face
- D. Condensate Gravity Return, Vented
 - 1. Pipe and Fittings
 - a. Size 2" and Smaller
 - 1) Pipe: Carbon Steel, ASTM-A53 Grade B E or S , Schedule 80, Threaded
 - 2) Fittings: Cast Iron, Class 150, NPT
 - 3) Unions: Cast Iron, Class 250, NPT
 - b. Size 2-1/2" and Larger
 - 1) Pipe: Carbon Steel, ASTM-A53 Grade B E or S , Schedule 80
 - 2) Fittings: Carbon Steel, ASTM-A234 WPB Seamless, Schedule Standard, Long Radius, Welding
 - 3) Flanges: Forged Steel, Class 150, ASTM-A105, ASME/ANSI-B16.5, Weld Neck, Raised Face
- E. Pumped Condensate Normal Operation: <60-PSIG, < 212-degrees-F Worst Case: Same
 - 1. Pipe and Fittings
 - a. Size 2" and Smaller
 - 1) Pipe: Carbon Steel, ASTM A53 Grade B E or S, Schedule 80, Threaded
 - 2) Fittings: Cast Iron, Class 125, Threaded
 - 3) Unions: Cast Iron, Class 250, Threaded
 - b. Size 2-1/2" and Larger
 - 1) Pipe: Carbon Steel, ASTM-A53 Grade B E or S , Schedule 80

- 2) Fittings: Carbon Steel, ASTM-A234 WPB Seamless, Schedule Standard, Long Radius, Welding
- 3) Flanges: Forged Steel, Class 150, ASTM-A105, ASME/ANSI-B16.5, Weld Neck, Raised Face except where bolted to flat face flange

1.5 JOINING MATERIALS

- A. Threaded, flanged and welded pipe connections shall comply with requirements of ASME B31.9 Building Services Piping.
- B. Threaded Joints
 - 1. Thread Sealant
 - a. Paste type, non-hardenening, rated for temperature
- C. Flanged Joints
 - 1. Gaskets
 - a. Low pressure steam and condensate
 - 1) Compressed non-asbestos
 - 2) Synthetic fiber/ Nitrile binder
 - 3) Precut ring or sheet material
 - a) Ring conforms to ASME-B16.21
 - 4) Thickness: 1/16"
 - b. Medium and high pressure steam
 - 1) Spiral wound type with centering ring
 - 2) Stainless steel with flexible graphite filler material

D. WELDING

- 1. Qualifications
 - a. welders and welding procedure specifications (WPS) shall be qualified as set forth in ASME Boiler *and Pressure Vessel Code, Section IX*
 - 1) Welder
 - Prior to performing project welds documentation shall be submitted confirming that each welder has passed required procedure test.
 Welders shall be qualified as required by ASME-B31.1 or ASME-B31.9 as applicable.

- b) Welder qualifications shall be current. If qualification test is more than six months old record of continuity shall be provided indicating welder has performed applicable and approved welding at least every six months since date of qualification test.
- 2. Weld Procedure Specifications (WPS)
 - a. Welding procedure specifications shall be provided for project specific welding methods and materials.
- E. Weld Inspection and Examination
 - 1. Welds in piping and piping components shall be carefully visually examined in accordance with ASME Standard B31.1 or ASME-B31.9 as applicable.
- F. Welding Qualifications
 - 1. Materials and Methods: In compliance with Weld Procedure Specifications (WPS)

1.6 SHUT-OFF VALVES

- A. High Pressure Steam and Condensate
 - 1. Size 2" and Smaller, Socket-Weld Forged Steel Wedge Gate Valve
 - a. ANSI Class 800
 - b. Shut-off class IV, bi-directional
 - c. Forged carbon steel body
 - d. Socket-welding connections
 - e. Bolted bonnet
 - f. Outside screw and yoke, rising stem design
 - g. 13% chrome steel wedge
 - h. Alloy 6 (Stellite) hard-faced seats
 - i. Renewable seat rings
 - j. Integral back seat for positive packing chamber isolation
 - k. Stainless steel gasket with graphite filler
 - l. Graphite stem packing
 - m. Spoked hand wheel
 - n. Manufacturers
 - 1) Bonnie Forge
 - 2) Hancock
 - 3) Smith
 - 2. Size 2-1/2 and 3", Butt-Weld Cast Steel Wedge Gate Valve
 - a. ANSI Class 300
 - b. Shut-off class IV, bi-directional
 - c. Cast carbon steel body

- d. Butt-welding connections
- e. Outside screw and yoke, rising stem design
- f. 13% chrome steel flexible wedge
- g. Alloy 6 (Stellite) hard-faced seats
- h. Seal-welded seat rings
- i. Integral back seat for positive packing chamber isolation
- j. Stainless steel gasket with graphite filler
- k. Graphite stem packing
- 1. Spoked hand wheel
- m. Manufacturers
 - 1) Kitz
 - 2) Velan
- 3. Size 4" and Larger, Butt-Weld Triple or Quad Offset Butterfly Valve
 - a. ANSI Class 300
 - b. API-598 zero leakage shutoff rating, bi-directional
 - c. Carbon steel body steel body
 - d. Butt-welding connections to match pipe schedule
 - e. Carbon steel "floating disk" (i.e. disk not pinned or rigidly attached to shaft)
 - f. 316 stainless steel disk rings and body seat
 - g. "Torque seated" rather than flexible-seal design
 - h. Adjustable graphite shaft packing
 - i. Geared rotary hand-wheel operator sized for maximum rim pull of 100-lb.
 - j. Manufacturers
 - 1) Zwick Series / Tri-Con
 - 2) Xomox / Series 9000
 - 3) FlowSeal / MS
- B. Medium Pressure Steam and Condensate
 - 1. Size 2-1/2" and Smaller, Threaded Two-Piece Ball Valve
 - a. ANSI Class 600
 - b. Shut-off class VI, bi-directional
 - c. Carbon steel body
 - d. NPT connections
 - e. 316 stainless steel ball and stem
 - f. Blow-out proof stem design
 - g. Vented ball
 - h. Carbon/graphite reinforced TFM seats
 - i. Live-loaded or adjustable graphite stem packing
 - j. Latch-lock handle
 - k. Extended stem to clear insulation
2. Manufacturers

- a. Jamesbury
- b. Habonim
- c. PBM
- d. Worcester
- 3. Size 2-1/2" and Larger, Lug-Style High Performance Butterfly Valve
 - a. ANSI Class 150
 - b. Shut-off class VI, bi-directional
 - c. Stainless steel or carbon steel lug-style body
 - d. 316 stainless steel double-offset disc
 - e. Reinforced TFM seats
 - f. Disc centering feature
 - g. 17/4 PH stainless steel shaft
 - h. Blow-out proof shaft design
 - i. Stainless steel / polymer composite shaft bearings
 - j. Adjustable graphite shaft packing
 - k. Geared rotary hand-wheel operator
 - l. Manufacturers:
 - 1) Jamesbury
 - 2) Cameron W-K-M
 - 3) Xomox
- C. Low Pressure Steam and Condensate
 - 1. Size 2 1/2" and Smaller, Threaded Two-Piece Ball Valve
 - a. 600 CWP, 150 SWP
 - b. Shut-off class VI, bi-directional
 - c. Cast bronze body
 - d. NPT connections
 - e. 316 stainless steel ball
 - f. Vented ball
 - g. 316 stainless steel stem and nut
 - h. Blow-out proof stem design
 - i. Reinforced PTFE (RPTFE) seats
 - j. Adjustable stem packing
 - k. Extended stem to clear insulation
 - l. Latch-lock handle
 - m. Basis of Design
 - 1) Apollo Series / 70-140-64
 - 2) Nibco / T-585-70-66-ST
 - 3) Milwaukee / BA-400S3

- 2. Size 2-1/2" and Larger, Lug-Style High Performance Butterfly Valve
 - a. ANSI Class 150
 - b. Shut-off class VI, bi-directional
 - c. Stainless steel or carbon steel lug-style body
 - d. 316 stainless steel double-offset disc
 - e. Reinforced TFM seats
 - f. Disc spacers to center disc in seat
 - g. PH-4 stainless steel shaft
 - h. Blow-out proof shaft design
 - i. Stainless steel backed polymer shaft bearings
 - j. Adjustable graphite shaft packing
 - k. Geared rotary hand-wheel operator
 - 1. Manufacturers
 - 1) Jamesbury
 - 2) Cameron W-K-M
 - 3) Xomox
- D. Pumped Condensate Normal Operation: <60-PSIG, < 212-degrees-F
 - 1. Size 2 1/2" and Smaller, Threaded Two-Piece Ball Valve
 - a. 2,000-CWP, 150-SWP
 - b. Shut-off class VI, bi-directional
 - c. Carbon steel body
 - d. NPT connections
 - e. 316 stainless steel ball and stem
 - f. Blow-out proof stem design
 - g. Vented ball
 - h. Reinforced PTFE (RPTFE) seats
 - i. Adjustable stem packing
 - j. Extended stem to clear insulation
 - k. Latch-lock handle
 - l. Manufacturers
 - 1) Apollo Series / 73A-140
 - 2) Nibco / TC-580-CS-R-25-LL
 - 3) Milwaukee / 20CSOR-N1-XLH
 - 2. Size 2-1/2" and Larger, Lug-Style High Performance Butterfly Valve
 - a. ANSI Class 150
 - b. Shut-off class VI, bi-directional
 - c. Stainless steel or carbon steel lug-style body
 - d. 316 stainless steel double-offset disc
 - e. Reinforced TFM seats
 - f. Disc spacers to center disc in seat

- g. PH-4 stainless steel shaft
- h. Blow-out proof shaft design
- i. Stainless steel backed polymer shaft bearings
- j. Adjustable graphite shaft packing
- k. Geared rotary hand-wheel operator
- l. Manufacturers
 - 1) Jamesbury
 - 2) Cameron W-K-M
 - 3) Xomox

1.7 GLOBE VALVES

- A. High Pressure Steam and Condensate
 - Typical application: Warmup line at building entrance valve
 - 1. Size 2" and Smaller, Threaded Forged Steel Globe Valve
 - a. ANSI Class 800
 - b. Forged carbon steel body
 - c. NPT connections
 - d. Bolted bonnet
 - e. Outside screw and yoke, rising stem design
 - f. 13% chrome steel loose solid disc
 - g. Alloy 6 (Stellite) hard-faced seat
 - h. Integral back seat for positive packing chamber isolation
 - i. Manufacturers
 - 1) Bonney Forge
 - 2) Hancock
 - 3) Smith
 - 2. Size 2-1/2 and 3", Butt-Weld Cast Steel Globe Valve
 - a. ANSI Class 150
 - b. Cast carbon steel body
 - c. Butt-welding connections
 - d. Outside screw and yoke, rising stem design
 - e. 13% chrome steel plug
 - f. Alloy 6 (Stellite) hard-faced seat
 - g. Seal-welded seat ring
 - h. Integral back seat for positive packing chamber isolation
 - i. Stainless steel gasket with graphite filler
 - j. Graphite stem packing
 - k. Spoked hand wheel
 - 1. Manufacturers
 - 1) Kitz

- 2) Velan
- B. Medium Pressure Steam and Condensate

- Typical application: Manual bypass at control valve

- 1. Size 2" and Smaller, Cast Bronze Globe Valve
 - a. ANSI Class 300
 - b. Cast bronze body
 - c. Union bonnet
 - d. NPT connections
 - e. Renewable stainless steel plug and disc
 - f. Basis of design:
 - 1) Nibco / T-276-AP
- 2. Size 2 1/2" and Larger, Flanged Cast Iron Globe Valve
 - a. ANSI Class 250
 - b. Cast iron body
 - c. Bolted bonnet
 - d. Flanged connections
 - e. Bronze seat and trim
 - f. Renewable disc and seat
 - g. Basis of design:
 - 1) Nibco / F-768-B
- C. Low Pressure Steam and Condensate
 - 1. Size 2" and Smaller, Cast Bronze Globe Valve
 - a. ANSI Class 150
 - b. Cast bronze body
 - c. Union bonnet
 - d. NPT connections
 - e. Renewable disc
 - f. Basis of design:
 - 1) Nibco / T-235
 - 2. Size 2-1/2" and Larger, Flanged Cast Iron Globe Valve
 - a. ANSI Class 125
 - b. Cast iron body
 - c. Bolted bonnet
 - d. Flanged connections
 - e. Bronze trim
 - f. Renewable disc and seat

1.8 SWING CHECK VALVES

- A. High Pressure Steam and Condensate
 - 1. Size 2" and Smaller, Socket-Weld Forged Steel Swing Check
 - a. ANSI Class 800
 - b. Forged carbon steel body
 - c. Socket-welding connections
 - d. Bolted cover
 - e. Stainless steel disc
 - f. Alloy 6 (Stellite) hard-faced seats
 - g. Renewable seat rings
 - h. Stainless steel gasket with graphite filler
 - i. Manufacturers
 - 1) Bonnie Forge
 - 2) Hancock
 - 3) Smith
- B. Medium Pressure Steam and Condensate
 - 1. Size 2" and Smaller, Threaded Bronze Swing Check
 - a. ANSI Class 300
 - b. Cast bronze body
 - c. NPT connections
 - d. Renewable disc, regrindable seat
 - 2. Size 2 1/2:" and Larger, Flanged Cast Iron Swing Check
 - a. ANSI Class 250
 - b. Cast iron body
 - c. Bolted bonnet
 - d. Flanged connections
 - e. Bronze trim
 - f. Renewable disc and seat
- C. Low Pressure Steam and Condensate
 - 1. Size 2" and Smaller, Threaded Swing Check
 - a. ANSI Class 150
 - b. Bronze body
 - c. NPT connections
 - d. Renewable disc, regrindable seat
 - 2. Size 2-1/2" and Larger, Flanged Cast Iron Swing Check
 - a. ANSI Class 125

- Cast iron body and cover Flanged connections Bolted bonnet b.
- c.
- d.
- Bronze trim e.
- Renewable disc and seat f.

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING Section 232216 – Steam and Condensate Specialties

SECTION 232216 - STEAM AND CONDENSATE SPECIALTIES

1.1 PRODUCTS

A. Y-PATTERN PIPELINE STRAINERS

- 1. High Pressure Steam and Condensate \leq 150-PSIG (175-PSIG worst case)
 - a. Size 2" and Smaller, Threaded Cast Iron
 - 1) Pressure class 250
 - 2) Cast iron body
 - 3) NPT connections
 - 4) Threaded blow-off connection
 - 5) 20 mesh stainless steel screen
 - b. Size 2" and Smaller, Threaded Cast Steel
 - 1) Pressure class 300
 - 2) Cast carbon steel body
 - 3) NPT connections
 - 4) Threaded blow-off connection
 - 5) 20 mesh stainless steel screen
 - c. Size 2-1/2" and Larger, Flanged Cast Steel
 - 1) Pressure class 300
 - 2) Cast carbon steel body
 - 3) Flanged connections
 - 4) Threaded blow-off connection
 - 5) Size 2-1/2" through 4": 1/16" perforated stainless steel screen
 - 6) Size 6" and larger: 1/8" perforated stainless steel screen
- 2. Medium Pressure Steam and Condensate \leq 60-PSIG (125-PSIG worst case)
 - a. Size 2" and Smaller, Threaded Cast Iron
 - 1) Pressure class 250
 - 2) Cast iron body
 - 3) NPT connections
 - 4) Threaded blow-off connection
 - 5) 20 mesh stainless steel screen
 - b. Size 2-1/2" and Larger, Flanged Cast Iron
 - 1) Pressure class 250
 - 2) Cast iron body
 - 3) Flanged connections

- 4) Threaded blow-off connection
- 5) Size 2-1/2" through 4": 1/16" perforated stainless steel screen
- 6) Size 6" and larger: 1/8" perforated stainless steel screen
- c. Size 2-1/2" and Larger, Flanged Cast Steel
 - 1) Pressure class 150
 - 2) Cast carbon steel body
 - 3) Flanged connections
 - 4) Threaded blow-off connection
 - 5) Size 2-1/2" through 4": 1/16" perforated stainless steel screen
 - 6) Size 6" and larger: 1/8" perforated stainless steel screen
- 3. Low Pressure Steam and Condensate \leq 15-PSIG (25-PSIG worst case)
 - a. Size 2" and Smaller, Threaded Cast Iron
 - 1) Pressure class 125
 - 2) Cast iron body
 - 3) NPT connections
 - 4) Threaded blow-off connection
 - 5) 20 mesh stainless steel screen
 - b. Size 2-1/2" and Larger, Flanged Cast Iron
 - 1) Pressure class 125
 - 2) Cast iron body
 - 3) Flanged connections
 - 4) Threaded blow-off connection
 - 5) Size 2-1/2" through 4": 1/16" perforated stainless steel screen
 - 6) Size 6" and larger: 1/8" perforated stainless steel screen
 - c. Size 2-1/2" and Larger, Flanged Cast Steel
 - 1) Pressure class 150
 - 2) Cast steel body
 - 3) Flanged connections
 - 4) Threaded blow-off connection
 - 5) Size 2-1/2" through 4": 1/16" perforated stainless steel screen
 - 6) Size 6" and larger: 1/8" perforated stainless steel screen

B. STEAM TRAPS

- 1. Rating
 - a. Trap body and internals shall be rated for minimum of 1.5-times system design operating pressure or relief valve pressure setting, whichever is greater. Trap shall be rated for simultaneous temperature listed.
- 2. Inverted Bucket

- a. Body: Cast iron
- b. Cover: removable, bolted
- c. Internals, including valve and seat: Replaceable, stainless steel
- d. Connections: NPT
- e. Manufacturers:
 - 1) Armstrong
 - 2) Sarco
 - 3) Mepco
- 3. Float and Thermostatic
 - a. Body: Cast iron
 - b. Cover plate: Removable, bolted
 - c. Internals, including valve and seat: Replaceable, stainless steel
 - d. Connections: NPT
 - e. Manufacturers
 - 1) Armstrong
 - 2) Sarco
 - 3) Mepco

C. VACUUM BREAKERS

- 1. Stainless steel construction
- 2. 1/2" or 3/4" NPT connection
- 3. Rated 300-PSIG, 400-degrees-F
- D. STEAM PRESSURE REGULATING VALVES

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SECTION 232300 - REFRIGERANT PIPING

1.1 PERFORMANCE REQUIREMENTS

- A. Quality Standards: ASHRAE 15 and ASME B31.5.
- B. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Hot-Gas and Liquid Lines: 535 psig.

1.2 PRODUCTS

- A. Copper Tube and Fittings: Type "L" ACR, with long radius fittings.
- B. Stainless-steel bellows, flexible connectors.
- C. Valves and Specialties:
 - 1. Diaphragm packless valves.
 - 2. Packed-angle valves.
 - 3. Check valves.
 - 4. Service valves.
 - 5. Solenoid Valves: 24 or 120-V ac.
 - 6. Safety relief valves.
 - 7. Thermostatic expansion valves for 40 deg F suction temperature; adjustable superheat.
 - 8. Moisture/liquid indicators.
 - 9. Permanent filter dryers with activated alumina media, 2-psig maximum pressure loss.

1.3 REFRIGERANTS

A. R-410A.

1.4 PIPING APPLICATION SCHEDULES

- A. Piping Applications for Refrigerant R-410A: Maximum NPS 4.
 - 1. Suction Lines for Conventional Air-Conditioning Applications: Copper.
 - 2. Hot-Gas and Liquid Lines:
 - a. NPS 2 and Smaller: Copper with brazed joints.

- 3. Safety-Relief-Valve Discharge Piping:
 - a. NPS 2 and Smaller: Copper with brazed joints.

<u>DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING</u> Section 232513 – Water Treatment for Closed-Loop Hydronic Systems

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

1.1 PRODUCTS

- A. Performance Requirements:
 - 1. pH: 9.0 to 10.5.
 - 2. "P" Alkalinity: 100 to 500 ppm.
 - 3. Boron: 100 to 200 ppm.
 - 4. Chemical Oxygen Demand: Maximum value of 100 ppm.
 - 5. Soluble Copper: Maximum value of 0.20 ppm.
 - 6. TSS: Maximum value of 10 ppm.
 - 7. Ammonia: Maximum value of 20 ppm.
 - 8. Free Caustic Alkalinity: Maximum value of 20 ppm.
 - 9. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maximum value of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maximum value of 100 organisms/mL.
 - c. Nitrate Reducers: Maximum value of 100 organisms/mL.
 - d. Sulfate Reducers: Maximum value of zero organisms/mL.
 - e. Iron Bacteria: Maximum value of zero organisms/mL.
- B. Bypass Feeders: Steel, with corrosion-resistant exterior coating.
 - 1. Capacity: 5 gal..
 - 2. Minimum Working Pressure: 125 psig.
- C. Water Meter: Turbine-type, magnetic-drive, totalization meter.
 - 1. Body: Bronze.
 - 2. Minimum Working-Pressure Rating: 100 psig.
 - 3. Maximum Pressure Loss at Design Flow: 3 psig.
 - 4. Registration: Gallons or cubic feet.
 - 5. End Connections: Threaded.
- D. Chemical Solution Tanks: 120 gal..
- E. Chemical Solution Injection Pumps: Self-priming, positive displacement.
 - 1. Adjustable flow rate.
 - 2. Metal and thermoplastic construction.
 - 3. Built-in relief valve.
 - 4. Fully enclosed, continuous-duty, single-phase motor.

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SECTION 233113 - METAL DUCTS

1.1 RELATED REQUIREMENTS: NFPA 90A STANDARD FOR THE INSTALLATION OF AIR-CONDITIONING AND VENTILATION SYSTEMS.

1.2 MATERIALS

- A. Single-wall rectangular ducts and fittings.
- B. Double-wall rectangular ducts and fittings.
 - 1. Fibrous-glass duct liner for interstitial insulation.
 - 2. Solid inner duct.
- C. Single-wall round and flat-oval ducts and fittings.
- D. Double-wall round and flat-oval ducts and fittings.
 - 1. Fibrous-glass duct liner for interstitial insulation.
 - 2. Solid inner duct.
- E. Sheet Metal Materials:
 - 1. Galvanized sheet steel.
 - 2. PVC-coated, galvanized sheet steel.
 - 3. Carbon-steel sheets.
 - 4. Stainless-steel sheets.
 - 5. Aluminum sheets.
 - 6. Factory-applied antimicrobial coating.
 - 7. Type 304 stainless steel for ductwork exposed to weather.
- F. Sealant Materials:
 - 1. Two-part tape sealing system.
 - 2. Water-based joint and seam sealant.
 - 3. Solvent-based joint and seam sealant.
 - 4. Flanged joint sealant.
 - 5. Flange gaskets.
 - 6. Round duct joint O-ring seals.
- G. Duct Construction Standards: SMACNA, Metal and Flexible.

1.3 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

- B. Clean the following items:
 - 1. Air outlets and inlets.
 - 2. Supply, return, and exhaust fans.
 - 3. Air-handling units.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
 - 7. Dedicated exhaust and ventilation components and makeup air systems.

1.4 DUCT SCHEDULE

- A. All ducts shall be galvanized steel except as follows:
 - 1. Commercial Kitchen Hood Exhaust Ducts:
 - a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
 - b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
 - c. Welded seams and joints.
 - 2. Dishwasher Hood Exhaust Ducts:
 - a. Type 304, stainless-steel sheet.
 - b. Exposed to View: No. 4 finish.
 - c. Concealed: No. 2D finish.
 - d. Welded seams and flanged joints with watertight EPDM gaskets.
 - 3. Moist Environment Duct Material: 304 stainless steel.

SECTION 233300 - AIR DUCT ACCESSORIES

1.1 QUALITY ASSURANCE

A. Installation Standards: NFPA 90A, NFPA 90B, and SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1.2 PRODUCTS

- A. Backdraft and Pressure Relief Dampers: Multiple blade, parallel action, gravity balanced with return springs.
- B. Barometric Relief Dampers: Horizontal or vertical mounting; multiple blade, parallel action, gravity balanced with return springs.
- C. Manual Volume Dampers: Multiple and single blade, opposed-blade design.
 - 1. Standard, steel, manual volume dampers.
 - 2. Standard, aluminum, manual volume dampers.
 - 3. Low-leak, steel, manual volume dampers.
 - 4. Low-leak, aluminum, manual volume dampers.
- D. Control Dampers: Opposed-blade design; galvanized-steel frame and blades.
- E. Fire Dampers: Static and dynamic, replaceable electric heat-responsive device.
- F. Ceiling Radiation Dampers: Replaceable heat-responsive device.
- G. Smoke Dampers:
 - 1. Multiple-blade type.
 - 2. Leakage: Class I.
- H. Combination Fire and Smoke Dampers: Static and dynamic, replaceable electric heat-responsive device.
- I. Flange connectors.
- J. Duct Silencers: Factory fabricated and tested, round or rectangular.
- K. Turning Vanes: Single-blade, galvanized sheet steel.
- L. Remote damper operators.
- M. Duct-Mounted Access Doors: Double wall, rectangular, galvanized sheet steel with insulation.
- N. Pressure Relief Access Doors: Double wall with insulation fill.

- O. Flexible Connectors: Indoor and outdoor, high temperature.
- P. Duct security bars.
- Q. Duct accessory hardware.

SECTION 233346 - FLEXIBLE DUCTS

1.1 QUALITY ASSURANCE

A. Installation Standards: NFPA 90A, SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1," and ASTM E 96/E 96M.

1.2 PRODUCTS

- A. Non-Insulated Flexible Ducts:
 - 1. Two-ply vinyl film supported by helically wound, spring-steel wire.
 - 2. Black polymer film supported by helically wound, spring-steel wire.
 - 3. Multiple layers of aluminum laminate supported by helically wound, spring-steel wire.
 - 4. Aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.
 - 5. Interlocking spiral of aluminum foil.
- B. Insulated Flexible Ducts:
 - 1. Two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
 - 2. Black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
 - 3. Multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
 - 4. Aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
 - 5. Interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action.

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SECTION 233423 - HVAC POWER VENTILATORS

- 1.1 QUALITY ASSURANCE
 - A. AMCA-Certified Ratings Seal.

1.2 CENTRIFUGAL ROOF VENTILATORS

- A. Direct-drive or belt-driven centrifugal type, with spun-aluminum housing.
 - 1. Variable-speed controller.
 - 2. Disconnect switch outside fan housing.
 - 3. Bird screens.
 - 4. Backdraft dampers.
 - 5. Motorized dampers.
 - 6. Galvanized-steel roof curbs with self-flashing without cant strip and with mounting flange.

1.3 UPBLAST PROPELLER ROOF EXHAUST FANS

- A. Direct-drive or belt-driven propeller type, with aluminum housing.
 - 1. Replaceable fan wheel with extruded-aluminum, airfoil blades.
 - 2. Galvanized-steel roof curbs with self-flashing without cant strip and with mounting flange.

1.4 CENTRIFUGAL WALL VENTILATORS

- A. Direct-drive or belt-driven centrifugal type, with spun-aluminum housing.
 - 1. Variable-speed controller.
 - 2. Disconnect switch.
 - 3. Bird screens.
 - 4. Wall grille.
 - 5. Backdraft dampers.
 - 6. Motorized dampers.

1.5 CEILING-MOUNTED VENTILATORS

- A. Housing: Steel with acoustical insulation.
- B. Grille: Plastic or Aluminum, louvered.
- C. Accessories:

- 1. Variable-speed controller.
- 2. Manual starter switch.
- 3. Time-delay switch.
- 4. Motion sensor.
- 5. Ceiling radiation damper.
- 6. Washable filter.
- 7. Vibration isolators.
- 8. Roof jack or wall cap and transition fittings.

1.6 IN-LINE CENTRIFUGAL FANS

- A. In-line, belt-driven centrifugal type, with split, spun-aluminum housing, wheel, and outlet guide vanes.
 - 1. Variable-speed controller.
 - 2. Volume-control damper.
 - 3. Companion flanges.
 - 4. Fan guards.
 - 5. Motor and drive cover (belt guard).

1.7 PROPELLER FANS

- A. Direct-drive or belt-driven propeller type, with galvanized-steel housing and orifice ring.
 - 1. Fan Wheels: Steel.
 - 2. Gravity shutters.
 - 3. Motor-side back guard.
 - 4. Wall sleeve.
 - 5. Weathershield hood.
 - 6. Weathershield front guard.
 - 7. Variable-speed controller.
 - 8. Disconnect switch.

1.8 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

233600 - AIR TERMINAL UNITS

1.1 **PRODUCTS**

- A. Shutoff, Single-Duct Air Terminal Units:
 - 1. Configuration: Volume-damper assembly inside unit casing.
 - 2. Casing: Galvanized steel, double wall.
 - a. Lining: 1/2-inch- thick, fibrous-glass duct liner.
 - 3. Regulator Assembly: System-air-powered bellows.
 - 4. Volume Damper: Normally open, galvanized steel with maximum damper leakage of 2 percent at 3-inch wg inlet static pressure.
 - 5. Hydronic Heating Coils: Copper tube and aluminum fins.
 - 6. Factory-mounted and -wired, DDC microprocessor-based controls.
- B. Hangers and supports.

1.2 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.

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SECTION 233713.13 - AIR DIFFUSERS

1.1 PRODUCTS

- A. Rectangular and square ceiling diffusers, adjustable.
- B. Perforated diffusers, surface and panel mounted with pattern controllers.
- C. Louver face diffusers.
- D. Linear bar diffusers with core spacing arrangement.
- E. Linear slot diffusers.
- F. Ceiling-integral continuous diffusers.

END 233713.13

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DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING Section 233713.23 – Registers and Grilles

SECTION 233713.23 - REGISTERS AND GRILLES

1.1 PRODUCTS

- A. Registers: Adjustable and fixed with adjustable opposed-blade damper.
- B. Grilles: fixed.

END 233713.23

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DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING Section 234100 - Particulate Air Filtration

SECTION 234100 - PARTICULATE AIR FILTRATION

- 1.1 QUALITY ASSURANCE
 - A. Quality Standards: ASHRAE 62.1, ASHRAE 52.2, NFPA 90A, NFPA 90B, and UL 900.

1.2 PRODUCTS

- A. Pleated Panel Filters:
 - 1. Media: Cotton and synthetic fibers.
 - 2. Filter-Media Frame: Cardboard frame with perforated metal retainer.
 - 3. MERV Rating: 13.
- B. Filter Gauges: Manometer type.

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SECTION 235216 - CONDENSING BOILERS

1.1 WARRANTY

- A. Warranty Period for Fire-Tube Condensing Boilers:
 - 1. Leakage and Materials: 10 years from date of Substantial Completion.
 - 2. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for five years from date of Substantial Completion.
- B. Warranty Period for Water-Jacketed Condensing Boilers:
 - 1. Leakage and Materials: Eight years from date of Substantial Completion.
 - 2. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for five years from date of Substantial Completion.

1.2 PERFORMANCE REQUIREMENTS

- A. Quality Standard: ASME Boiler and Pressure Vessel Code.
- B. Minimum Efficiency: ASHRAE/IESNA 90.1.
- C. UL Compliance: UL 795.

1.3 MANUFACTURED UNITS

- A. Forced-Draft, Fire-Tube Condensing Boilers:
 - 1. Heat Exchanger: Nonferrous combustion chamber and forced-draft burner for natural gas.
 - 2. Pressure Vessel: Carbon steel with welded heads and tube connections.
 - 3. Burner: Natural gas, forced draft.
 - 4. Blower: Centrifugal fan.
 - 5. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
 - 6. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
 - 7. Casing: Factory-finished sheet metal jacket, with insulation.

B. Trim:

- 1. Aquastat controllers.
- 2. Safety Relief Valve: ASME rated.
- 3. Pressure and temperature gage.
- 4. Boiler Air Vent: Manual.
- 5. Drain valve.
- 6. Circulation pump.

C. Controls:

- 1. Boiler Operating Controls:
 - a. Control transformer.
 - b. Operating pressure control.
 - c. Low-water cutoff and pump control.
 - d. Sequence of Operation: Reset supply-water temperature.
- 2. Burner Operating Controls:
 - a. High Cutoff: Manual reset.
 - b. Low-Water Cutoff Switch: Manual reset.
 - c. Blocked inlet safety switch.
 - d. Audible alarm.
- 3. Building management system interface.
- D. Electrical Power: Single-point field power connection to nonfused disconnect switch.
- E. Venting Kits:
 - 1. Kit: Stainless steel.
 - 2. Combustion-Air Intake: Stainless steel.

1.4 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.

SECTION 235233 - WATER-TUBE BOILERS

1.1 SUMMARY

1. Section includes packaged, factory assembled, water-tube boilers for generating steam.

1.2 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace drums, tubes, headers, cabinets, atmospheric gas burners, and pressure vessels of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Drums, Tubes, Headers, Cabinets, and Atmospheric Gas Burner: Five years from date of Substantial Completion.
 - 2. Warranty Period for Pressure Vessel: 10 years from date of Substantial Completion.

1.3 PERFORMANCE REQUIREMENTS

- A. Fuel-to steam efficiency indicated shall be based on the following:
 - 1. Efficiency Testing Method: BTS-2000.
 - 2. Efficiency Testing Method: ASME Performance Test Code (PTC) 4.
- B. Gas-Fired Boiler Emissions: Not to exceed allowable ambient-air quality standards in governing jurisdiction.
- C. Seismic Performance: Boiler shall withstand the effects of earthquake motions determined according to Section 230548.
- D. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.
- E. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers Minimum Efficiency Requirements."
- F. DOE Compliance: Minimum efficiency for boilers with capacity of 300,000 Btu/h (87.9 kW) shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- G. UL Compliance: Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.4 STEEL OR FLEXIBLE WATER-TUBE BOILERS

- A. Description: Factory-fabricated water-tube boiler, with heat exchanger sealed pressure tight, and built on a steel base; including insulated jacket, flue-gas vent, supply and return connections, and controls inclusive of DDC Building Automation System Interface.
- B. Network and Phone Connections:
 - 1. Connect LAN/WAN network cable to boiler controls to provide connectivity for remote monitoring through integrated boiler control system.
 - 2. Connect phone system cable to boiler controls to provide connectivity for remote monitoring and alarm notification through integrated boiler control system

1.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Hydrostatic Leak Test: Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
 - b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and steam pressure.
 - c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Boiler will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Occupancy Adjustments: When requested, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
- G. Performance Tests:

- 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
- 2. Boilers shall comply with performance requirements indicated, as determined by fieldperformance tests. Adjust, modify, or replace equipment in order to comply.
- 3. Perform field-performance tests to determine the capacity and efficiency of the boilers.
 - a. For dual-fuel boilers, perform tests for each fuel.
 - b. Test for full capacity.
 - c. Test for boiler efficiency throughout firing range. Determine and document efficiency at each test point.
- 4. Test each safety valve. Record pressure at valve blowdown and reset. Test valve(s) with boiler operating at full capacity to ensure valve has capacity to prevent further rise in pressure.
- 5. For boilers equipped with automatic oxygen trim control, conduct tests with automatic oxygen trim control on manual at zero trim and record performance. Repeat tests with automatic oxygen trim control under automatic control and record performance.
- 6. Repeat tests until results comply with requirements indicated.
- 7. Provide measurement and analysis equipment required to determine performance.
- 8. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
- 9. Document test results in a report and submit with informational submittals.

1.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions and provide electronic copy of video to Using Agency.

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SECTION 236313 - AIR-COOLED REFRIGERANT CONDENSERS

1.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. Fabricate and label refrigeration system according to ASHRAE 15 and ASHRAE 34.
- C. International Energy Conservation Code, 2018.

1.2 PACKAGED AIR-COOLED REFRIGERANT CONDENSERS

- A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.
- B. Refrigerant: Match chiller.
- C. Condenser:
 - 1. Tube: Seamless copper.
 - 2. Coil Fin: Aluminum.
 - 3. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors in accord with 2018 IECC.
 - a. Mount unit-mounted disconnect switches on exterior of unit.
 - 4. Coating, Coils: Corrosion resistant.
 - 5. Coating, Fans: Corrosion resistant.
 - 6. Coating, Casing: Corrosion resistant.
 - 7. Circuit: To match compressors with liquid subcooling coil.
- D. Wind and Seismic Restraints: Metal brackets compatible with the support and casing, painted to match unit, used to anchor unit to the support, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for windload requirements.

1.3 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.

END 236313

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SECTION 236426 - AIR-COOLED, ROTARY-SCREW WATER CHILLERS

1.1 QUALITY ASSURANCE

- A. Certification and Performance Ratings: AHRI 370, AHRI 575, AHRI 590, and AHRI 550/590.
- B. ASHRAE Compliance: ASHRAE 15 and ASHRAE 147.
- C. ASME Compliance: ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. International Energy Conservation Code, 2018.

1.2 PACKAGED, AIR-COOLED CHILLERS

- A. Cabinet: Galvanized steel.
 - 1. Corrosion-resistant coating.
 - 2. Sound-reduction package.
 - 3. Security package.
- B. Compressor: Hermetic.
- C. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with a variable-frequency controller and hot-gas bypass, if necessary, to achieve performance indicated.
 - 1. Operating Range: From 100 to 15 percent of design capacity.
 - 2. Condenser-Air Unloading Requirements over Operating Range: Drop-in entering, condenser-air temperature of 5 deg F drop for each 10 percent in capacity reduction.
- D. Oil Lubrication System: Pump if required, filtration, heater, cooler, factory-wired power connection, and controls.
- E. Vibration-balanced compressors individually mounted on vibration isolators.
- F. Compressor Motor: Hermetically sealed and cooled by refrigerant suction gas.
- G. Motor Controllers: Variable frequency.
- H. Refrigerant Circuit:
 - 1. Refrigerant Type: R-134a.
 - 2. Replaceable-core filter-dryer.
 - 3. Spring-loaded, pressure relief valve.
- I. Evaporator: Shell-and-tube type.

- 1. Fluid nozzles having mechanical-coupling connections.
- 2. Evaporator heater for freeze protection.
- J. Air-Cooled Condenser:
 - 1. Coil Casing: Galvanized or stainless steel.
 - 2. Copper tubes with aluminum fins.
 - 3. Hail protection.
 - 4. Refer also 236313 Air-Cooled Refrigerant Condensers.
- K. Electrical Power: Single-point, field-power connection to circuit breaker.
- L. Controls: Microprocessor based.
 - 1. Enclosure with electrical power devices or separate enclosure.
 - 2. Operator Interface: Keypad or touch screen. Multiple-character, digital display.
 - 3. Interface with DDC System for HVAC: Communication interface.
- M. Insulation for Cold Surfaces: Closed-cell, flexible elastomeric.
- N. Accessories:
 - 1. Flow Switch: Chilled water.
 - 2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
 - 3. Vibration Isolation: Neoprene pads.
 - 4. Tool kit.
- O. Packaged portable unit consisting of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valving.

1.3 SOURCE QUALITY CONTROL

- A. Factory tested.
- B. Evaporator and Condensers: Factory tested and inspected according to ASME Boiler and Pressure Vessel Code.

1.4 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.

END 236426

SECTION 237223 - PACKAGED, OUTDOOR, HEAT WHEEL ENERGY RECOVERY UNITS

1.1 SUMMARY

- A. Section Includes:
 - 1. Heat wheels in packaged, outdoor, total energy-recovery units, with hot gas reheat.

1.2 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, outdoor, heat-wheel, energy-recovery units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Packaged Energy-Recovery Units: 5 years from date of Substantial Completion.

1.3 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of airhandling units and components.
- B. ASHRAE Compliance:
 - 1. Applicable requirements in ASHRAE 62.1.
 - 2. Capacity ratings for heat-wheel, energy-recovery equipment: Comply with ASHRAE 84.
- C. International Energy Conservation Code, 2018.

1.4 PACKAGED, OUTDOOR, HEAT-WHEEL, ENERGY-RECOVERY UNITS

- A. Source Limitations: Obtain packaged, outdoor, heat-wheel, energy-recovery units from single manufacturer.
- B. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1.
- C. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum thermal insulation, knockouts for electrical connections, exterior drain connection, and lifting lugs.
- D. Heat Wheel:
 - 1. Casing:

- a. Manufacturer's standard construction with standard factory finish.
- b. Slide-in, slide-out cassette style.
- c. Provide unit with integral purge section, limiting carryover of exhaust air.
- d. Provide casing seals on periphery of rotor and on duct divider and purge section.
- e. Support vertical rotors on grease-lubricated ball bearings having permanently lubricated bearings with minimum 200,000 hours. Support horizontal rotors on tapered roller bearing.
- 2. Drive: Electric motor with speed changed by variable-frequency motor controller and self-adjusting multilink belt around outside of rotor.
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in 2018 IECC.
 - b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- E. Wiring: Fabricate units with space within housing for electrical conduits. Wire motors and controls, so only external connections are required during installation.
 - 1. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
 - 2. Include disconnect switches.
- F. Controls
 - 1. Control Panel: Solid-state, programmable, microprocessor-based control unit. Integrate to BACnet.
 - 2. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 - 3. Frost Control.
 - 4. Carbon Dioxide Sensor: Adjustable control from 600 to 2000 ppm, with digital display and direct digital control (DDC) system interface to energize unit.
 - 5. Economizer Control, Stop Wheel: Stop wheel rotation or modulate wheel rotation speed when conditions are favorable for economizer operation.
 - 6. Enthalpy sensor.
 - 7. Rotation sensor and alarm.
 - 8. Dirty filter switch.
 - 9. Low-Voltage Transformer: Integral transformer to provide control voltage to unit from primary incoming electrical service.
 - 10. Variable-Frequency Motor Controller: Serving wheel rotation motor.
- G. Source Quality Control
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended application.
 - 2. Retain "AHRI Compliance" Paragraph below if AHRI-certified capacity ratings are required for a project.
 - 3. AHRI Compliance: Capacity ratings for air-to-air energy-recovery equipment certified as complying with AHRI 1060 (IP) (AHRI 1061).

- 4. Fan Performance Rating: Comply with AMCA 211, and label fans with AMCA-certified rating seal. Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210 and ASHRAE 51.
- 5. Fan Sound Rating: Comply with AMCA 301 or AHRI 260 (IP) (AHRI 261 [SI]).
- 6. UL Compliance:
 - a. Packaged Heat-Recovery Ventilators: Comply with requirements in UL 1812.
 - b. Electric Coils: Comply with UL 1995.
- H. Roof Curbs
 - 1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 2. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

1.5 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.

END 237223

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SECTION 237313.16 - INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

1.1 SUMMARY

A. Insulated, double-wall-casing, indoor, semi-custom, factory-assembled, air-handling units.

1.2 QUALITY ASSURANCE

A. Quality Standards: AHRI 430, AMCA 301 or AHRI 260, AMCA 210, NFPA 70, and NFPA 90A.

1.3 SUSTAINABLE DESIGN REQUIREMENTS

A. Comply with ASHRAE 62.1 and ASHRAE/IES 90.1.

1.4 COMPONENTS

- A. Unit Casing:
 - 1. Base Rail: Galvanized steel.
 - 2. Outside Casing: Galvanized steel.
 - 3. Outside Casing Finish: Manufacturer's standard.
 - 4. Inside Casing: Galvanized steel; solid;.
 - 5. Floor Plate: Galvanized steel;.
 - 6. Cabinet Insulation: 2 inches thick.
 - 7. Casing Panel R-Value: Minimum R-13.
 - 8. Static-Pressure Classifications for Unit Sections Upstream of Fans: 6-inch wg.
 - 9. Static-Pressure Classifications for Unit Sections Downstream and Including Fans: 6-inch wg.
 - 10. Inspection access panels and access doors.
 - 11. Condensate Drain Pans: Double-wall, stainless steel;.
- B. Supply Fan Section:
 - 1. Type: DWDI, airfoil centrifugal.
 - 2. Drive: V-belt.
 - 3. Number of Fan Wheels: One.
 - 4. Internal vibration control.
 - 5. Motors.
 - 6. Variable-frequency motor controller serving each fan individually.
- C. Coils:
 - 1. Coil Sections: Common or individual, insulated, galvanized-steel casings.
 - 2. Heating Coil: Hot water.

- 3. Cooling Coil: Chilled water.
- 4. Water Coils: Continuous circuit.
 - a. Tubes: Copper.
 - b. Fins: Aluminum.
 - c. Headers: Cast iron.
 - d. Frames: Stainless steel.

D. Filters:

- 1. UL 900.
- E. Filter Access: Side.
- F. Filter gauges.
- G. Dampers:
 - 1. Leakage Rate: Not to exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg; AMCA 500.
 - 2. Damper Operators: Electronic.
 - 3. Face-and-Bypass Dampers: Opposed blade; galvanized steel.
 - 4. Low-Leakage, Outdoor-Air Dampers: Double skin; airfoil blade; galvanized steel.
 - 5. Outdoor- and Return-Air Dampers: Opposed blade; galvanized steel.
 - 6. Combination filter and mixing box.

1.5 INSTALLATION

A. Equipment Mounting: Install air-handling units on concrete bases using restrained spring isolators.

1.6 ROOF SUPPORTS

A. Wind and Seismic Restraints: Metal brackets compatible with the support and casing, painted to match unit, used to anchor unit to the support, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

1.7 STARTUP SERVICES

- A. Engage a factory-authorized representative to perform startup service.
- B. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units

END 237313.16

<u>DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING</u> Section 237416.13 - Packaged, Large-Capacity, Rooftop Air-Conditioning Units

SECTION 237416.13 - PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

1.1 MANUFACTURED UNITS

- A. Casing:
 - 1. Double-wall construction.
 - 2. Galvanized steel painted with baked enamel.
 - 3. Galvanized-steel liner.
 - 4. Insulated with foam injected panels.
 - 5. Stainless-steel drain pan.
- B. Supply-Air Fan: Direct driven.
- C. Relief-Air Fan: Propeller.
- D. Outdoor-air-intake relief-air fan.
- E. Motors: NEMA MG 1.
 - 1. Premium efficient.
- F. Rotary Heat Exchanger:
 - 1. Integral with unit.
 - 2. Painted steel casing.
- G. Supply-Air Refrigerant Coil:
 - 1. Aluminum-plate fins and seamless copper tube.
 - 2. Corrosion-resistant coating.
- H. Outdoor-Air Refrigerant Coil:
 - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing.
 - 2. Corrosion-resistant coating.
- I. Refrigerant Circuit Components:
 - 1. Compressor: Hermetic, variable-speed scroll.
 - 2. Refrigerant Charge: R-410A.
- J. Filters: Arrestance and MERV according to ASHRAE 52.2.
- K. Gas Furnace:
 - 1. Heat Exchanger and Drain Pan: Stainless steel.
 - 2. Fuel: Natural gas.

- 3. Power vent.
- L. Dampers:
 - 1. Outdoor-air dampers.
 - 2. Outdoor- and return-air mixing dampers.
 - 3. Barometric relief dampers.
- M. Electrical Power Connection: Single with unit-mounted disconnect.
- N. DDC Controllers:
 - 1. Safety controls.
 - 2. Scheduled controls.
 - 3. Unoccupied period controls.
 - 4. Supply fan controls.
 - 5. Refrigerant circuit controls.
 - 6. Gas furnace controls.
 - 7. Fixed minimum outdoor-air controls.
 - 8. Economizer enthalpy-based controls.
 - 9. Carbon dioxide sensor.
 - 10. Terminal unit relays.
- O. Interface with HVAC instrumentation and control system.
- P. Accessories:
 - 1. Duplex electrical outlet.
 - 2. Filter differential pressure switch.
 - 3. Demand-control ventilation.
 - 4. Safeties.
 - 5. Coil and hail guards.
 - 6. Door switches.
 - 7. Weather hood.
 - 8. Service lights.
- Q. Roof Curb:
 - 1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 2. Wind and Seismic Restraints: Metal brackets compatible with the support and casing, painted to match unit, used to anchor unit to the support, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

R. Startup Services

- 1. Engage a factory-authorized representative to perform startup service.
- 2. Engage a factory-authorized representative to train Using Agency's maintenance personnel to adjust, operate and maintain units.

END 237416.13

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SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

1.1 SUMMARY

A. Section includes factory-assembled, dedicated outdoor air-handling units, including multiple components, capable of heating and cooling 100 percent outdoor air.

1.2 WARRANTY

- A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Dedicated Outdoor-Air-Handling Units: Two years from date of Substantial Completion.
 - 2. Warranty Period for Compressors: Five years from date of Substantial Completion.
 - 3. Warranty Period for Heat Exchangers: Ten years from date of Substantial Completion.
 - 4. Warranty Period for Rotary Heat Exchangers: Five years from date of Substantial Completion.

1.3 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an "NRTL" (nationally recognized testing laboratory), and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 "Systems and Equipment" and Section 7 "Construction and Startup."
- D. ASHRAE 15 and ASHRAE 34 Compliance: For refrigeration system safety.
- E. International Energy Conservation Code, 2018.
- F. ASHRAE 84 Compliance: Comply with capacity ratings for [heat-wheel] [fixed plate] energyrecovery equipment.

1.4 UNIT CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Configuration: Horizontal unit with bottom discharge for roof-mounting installation.

- C. Double-Wall Configuration.
- D. Condensate Drain Pans:
 - 1. Location: Each refrigerant coil and rotary heat exchanger.
 - 2. Construction:
 - a. Single-wall, stainless steel sheet.
 - 3. Size: Large enough to collect condensate from cooling coils, including coil piping connections, coil headers, and return bends.
 - 4. Slope: Minimum slope, to comply with ASHRAE 62.1.
 - 5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
 - 6. Width: Entire width of water-producing device.
 - 7. Depth: A minimum of 2 inches deep.
 - 8. Provide units having stacked coils with intermediate drain pan to collect condensate from top coil.

1.5 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Variable-Frequency Motor Controller: Serving all fans combined in fan array.

1.6 COILS

- A. General Requirements for Coils:
 - 1. Comply with AHRI 410.
 - 2. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 - 3. Coils are not to act as structural component of unit.
- B. Supply-Air Refrigerant Coils.
- C. Condenser Refrigerant Coils.
- D. Hot Gas Refrigerant Coils.

1.7 ROTARY HEAT EXCHANGER

A. Casing:

- 1. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factorypainted finish.
- 2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6inch wg and 0.20 percent at 4-inch wg.
- B. Rotor Aluminum, Metallic, or Polymer: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
- C. Drive: Fractional horsepower motor and gear reducer, with speed changed by variablefrequency controller. Provide permanently lubricated wheel bearings.

1.8 INDIRECT-FIRED GAS FURNACE HEATING

- A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.
- B. CSA Approval: Designed and certified by and bearing label of CSA.
- C. Burners:
 - 1. Heat-Exchanger Material: Stainless steel.
 - 2. Fuel: Natural gas.
 - 3. Ignition: Electronically controlled electric spark with flame sensor.
 - 4. Gas Control Valve: Electronic modulating.
 - 5. Gas Train: Single-body, regulated, redundant, 24 V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
- D. Venting, Gravity: Gravity vented.
- E. Heat-Exchanger Drain Pan: Stainless steel.

1.9 DAMPERS

A. Outdoor- and Relief-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement.

1.10 ELECTRICAL POWER CONNECTIONS

A. Single-Point Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.

1.11 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

1.12 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain units.

END 237433

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING

Section 238123 - Computer-Room Air-Conditioners, Ceiling-Mounted Units (IT And Electrical Rooms)

SECTION 238123 - COMPUTER-ROOM AIR-CONDITIONERS, CEILING-MOUNTED UNITS (IT AND ELECTRICAL ROOMS)

1.1 SUMMARY

A. Section includes ceiling-mounted, computer-room air conditioners.

1.2 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

1.3 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
- C. International Energy Conservation Code, 2018.
- D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

1.4 MANUFACTURED UNITS

- A. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls.
 - 1. Mounting Configuration: Exposed in the space.
 - 2. Mounting Configuration: Fit T-bar in lay-in ceiling opening.
 - 3. Mounting Configuration: Concealed above a hard ceiling.
- B. Cabinet: Galvanized steel serviceable from one side, with baked-enamel finish, insulated with 1/2-inch- (13-mm-) thick duct liner, and mounting bracket attached to the unit.

- 1. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches (610 by 1220 mm), with filter.
- 2. Unit with supply and return collars for ducting in the field.
- 3. Unit with 24-by-48-inch (610-by-1220-mm) air distribution plenum, with integral MERV 8 filter and three-way air distribution.
- 4. Unit with two-speed, centrifugal direct-drive fan.
- 5. Unit with single-speed, centrifugal belt-driven fan.
- 6. Unit with high static blower assembly consisting of field-attached blower box with double-inlet, centrifugal belt-driven fan; with single-speed motor mounted on an adjustable base, and providing up to 2 inches wc (500 Pa) of external pressure.
- 7. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Supply-Air Fan:
 - 1. Forward curved, double width, double inlet, centrifugal, with adjustable V-belt drive.
 - 2. Plug/plenum, single inlet, direct drive, electronically commutated, and variable speed.
- D. Refrigeration System:
 - 1. Compressor: Scroll, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
 - 2. Integral, Glycol Based Water-Cooled Refrigerant Condenser.
- E. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with two-way control valve.
 - 1. Cooling Medium: Glycol solution.
 - 2. Mount stainless-steel drain pan complying with ASHRAE 62.1
- F. Remote, Air-Cooled, Glycol-Solution Cooler:
 - 1. Corrosion-resistant cabinet.
 - 2. Copper-tube aluminum-fin coil.
 - 3. Direct-drive propeller fan with fan guards.
 - 4. Single-phase motors with internal overload protection.
- G. Glycol-Solution Pump Package:
 - 1. Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.
 - 2. Piping: Interconnecting piping, to and from remote, air-cooled glycol-solution cooler, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.
 - 3. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F.
- H. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

I. Single point power kit permitting single electrical feed to the evaporator and condensing unit of a close-coupled system.

1.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain units.

1.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END 238123

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SECTION 238219 - FAN COIL UNITS

1.1 SUMMARY

- A. Section Includes:
 - 1. Ducted fan coil units and accessories.

1.2 SYSTEM DESCRIPTION

- 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. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

1.3 DUCTED FAN COIL UNITS

- A. Coil Section Insulation: 1-inch-thick, coated glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
 - 1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
 - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Drain Pans: Insulated stainless steet. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- C. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
- D. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain.
- E. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- F. Factory, Hydronic Piping Package: ASTM B88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
 - 1. Two-way, modulating control valve for chilled-water coil.
 - 2. Two-way, modulating control valve for heating coil.

- 3. Hose Kits: Minimum 400-psig (2758-kPa) working pressure and operating temperatures from 33 to 211 deg F (0.5 to 99 deg C). Tag hose kits to equipment designations.
- 4. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.
- 5. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig (860-kPa) working pressure, 250 deg F (121 deg C) maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.
- 6. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig (2070-kPa) working pressure at 250 deg F (121 deg C); with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig (13.8 to 552 kPa).
- 7. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A126, Class B); 125-psig (860kPa) working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 (DN 15) hose-end, fullport, ball-type blowdown valve in drain connection.
- 8. Wrought-Copper Unions: ASME B16.22.
- 9. Reheat-Coil Operation:
 - a. Humidity Control for Occupied Periods.
- G. Interface with DDC System for HVAC Requirements:
 - 1. Interface relay for scheduled operation.
 - 2. Interface relay to provide indication of fault at the central workstation.
 - 3. Provide interface for central DDC system for HVAC workstation for the following functions:
 - a. Adjust set points.
 - b. Fan coil unit start, stop, and operating status.
 - c. Data inquiry, including supply- and room-air temperature and humidity.
 - d. Occupied and unoccupied schedules.
- H. Electrical Connection: Factory wire motors and controls for a single electrical connection.

1.4 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste.
 - a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

- B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to 8 visits to Project during other-than-normal occupancy hours for this purpose.
- D. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain fan coil units.

END 238219

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SECTION 26 00 10 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section and all following Division 26 and 28 sections.
- B. Refer to specification section 019113 GENERAL COMMISSIONING REQUIREMENTS for commissioning requirements.

1.2 SUMMARY

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Division 26 of these Specifications, and Drawings numbered with prefixes E, generally describe these systems, but the scope of the electrical Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 QUALITY ASSURANCE

- A. Execute all Work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the Work specified.
- B. Install all Work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best

quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.4 CODES, REFERENCES AND STANDARDS

- A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Architect's and Engineer's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
- B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Architect and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.
- D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:
 - International Building Code IBC ADA Americans with Disabilities Act Association of Edison Illuminating Companies AEIC ANSI American National Standards Institute ASTM American Society of Testing Materials American Welding Society AWS American Water Works Association AWWA CSA/USA Canadian Standards Association/USA Insulated Conductors Engineers Association ICEA IEEE Institute of Electrical and Electronics Engineers IES Illuminating Engineering Society NBFU National Board of Fire Underwriters NEC National Electrical Code, NFPA 70 NECA National Electrical Contractors Association

NEMA	National	Electrical	Manufactures'	Association
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- NETA National Electrical Testing Association
- NFPA National Fire Protection Association
- OSHA Occupational Safety and Health Act
- UL Underwriter's Laboratories
- E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.
- G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

1.5 DEFINITIONS

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
 - 1. Furnish: "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
 - 2. Install: "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
 - 3. Provide: "To furnish and install complete, and ready for the intended use."
 - 4. Furnished by Owner (or Owner-Furnished) or Furnished by Others within the Design Build Contractor's scope of work: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.
 - 5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
 - 6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
 - 7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.
 - 8. Commissioning: A systematic process of verifying that the building systems perform interactively according to the construction documents and the USER AGENCY's operational needs. Also see specification section 019113 GENERAL COMMISSIONING REQUIREMENTS.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term

"approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

- C. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.
- D. The following definitions apply to excavation operations:
 - 1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 - 2. Sub-base: as used in this Section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.
 - 3. Sub-grade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
 - 4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Architect.

1.6 COORDINATION

- A. Coordinate with other Divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.
- C. Refer to Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.
- D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. Maintain an electrical foreman on the jobsite at all times to coordinate this Work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

1.7 MEASUREMENTS AND LAYOUTS

A. The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Using Agency, errors that could have been avoided by proper checking and inspection.

1.8 SUBMITTALS

- A. [Refer to Division 01 and General Conditions for submittal requirements.]
- B. Submittals and shop drawings shall not contain EC&S, Inc. firm name or logo, nor shall it contain the EC&S, Inc. engineers' seal and signature. They shall not be copies of EC&S, Inc. work product. If the contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.
- C. Assemble and submit for review, manufacturer's product literature for material and equipment to be furnished, installed, or both, under this Division, including shop drawings, manufacturers' product data and performance sheets, samples, and other submittals required by this Division. Provide the number of submittals required by Division 01; however, at a minimum, submit seven (7) sets.
- D. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed.
- E. Refer to individual Sections for additional submittal requirements.
- F. Transmit submittals as early as required to support the project schedule. Allow for two weeks Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before construction starts.
- G. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- H. Submittals shall contain the following information. Submittals not so identified will be returned to the Contractor without action:
 - 1. The project name.
 - 2. The applicable Specification Section and paragraph.
 - 3. The submittal date.
 - 4. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
- I. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the shop drawings have been posted. If

electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

J. The Engineer's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless he has, in writing, called the Engineer's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve him from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.

1.9 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at his option, obtain electronic drawing files in AutoCAD format from the Engineer. Contact the Architect for Architect's associated written authorization. Contractor shall request a written Engineer's release agreement form which must be signed and received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

- A. Refer to Bid documents, General and Supplementary Conditions and Division 01 Specification Sections for limitations and restrictions on substitutions.
- B. Materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. No substitutions will be considered with receipt of Bids, unless the Architect and Engineer have received from the Bidder a written request for approval to bid a substitution at least ten calendar days prior to the date for receipt of Bids, and have approved the substitution request. Include, with each such request, the name of the material or equipment for which substitution is being requested, and a complete description of the proposed substitution, including drawings, cut sheets, performance and test data, and all other information necessary for an evaluation. Include also a statement setting forth changes in other materials, equipment or other work that would be required to incorporate the substitution. The burden of proof of the merit of the proposed substitute is upon the proposer. The Architect's or Engineer's decision to approve or disapprove a substitution in a Bid is final.
- D. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner, including verbal.
- E. No substitutions will be considered after receipt of Bids and before award of the Contract.
- F. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.
- 1.11 OPERATION AND MAINTENANCE DATA

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Data.
- B. Submit data prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of brochures in three-ring, loose-leaf, hard-back notebook form, divided and tabbed, containing equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer's service and maintenance data, warranties, guarantees, etc. Include local contacts complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

1.12 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections of this Division.

1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings.
- B. Keep a set of jobsite work prints of the Issued for Construction Drawings on the jobsite during construction, for the purpose of annotating changes. During the course of construction, indicate on these Documents, changes made from the Conformed Contract Documents. Pay particular attention to those items that require locating for servicing.
- C. At the completion of the project, obtain reproducible copies of the final Drawings and incorporate changes noted on the jobsite work prints. These changes shall be done by a skilled drafter. Mark each sheet "Record Drawing", along with the date, and deliver these Record Drawings to the Architect.

1.14 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect and Engineer.
- D. Be responsible for the safe storage of tools, material and equipment.

1.15 WARRANTIES

- A. Refer to Division 01 and General Conditions for Warranties.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.
- D. Also warrant the following additional items:
 - 1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.
 - 2. All raceway seals are effective.
 - 3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.
- E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Using Agency.
- F. Perform the remedial work promptly, upon written notice from the Architect or Using Agency.
- G. At the time of Substantial Completion, deliver to the [Using Agency] [Owner] all warranties, in writing and properly executed, including term limits for warranties extending beyond the one-year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.16 TEMPORARY FACILITIES

- A. Refer to Division 01 and General Conditions for Temporary Facilities requirements.
- B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
- C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.
 - 1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.
 - 2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where

steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

1.17 PROJECT CONDITIONS

- A. Conditions Affecting Work in Existing Buildings: The following project conditions apply:
 - 1. The drawings describe the general nature of remodeling to the existing building, however, visit the site prior to submitting bid to determine the nature and extent of work involved.
 - 2. Schedule Work in existing building with the Using Agency.
 - 3. Perform certain demolition work prior to remodeling. Perform the demolition that involves electrical systems, light fixtures, equipment, raceways, equipment supports or foundations and materials.
 - 4. Remove articles that are not required for the new work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.
 - 5. Relocate and reconnect electrical facilities that must be relocated in order to accomplish the remodeling shown on the drawings or indicated in the Specifications. Where electrical equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.
 - 6. Finish materials will be installed under other Divisions.
 - 7. Obtain permission from the Architect for channeling floors or walls not specifically noted on the Drawings.
 - 8. Protect adjacent materials indicated to remain. For Work specified to this Division, install and maintain dust and noise barriers to keep dirt, dust and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 9. Locate, identify and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, provide temporary services for affected areas.
- B. Conditions Affecting Excavations: The following project conditions apply:
 - 1. Maintain and protect existing building services that transit the area affected by selective demolition.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
- C. Site Information: Subsurface conditions were investigated during the design of the Project.
 - 1. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
- D. Use of explosives is not permitted.
- E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

- A. Refer to Division 31 for Excavation Backfill Material Requirements.
- B. Sub base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.
- C. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.
- D. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW and SP, free of clay, rock, or gravel larger than 2-inches in any dimension, debris, waste, frozen material; and vegetable and other deleterious matter.

PART 3 - EXECUTION

3.1 PERMITS

A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others within the Design Build Contractor's scope of work.

3.2 TEMPORARY ELECTRICAL SERVICE AND WIRING

- A. Refer to Division 01 and General Conditions for Temporary Electrical Service Wiring requirements.
- B. Provide 208Y/120 volt, three-phase, four-wire, temporary electrical service and temporary lighting system to facilitate construction.
- C. Pay all charges made by the Electric Utility, with respect to installation and energy charges for temporary services.
- D. Work for the temporary power shall consist of all labor and materials, including, but not limited to conduit, wiring, panelboards, fuse blocks, fused disconnecting switches, fuses, pig-tails, receptacles, wood panel switch supports, and other miscellaneous material required to complete the power system.
- E. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.
- F. Provide an adequate number of GFCI type power distribution centers, rated 208Y/120 volt, four-wire, and not less than 60A, with sufficient fuse blocks or breakers for lighting and hand tool circuits, 60A four-wire feeders, all mounted within pre-fabricated enclosures UL listed for this application or on suitable wood panels bolted to columns or upright wood supports as required.
- G. Install circuits to points on each level of each building so that service outlets can be reached by a 5-foot extension cord for 120V power and a 100-foot extension cord for 208V power (or as required by OSHA or local authorities).
- H. Provide one lighting outlet per 30 linear feet of corridor and at least one light in each room and for every 800 square feet of floor area. Temporary lighting shall comply with OSHA requirements.
- I. If additional service is required for cranes, electrical welders or for electric motors over 1/2 HP per unit, such additional service shall become the responsibility of the trade involved.
- J. When permanent wiring for lighting and power is installed, with approval of the Architect and Owner, the permanent system may be used, provided the Contractor assumes full responsibility for all electrical material, equipment, and devices contained in the system and provided that roof drainage system and roofing are complete.
- K. When directed by the Architect, remove all temporary services, lighting, wiring and devices from the property.
- L. In addition to the requirements in Division 01 and General Conditions, provide the following related to temporary lighting.
 - 1. For project areas under construction that are to be used as part of the building means/path for egress, provide temporary lighting as required to achieve required light levels along the means of egress during normal and emergency conditions.
 - a. Normal exterior egress: Provide 1 fc average along means of egress.
 - b. Emergency exterior egress: along means of egress, provide 1 fc, not less than 0.1 fc and not greater than 40:1 maximum to minimum uniformity ratios. Any temporary lighting shall also be powered by an approved emergency backup means.
 - c. Perform nighttime light level measurements, with both permanent and temporary light fixtures ON, for verification that required light levels along the means of egress have been achieved. Provide test reports to Owner, including documentation of temporary lighting locations and their performance/lamping information.
 - d. Temporary lighting along the means of egress should be thought of as consistent in location/placement during project construction. Should the contractor need to relocate temporary lighting that affects the means of egress, provide updated light level measurements or other documentation meeting Owner's satisfaction, showing required light levels are maintained.
 - e. Refer to Division 01 requirements for checklist requirements.

3.3 SELECTIVE DEMOLITION

- A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements.
- B. General: Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

- E. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:
 - a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 26.

3.4 EXISTING CONDITIONS

- A. Existing conditions indicated on the Drawings are taken from the best information available from the Using Agency, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new Work.
- B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

3.5 EXISTING UTILITIES

- A. Schedule and coordinate with the Utility Company, Using Agency and with the Architect/Engineer all connections to, relocation of, or discontinuation of normal utility services from any existing utility line. Include all premium time required for all such work in the Bid.
- B. Repair all existing utilities damaged due to construction operations to the satisfaction of the Using Agency or Utility Company without additional cost.
- C. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Using Agency or Architect/Engineer.
- D. Make repairs and restoration of utilities before workmen leave the project at the end of the workday in which the interruption takes place.
- E. Include in Bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

3.6 EXCAVATION AND BACKFILLING

- A. Refer to Division 01, Division 02, Division 31 and General Conditions for Excavation and Backfilling.
- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.
- C. Restore roads, alleys, streets and sidewalks damaged during this Work to the satisfaction of Authorities Having Jurisdiction.

- D. Do not excavate trenches close to walks or columns without prior consultation with the Architect.
- E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep them burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.
- F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
 - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip- line of trees indicated to remain.
 - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- K. Excavation for Underground Tanks and Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
 - 1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
 - 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- L. Trenching: Excavate trenches for electrical installations as follows:
 - 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a

minimum of six to nine inches clearance on both sides of raceway and cables.

- 2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
- 3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.
- 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.
- 5. Excavate trenches for raceway and cables and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.
- M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
- N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
 - 1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 - 2. Under building slabs, use drainage fill materials.
 - 3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 - 4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch- thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 - 5. Other areas use excavated or borrowed materials.
- O. Backfill excavations as promptly as work permits, but not until completion of the following:
 - 1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 - 2. Removal of concrete formwork.
 - 3. Removal of shoring and bracing, and backfilling of voids.
 - 4. Removal of trash and debris.
- P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
 - 1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less that 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.
- Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around

them to approximately same elevation in each lift.

- S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:
 - 1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture- density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesion less soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesion less soils.
 - 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.7 WORK IN EXISTING FACILITIES

- A. The drawings describe the general nature of remodeling to the existing facilities; however, visit the Site prior to submitting a Bid, to determine the nature and extent of the Work involved.
- B. Schedule Work in the existing facility with the Owner.
- C. Certain demolition work shall be performed prior to remodeling. Perform the demolition that involves electrical systems, fixtures, conduit, wiring, equipment, equipment supports of foundations and materials.
- D. Remove all of these articles that are not required for the new work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.
- E. Interruption of existing Electrical Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than two weeks in advance of proposed interruption of electrical service.
 - 2. Do not interrupt the electrical service without Owner's written permission.

- F. Relocate and reconnect all electrical facilities that must be relocated in order to accomplish the remodeling shown on the Drawings or indicated in the Specifications. Where electrical fixtures or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.
- G. Finish materials are specified in other Divisions.
- H. Where removal of existing wiring interrupts electrical continuity of circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued electrical continuity.
- I. Channel walls and floors as required to produce the desired result; however, obtain permission from the Architect or Owner for all channeling not specifically noted on the Drawings.

3.8 ACCESS TO EQUIPMENT

- A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Maintain all code required clearances and clearances required by manufacturers.

3.9 PENETRATIONS

- A. Unless otherwise noted as being provided under other Divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete or block walls.
- C. The cutting of new and/or existing construction will not be permitted except by written approval of the Architect.

3.10 CUTTING AND PATCHING

- A. Provide all necessary cutting of walls, floors, ceilings and roofs for work under this Division.
- B. Cut no structural member without permission from Architect.
- C. Patch around all openings to match adjacent construction.
- D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect/Engineer.

3.11 SEISMIC REQUIREMENTS

A. The project is located in Seismic Zone 1 as defined in IBC. Refer to Division 26 Section "Vibration and Seismic for Electrical Systems" for seismic bracing requirements.

3.12 PAINTING

- A. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under Division 09 of the Specifications; colors shall be as selected by the Architect.
- C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Architect and Engineer, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Engineer, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.13 CLEANING

- A. Refer to Division 01 for cleaning requirements.
- B. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.
- C. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises broom clean. Clean all material and equipment installed under this Division.
- D. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.
- E. Touch up and restore damaged finishes to their original condition.

3.14 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.
- B. Check motors for alignment with drive and proper rotation, and adjust as required.
- C. Check and test protective devices for specified and required application, and adjust as required.
- D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.
- E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.

- G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.
- H. Notify the Architect immediately of all operational failures caused by defective material, labor or both.
- I. Maintain service and equipment for all testing of electrical equipment and systems until all Work is approved and accepted by the Owner.
- J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.
- K. Refer to individual Sections for additional and specific requirements.

3.15 START-UP OF SYSTEMS

- A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers' recommended torque values using appropriate torque tools.
- B. Adjust taps on each transformer for rated secondary voltages.
- C. Balance all single phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent.
- D. Replace the lamps of all light fixtures that use incandescent, halogen or quartz lamp sources that are installed as part of the finished building, but are used by the Contractor during construction, with new lamps of appropriate type and wattage prior to turning the facility over to the Using Agency or Tenant.
- E. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.
- F. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- G. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.
- H. Low Voltage Testing:
 - 1. Test for Faults: After wires and cables are in place and connected to devices and equipment the system shall be tested for short circuits, improper grounds and other faults. When a fault condition is present, the trouble shall be rectified, then retested.
 - 2. Within 2 percent: Voltage test shall be made at each lighting and distribution panel. When potential is not within 2 percent of rated voltage, the condition shall be corrected by tap changes or power company correction of the line voltage.
 - 3. Grounded or Shorted: All wiring devices and electrical apparatus furnished under this contract when grounded or shorted on any integral "live" part, shall be removed and the trouble rectified by

replacing all defective parts and materials.

4. Megger Test: All service feeders cables, after being pulled in place and before being connected, shall have a Megger test conducted to determine that the wire and cable insulation resistance is not less than that recommended by the NEC. Copies of all tests shall be given to the A/E. All cables failing insulation test shall be removed, replaced and retested.

3.16 GROUNDING TESTING

A. 25 Ohms max: The resistance between ground grid and absolute earth shall not exceed 25 ohms and shall be measured in the presence of the A/E before equipment is placed in operation.

3.17 TEST REPORTS

- A. Perform tests as required by these Specifications and submit the results in the operations and maintenance manuals. The tests shall establish the adequacy, quality, safety, and reliability for each electrical system installed. Notify the Architect and Engineer two working days prior to each test.
- B. For specific testing requirements of special systems, refer to the Specification section that describes that system.
- C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Architect, for Engineer's review, in duplicate, the test results for the following electrical items:
 - 1. Building service entrance voltage and amperes at each phase.
 - 2. Electrical service grounding conditions and grounding resistance.
 - 3. Proper phasing throughout the entire system.
 - 4. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
 - 5. Phase voltages and amperes at each three-phase motor.
 - 6. Test all wiring devices for electrical continuity and proper polarity of connections.
- D. Promptly correct all failures or deficiencies revealed by these tests as determined by the Engineer.

3.18 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
 - 1. Submit complete Operation and Maintenance Data.
 - 2. Submit complete Record Drawings.
 - 3. Perform all required training of Owner's personnel.
 - 4. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
 - 5. Perform start-up tests of all systems.
 - 6. Remove all temporary facilities from the site.
 - 7. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.
- B. Request in writing a review for Substantial Completion. Give the Architect at least seven (7) days'

notice prior to the review.

- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the abovementioned items, he shall reimburse the Architect and Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect and Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 26 00 10

SECTION 26 05 02 - EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes limited scope for electrical connections to equipment specified under other Sections and Divisions or furnished under separate contracts or by the Owner.
- B. Related Requirements:
 - 1. Section 26 00 10 "General Electrical Requirements" for general requirements and related documents that apply to this Section.
 - 2. Section 26 05 19 "Low-voltage Electrical Power Conductors and Cables" for building wires, cables, connectors, splices, and terminations, rated 600V and less.
 - 3. Section 26 05 33 "Raceway and Boxes for Electrical Systems" for conduit, pull, junction, and outlet boxes, floor boxes and electrical cabinets.
 - 4. Section 26 27 26 "Wiring Devices" for devices installed in boxes.
 - 5. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Shop drawings for:
 - a. Detailing electrical characteristics, wiring diagrams, fabrication and installation for wiring systems.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 2. Marked for intended location and application.
- B. Comply with NFPA 70.

1.5 COORDINATION

A. Unless otherwise noted, perform all electrical Work required for proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these specifications, furnished under other contracts, and/or furnished by the Owner for installation

under this Contract.

- B. Coordinate work with Division 23 Section, "Common Work results for HVAC".
- C. Coordinate work with Division 23 Section, "Direct-Digital Control for HVAC".
- D. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- E. Determine connection locations and rough-in requirements based on shop drawings.
- F. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- G. Sequence electrical connections to coordinate with start-up schedule for equipment.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Attachment Plugs: Conform to NEMA WD 1.
- C. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.
- D. Cord: Refer to Paragraph "Flexible Cords" in Section 26 05 19 "Low-voltage Electrical Power Conductors and Cables".
- E. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 ELECTRICAL DEVICES

- A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) as indicated.
- B. Install disconnect switches, controllers, control stations, and control devices (other than

temperature control devices) specified in other Divisions of these Specifications, furnished under other contracts and/or furnished by the Owner for installation under this Contract.

3.3 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with water-tight connectors in damp or wet locations.
- C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.
- D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the drawings.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the drawings.

3.4 HVAC EQUIPMENT

- A. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- B. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.
- C. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.

3.5 COOLERS AND FREEZERS

A. Cut conduit openings in freezer and cooler walls, floor and ceilings, in accordance with manufacturers' instructions, when openings are not provided by the manufacturers. Seal around conduit penetrations air tight with an approved pliable material suitable for low temperatures. Effectively seal interiors of conduits, by installing a conduit fitting at the boundary of the two spaces, and filling it with an approved pliable material, after conductors or cables have been installed and tested.

3.6 DOOR OPERATORS AND HARDWARE

A. Provide electrical connections to automatic entry doors, automatic corridor doors, electrically held door latches, remote release doors and all other required electrical connections for door systems included in other sections of these specifications.

- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control wiring and conduit for all equipment that is not included within the responsibility of the door hardware installer. Provide connection from junction boxes to the door operators or hardware and from door operators to actuation devices as required. Install key operated switches, push-pad switches, and other electrically controlled door operation devices furnished by other divisions within this contract.
- D. Provide fire alarm devices and wiring as required for proper operation of door systems in accordance with NFPA codes.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

- 4.1 GENERAL
 - A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 05 02

SECTION 26 05 04 - PROVISIONS FOR ELECTRIC UTILITY SERVICE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Provisions for Underground Secondary Electrical Service.
- B. Utility service voltage:
 - 1. 12.47 kV, three-phase, four-wire, 60Hz
- C. Utility service ampacity: As indicated on the Drawings.
- D. The extent of Work for the secondary electrical service includes providing the following:
 - 1. Raceways
 - 2. Provisions for metering
 - 3. Grounding and Bonding
 - 4. CT Cabinet
 - 5. Meter Base
 - 6. Primary raceways
- E. Utility Contact: Ameren IL

1.3 RELATED SECTIONS

- A. Section 26 00 10 "General Electrical Requirements" for general requirements and related documents that apply to this Section.
- B. Section 26 05 13 "Medium-Voltage Electrical Power Conductors and Cables" for conductors and connectors.
- C. Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for conductors and connectors.
- D. Section 26 05 33 "Raceway and Boxes for Electrical Systems" for raceways, fittings, boxes, enclosures and cabinets for electrical service.
- E. Section 26 05 53 "Identification for Electrical Systems" for raceway identification materials to use for marking or tagging service raceways and boxes.
- F. Section 26 05 26 "Grounding and Bonding for Electrical Systems" for conductors, connectors and electrodes for electrical service grounding systems.
- G. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

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1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products for:
 - a. Meter bases
 - b. Current transformer cabinets.
- B. Where equipment or material are specified to comply with utility standard and are listed above as required submittals, obtain approval from the serving utility before submitting to the Architect.
- C. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Accurately record actual routing of all exterior buried raceway and all interior conduits two inches and larger. Indicate dimensions from fixed structural elements.

1.5 QUALITY ASSURANCE

- A. Perform all work in accordance with Utility Company installation drawings and service standards.
- B. Maintain one copy of Utility Company installation drawings and service standards at the site.
- C. Prior to commencing work in this Section, meet with Utility Company representative to review service entrance requirements and details.
- D. Verify that field measurements are as indicated on Utility Company drawings.
- E. Electrical Components, devices and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100 by an NRTL as defined by OSHA in CFR 29 1910.7, and that are acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- F. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS (NOT USED)

PART 3 - EXECUTION

- 3.1 SECONDARY SERVICE ENTRANCE UNDERGROUND
 - A. Provide an underground secondary service from the pad mounted transformer in accordance with NFPA 70 Article 230 and the Utility Company standards. Reference the Drawings for service conductors and raceway quantities, sizes and types.
 - B. The Utility Company will provide the service transformer.

- C. Utility will provide the concrete pad or vault, for transformer mounting, and set coated GRS conduit elbows and riser(s), with grounding bushing(s), to receive primary and secondary raceways. Where direct burial primary is used, set coated GRS conduit elbow(s) and riser(s), with grounding bushing(s), to receive primary cables.
- D. Make connections to the secondary terminals of the transformer as required and in conformance with Utility Company requirements. Utility Company will provide primary conductors and terminal connections unless otherwise directed by the Utility Company.
- E. Provide underground raceways for primary cables from the transformer pad to the utility pole, and provide pull cord, per Utility Company standards, for the Utility Company's use in pulling primary conductors. Install raceways a minimum of 24 inches below finished grade line unless otherwise indicated on the Drawings or directed by the Utility Company. Provide excavation and backfill as required to accomplish the installation.

3.2 METERING

- A. Provide a 1-1/4-inch empty GRS conduit, with pull cord, from the current transformer compartment of service entrance equipment to the meter location indicated on the Drawings, or as directed by the Utility Company.
- B. Provide a meter base complying with the Utility Company standards.
- C. Provide a current transformer with side gutter cabinet complying with the Utility Company standards.
- D. The Utility Company will provide the meter and meter wiring

3.3 UTILITY SERVICE CHARGES

- A. It shall be the responsibility of the Division 26 contractor to apply for the electrical service, including the preparation and completion of all forms. Submit the completed application along with all other required documentation for the new or modified service.
- B. The Owner will pay all charges of the Utility Company for the electrical service.

END OF SECTION 26 05 04

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SECTION 26 05 05 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.2 DESCRIPTION OF WORK

- A. Furnish all materials, labor, equipment and services necessary to perform all electrical demolition work.
- B. Work included in this Section includes all demolition work as shown on the Electrical Drawings and as specified herein and as required to complete the Work.

1.3 **DEFINITIONS**

- A. Demolish: Completely remove and legally dispose of off-site.
- B. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- C. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.
- D. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- E. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- F. Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner. Include fasteners or brackets needed for reattachment elsewhere.

1.4 SUBMITTALS

- A. Schedule of Selective Electrical Demolition Activities: Indicate detailed sequence of selective electrical demolition and removal work, with starting and ending dates for each activity and interruption of electric power services.
- B. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
- C. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective electrical demolition operations. Comply with Division 01 Section "Photographic

Documentation." Submit before the Work begins.

- D. Disposal Records: If hazardous wastes are removed by Contractor, submit the following:
 - 1. Hazardous Waste Transporter license
 - 2. Permit or license for hazardous waste treatment or disposal facilities
 - 3. Completed Uniform Hazardous Waste Manifest for all shipments
 - 4. Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI A10.6 and NFPA 241, latest editions.
- C. Prior to beginning demolition, arrange a conference with the Owner's Representative to review electrical demolition scope, procedures, schedule and items to be salvaged for the Owner.

1.6 PROJECT CONDITIONS

- A. Owner will occupy building during construction. Localized areas to be demolished will be vacated during demolition work. Conduct selective electrical demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Owner's Representative of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb: immediately notify Engineer and Owner's Representative. Any hazardous materials will be removed by Owner under a separate contract.
- E. On-site storage or sale of removed items or materials is not permitted.
- F. Utility Service: Maintain electrical service to building during selective electrical demolition operations.
 - 1. Disconnect electrical power only to the items of equipment or the panelboard that is identified for removal under the selective electrical demolition operations.
- 1.8 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.9 MATERIALS OWNERSHIP

A. Except for items or materials to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option but in compliance with ordinances and regulations related to the materials being disposed.

1.10 COORDINATION

- A. Arrange demolition schedule so as not to interfere with Owner's on-site operations and the operations of adjacent occupied buildings.
- B. Review and finalize selective electrical demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
- C. Review requirements of General Demolition Contractor and work performed by other trades that rely on demolition of electrical circuitry or equipment to allow for structural demolition or removal of equipment.
- D. Review areas where existing electrical circuitry and/or equipment is to remain in place and requires protection.

PART 2 - PRODUCTS AND MATERIALS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION & RECORDING OF CONDITIONS

- A. Verify that utilities have been disconnected and capped before starting selective electrical demolition operations.
- B. Survey existing conditions and coordinate and identify the extent of the electrical demolition work required. Record existing conditions using preconstruction photographs.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document conditions.
- D. When unanticipated site, mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Owner's Representative and Engineer.
- E. Perform surveys as the work progresses to detect hazards resulting from the execution of the work.

3.2 COORDINATION

- A. No electrical demolition work shall be performed without prior approval of the Owner's Representative.
- B. Electrical demolition work shall be carried on in a manner so as not to interfere with operation of the Owner's facilities.
- C. Any electrical demolition work which interferes with Owner's operation shall be scheduled with the Owner's Representative and be subject to the Owner's approval.
- D. Maintain existing services required to avert disruption to the Owner's on-going operations and protect them against damage during the performance of the work.
- E. Do not interrupt existing electrical service to occupied facilities except when authorized in writing by the Owner's Representative.
- F. Provide temporary electrical service during interruptions to existing electrical systems, as acceptable to the Owner's Representative.
- G. Unless noted otherwise, provide not less than two weeks' notice to the Owner if shutdown of electrical service is required during the execution of the work.
- H. The Contractor shall not remove any material beyond the limits indicated on the Drawings unless given permission to do so by the Owner's Representative. Any such material removed shall be replaced by the Contractor at his expense. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.
- I. All damages to buildings and utilities to remain in place shall be promptly repaired at no cost to the Owner. Repairs and restoration of accidental utility interruptions shall be made before the workmen responsible for the repair and restoration leave the job on the day such interruptions occur.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective electrical demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
- D. Existing building openings may be used to remove material. No new openings may be made without approval of the Owner's Representative.

3.4 **PROTECTION**

- A. Comply with governing laws, codes, and regulations governing fire protection and environmental protection during electrical demolition operations.
- B. Provide dust control and ventilation as required in areas of electrical demolition.
- C. Execute electrical demolition work, so as to insure adjacent areas against damage which might occur from falling debris or other causes; do not interfere with the use of, operations in, or around adjacent areas; maintain free and safe passage of persons around the areas of electrical demolition.
- D. Provide temporary handrail, barricades, floor plates, etc. as required to provide protection for open elevated platforms, holes, etc. created by the electrical demolition work.
- E. Premises shall be maintained and protected from all unsafe or hazardous conditions at all times.
- F. Protect existing surfaces, active utility services, and equipment which are to remain in place.
- G. Protect lighting fixtures that are to remain in place from damage during demolition and construction operations. Exposed fixtures shall have a plastic bag or other suitable covering affixed over the fixture to protect from dust and paint splatters.

3.5 DUST CONTROL

- A. Contractor shall use temporary enclosures and other suitable methods as necessary to limit the amount of dust and dirt carrying over to other parts of the Owner's property.
- B. Adequacy of the dust control methods shall be subject to the approval of the Owner's Representative.
- C. Areas of major electrical demolition inside the Owner's property shall be enclosed by means of temporary walls constructed of wood framing with plywood or 6 mil polyethylene sheets.
- D. Temporary enclosures shall be removed by the Contractor upon completion of the electrical demolition work unless otherwise directed by the Owner's Representative.

3.6 ELECTRICAL DEMOLITION - GENERAL

- A. Remove all work indicated on the Drawings and as required to complete the new work indicated.
- B. During electrical demolition operations, keep areas adjacent to electrical demolition work free of dust and debris.
- C. During electrical demolition operations, if suspected hazardous materials or conditions are uncovered, stop work in that area, and inform the Owner's Representative.
- D. At concealed spaces, such as hollow walls, ducts, and pipe interiors, verify condition and contents of hidden space before starting electrical demolition operations.

- E. Neatly cut openings and holes plumb, square and true to dimensions, required.
- F. Use cutting methods least likely to damage construction to remain or adjoining construction.
- G. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
- H. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
- I. Do not use cutting torches until work area is cleared of flammable materials.
- J. Maintain portable fire-suppression devices during flame-cutting operations.
- K. Contractor shall take care when using a torch to cut steel welded or bolted to structural members so as to cut flush with but not damage the structural members.
- L. All hanger and support material for demolished piping and conduit shall be removed back to the primary structural support member. Grind connection to primary member smooth and touch up with paint to match adjacent surface.
- M. All elevated equipment and materials to be demolished shall be carefully lowered (not dropped) by means of temporary riggings. Contractor shall not overload any elements of existing structure during the rigging operation.
- N. Locate selective electrical demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- O. Dispose of demolished items and materials promptly.

3.7 ELECTRICAL DEMOLITION

- A. Protect existing electrical equipment and installations indicated to remain. If damaged in the course of the Work, remove damaged portions and install new products of equal capacity, quality and functionality.
- B. The Contractor shall use caution in the demolition of electrical systems and shall inform himself of the status (active, inactive) of all electrical systems to be demolished prior to proceeding.
- C. Prior to breaking or cutting conduit within the demolition area, the Contractor shall ascertain that the system has been identified or shown on the Drawings to be wrecked under this Contract. Contact the Owner's Representative for clarification prior to demolishing or wrecking questionable items.
- D. The Contractor shall remove, cap and/or relocate equipment, outlets, lighting fixtures, conduit, wire, etc., as specified or as shown on the Drawings and as may become necessary because of existing field conditions at no additional cost to Owner.
- E. All existing lighting fixtures, switches, receptacles, outlets, etc., shall be removed as required to complete the work and blank covers provided over the outlets, unless otherwise noted.

- F. All concealed conduit for circuits which are partially or completely abandoned may remain in place. Remove all wiring for concealed circuits that are to be completely abandoned and cut and remove concealed conduit 2 inches below the surface of adjacent construction. Cap conduits and patch surface to match existing finish. Exposed conduit for abandoned circuits shall be removed, unless otherwise noted.
- G. Exposed conduit containing circuits which are to be retained shall remain in place, unless otherwise indicated or required.
- H. Wiring for existing circuits which must be rerouted, or which are partially abandoned, shall be reconnected to service the outlets/loads remaining on the circuit.
- I. All wiring for a circuit which is to be removed or abandoned shall be removed back to the panel which supplied the circuit.
- J. Completely remove all hangers and supports to building structure. Grind off stubs without damaging parent material (steel, concrete, etc.) and touch up paint as required.
- K. All abandoned or remaining empty conduit with open ends resulting from demolition work shall be promptly capped, plugged, or sealed.
- L. All open conduit knockouts, holes or unused hubs in electrical boxes and enclosures shall be properly plugged with suitable blanking devices that maintain the NEMA rating of the box or enclosure.

3.8 CONCRETE AND MASONRY DEMOLITION

- A. Demolish concrete and masonry in small sections.
- B. Cut concrete and masonry at junctures with construction to remain, using power driven masonry saw or hand tools. Do not use power-driven impact tools.

3.9 PATCHING

- A. All holes or openings in floors, walls or ceilings resulting from electrical demolition shall be properly sealed with material similar to the adjacent surface/finish.
- B. All rough edges of openings created by electrical demolition shall be promptly patched to create a finished surface.
- C. Openings in concrete shall be patched with cement mortar.
- D. Openings in masonry shall be patched by toothing in masonry units to match existing.

3.10 REMOVED AND SALVAGED ITEMS

- A. Carefully remove and clean salvaged items.
- B. Pack or crate items after cleaning. Identify contents of containers.

- C. Store items in a secure area until delivery to Owner.
- D. Transport items to Owner's storage area as directed by Owner's Representative.
- E. Protect items from damage during transport and storage.

3.11 REMOVED AND REINSTALLED ITEMS

- A. Carefully remove items to be reinstalled.
- B. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
- C. Pack or crate items after cleaning and repairing. Identify contents of containers.
- D. Protect items from damage during transport and storage.
- E. Reinstall items in locations indicated.
- F. Comply with installation requirements for new materials and equipment.
- G. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- H. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

3.12 EXISTING ITEMS TO REMAIN

- A. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective electrical demolition.
- B. When permitted by Owner's Representative, items may be removed to a suitable, protected storage location during selective electrical demolition and reinstalled in their original locations after selective electrical demolition operations are complete.

3.13 DISPOSAL

- A. All debris resulting from electrical demolition operations shall become the property of the Contractor and shall be removed daily from the Owner's property unless otherwise permitted by the Owner's Representative.
- B. Storage of removed materials on site will not be permitted.
- C. Sale of removed materials on-site will not be permitted.
- D. Transport demolished materials off Owner's property and dispose of legally in accordance with Federal, State, and local laws and regulations.

E. Upon completion of work, remove tools, materials, apparatus, and rubbish. Leave area clean, neat, and orderly.

3.14 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective electrical demolition operations.
- B. Return adjacent areas to condition existing before selective electrical demolition operations began.
- 3.15 HAZARDOUS MATERIALS
 - A. The Owner, to the best of his knowledge, has identified hazardous materials such as friable asbestos or lead in the work areas.
 - B. Should the Contractor discover additional material requiring removal which is suspected to contain hazardous materials, do not disturb.
 - C. Contact and consult with the Owner's Representative prior to proceeding. The Owner's Representative shall direct the Contractor how to proceed.

END OF SECTION 26 05 05

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SECTION 26 05 10 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:
 - 1. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
 - 2. Electrical equipment nameplate data.
 - 3. Sleeves and seals for electrical penetrations.
 - 4. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 - 5. Sealing penetrations through noise critical spaces.
- B. Related Requirements:
 - 1. Section 26 00 10 "General Electrical Requirements" for general requirements and related documents that apply to this Section.
 - 2. Section 26 05 02 "Equipment Wiring Systems" for electrical connections to equipment specified under other Sections, Divisions, or furnished by the Owner.
 - 3. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Sleeve seals.
 - b. Through and membrane penetration firestopping systems.
 - c. Joint Sealers
 - d. Acoustical sealers
 - 2. Shop drawings for:
 - a. Detailed fabrication drawings of access panels and doors.
 - 3. Detailed list of proposed nameplates for Owner/Engineer review and acceptance before fabrication and attachment.
 - 4. Through and Membrane Penetration Firestopping Systems Product Schedule: Provide UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
 - a. Where Project conditions require modification to qualified testing and inspecting agency's illustrations for a particular firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated

assembly.

- b. Qualifications Data for testing agency.
- 5. Record Drawings: Submit Record Drawings as required by Division 1 and Division 26.
 - a. Accurately record actual locations of firestopped penetrations and access panel/door locations. Indicate dimensions from fixed structural elements.

1.4 DEFINITIONS

- A. The following abbreviations apply to this and other Sections of these Specifications:
 - 1. AFF: Above Finished Floor
 - 2. AHJ: Authority(ies) having Jurisdiction
 - 3. ATS: Acceptance Testing Specifications
 - 4. EMT: Electrical Metallic Tubing
 - 5. EPDM: Ethylene-propylene-diene terpolymer rubber
 - 6. FMC: Flexible Metal Conduit
 - 7. GRS: Galvanized Rigid Steel Conduit
 - 8. IMC: Intermediate Metal Conduit
 - 9. LFMC: Liquidtight Flexible Metal Conduit
 - 10. LFNC: Liquidtight Flexible Nonmetallic Conduit
 - 11. MC: Metal Clad
 - 12. MFR: Manufacturer
 - 13. N/A: Not Available or Not Applicable
 - 14. NBR: Acrylonitrile-butadiene rubber
 - 15. NRTL: Nationally Recognized Testing Laboratory
 - 16. PCF: Pounds per Cubic Foot
 - 17. RAC: Rigid Aluminum Conduit
 - 18. RMC: Rigid Metal Conduit
 - 19. RNC: Rigid Nonmetallic Conduit
- B. The following definitions apply to this and other Sections of these Specifications:
 - 1. HOMERUN: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
 - 4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.
- 1.6 NOISE CRITICAL SPACES
 - A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants.
 - 1. A/V Spaces
 - 2. Offices
 - 3. Teleconference Rooms
 - 4. Meeting Rooms
 - 5. Conference Rooms

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- C. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 ACCESS PANELS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517). Acceptable manufacturers include:
 - 1. Bar-Co., Inc.
 - 2. J.L Industries.
 - 3. Karp Associates, Inc.

- 4. Milcor
- 5. Nystrom Building Products
- 6. Wade
- 7. Zurn
- B. Access Doors:
 - 1. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.
 - 2. Joints and seams: continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
 - 3. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wideexposed perimeter flange and adjustable metal masonry anchors.
 - b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
 - 4. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - 5. Locking Devices: Flush, screwdriver-operated cam locks.
 - 6. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

2.3 NAMEPLATES

- A. Refer to Division 26 Section "Identification for Electrical Systems".
- B. Engraved, contrasting color, three-layer, laminated plastic indicating the name of the equipment, load or circuit designated on the Drawings and in the specifications.
- C. Self-adhering, with a permanent, weatherproof adhesive. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied.
- D. Color, white background with black letters for Normal Power; red background with white letters for Emergency Power. Letter height: 1/2-inch minimum.

2.4 STEEL SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.

2.5 CAST IRON WALL PIPE SLEEVES FOR RACEWAYS AND CABLES

- A. Acceptable manufacturers include:
 - 1. Josam Mfg. Co.
 - 2. Smith (Jay R) Mfg. Co.
 - 3. Tyler Pipe/Wade Div.; Subs of Tyler Corp.
 - 4. Watts Industries, Inc.

- 5. Zurn Industries, Inc.; Hydromechanics Div.
- B. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.
- C. Sleeves for rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.6 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Acceptable manufacturers include:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. O-Z/Gedney
 - e. Pipeline Seal and Insulator, Inc.
 - f. Hilti, Inc.
 - 2. Sealing Elements: EPDM interlocking or solid sealing links shaped or pre-drilled to fit surface of cable or raceway. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Carbon steel or PVC-coated steel. Include two for each sealing element. For multi-phase circuits, use slotted pressure plates if metal.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
 - 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

- 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. One-Part, Nonacid-Curing, Silicone Sealant:
 - 1) "Dow Corning 790," Dow Corning Corp.
 - 2) "Dow Corning 795," Dow Corning Corp.
 - 3) "Silglaze N SCS 2801," General Electric Co.
 - 4) "Silpruf SCS 2000," General Electric Co.
 - 5) "864," Pecora Corp.
 - 6) ."Omniseal," Sonneborn Building Products Div
 - 7) "Spectrem 1," Tremco, Inc.
 - 8) "Spectrem 2," Tremco, Inc.
 - b. One-Part, Mildew-Resistant, Silicone Sealant:
 - 1) "Dow Corning 786," Dow Corning Corp.
 - 2) "Sanitary 1700," General Electric Co.
 - 3) "898 Silicone Sanitary Sealant," Pecora Corp.
 - 4) "OmniPlus," Sonneborn Building Products Div.
 - 5) "Tremsil 600 White," Tremco Corp.
- D. Acrylic-Emulsion Sealants: One-part, non-sagging, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Chem-Calk 600," Bostik
 - b. "AC-20," Pecora Corp.
 - c. "Sonolac," Sonneborn Building Products Div.
 - d. "Tremflex 834," Tremco, Inc.

2.8 FIRESTOPPING

- A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters' Laboratories, Inc., or other NRTL acceptable to AHJ.
 - 1. Acceptable manufacturers include:
 - a. Hilti, Inc.
 - b. RectorSeal.
 - c. Specified Technologies Inc.
 - d. 3M Corp.
 - e. United States Gypsum Company.

2.9 ACOUSTICAL SEALANTS

- A. Foam Backer Rod: Closed cell polyethylene suitable for use as a backing for non-hardening sealant.
- B. Non-Hardening Penetration Sealant: Non-hardening polysulphide type. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
- C. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin.

Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 PCF (40 kg/m3).

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to raceways and piping systems installed at a required slope.
- F. Space Preference:
 - 1. Carefully verify and coordinate the location and level of all lines. Run preliminary levels and check with all other contractors so that conflict in locations may be avoided.
 - 2. If conflict occurs, the following preference schedule shall be followed:
 - a. Recessed electric fixture.
 - b. High pressure ductwork.
 - c. Sanitary drainage.
 - d. Steam condensate, hot and chilled water.
 - e. Low pressure ductwork.
 - f. Domestic water storm and vent lines.
 - g. Electric conduits.
 - 3. No other work shall have preference over plumbing lines below fixtures.
 - 4. No other work shall have preference over conduit above or below electric switchgear and above or below panels.
 - 5. No piping conveying fluids shall be provided directly over electrical or elevator equipment.
- G. Lines and Levels: Determine all grades, maintain necessary lines and levels

3.2 ACCESS DOORS

- A. Furnish adequately sized access doors for the devices served, with a minimum size of 18 inches x 18 inches, for installation under Division 09 "Finishes".
- B. Furnish access doors of the proper construction for type of ceiling or wall construction where installed.
- C. Verify the exact location, sizes, and types of all access doors with the Architect prior to purchase.

- D. Provide access doors for all concealed electrical equipment, except where above lay-in ceilings.
- E. Coordinate with architectural finishes to set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- F. Adjust hardware and panels after installation for proper operation.
- G. Label all access doors per Division 26 Section "Identification for Electrical Systems."

3.3 NAMEPLATES

- A. Refer to Division 26 Section "Identification for Electrical Systems" for requirements.
- B. Attach nameplates securely and permanently to the equipment, and in a manner acceptable to the equipment manufacturer.
- 3.4 SLEEVES AND SLEEVE SEALS
 - A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
 - B. Provide all sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for <u>all</u> electrical Work that passes through such construction. Coordinate with all other trades and Divisions to dimension and lay out <u>all</u> such openings.
 - C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other Divisions.
 - D. New Construction:
 - 1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support raceway penetrations.
 - E. Construction in Existing Facilities:
 - 1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.
 - F. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
 - G. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls. Do not cut or core drill new construction without written approval from the Architect and Structural Engineer.
 - H. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- I. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to or greater than, 16 inches, thickness shall be 0.138".
- J. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- K. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.
- L. Cut sleeves to length for mounting flush with both surfaces of walls.
- M. Extend sleeves installed in floors 2-inches above finished floor level.
- N. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require a different clearance; in which case, size sleeves as recommended by the seal manufacturer.
- O. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- P. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- Q. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with Division 07 Section "Penetration Firestopping."
- R. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boottype flashing units applied in coordination with roofing work.
- S. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (or larger, if required by the seal manufacturer) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- T. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the sleeve manufacturer) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.
- U. Above Grade Concrete or Masonry Penetrations
 - 1. Provide sleeves for cables or raceways passing through above grade concrete or masonry

walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

- a. Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
- b. Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.
- c. Install galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:
 - 1) For sleeve cross-section rectangle perimeter 50-inches and no side greater than 16 inches, thickness shall be 0.52 inches.
 - 2) For sleeve cross-section rectangular perimeter equal to, or greater than, 50 inches and one (1) or more sides equal to, or greater than, 16-inches, thickness shall be 0.138 inches.
- d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
- 2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with nonshrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2-inch of sealant.
- V. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between sleeve and cable or raceway. Provide mechanical sleeve seal.
 - 1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - 2. Inspect installed sleeve and sleeve-seal installation for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.
- W. Elevated Floor Penetrations of waterproof Membrane:
 - 1. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1" above finish floor. Size wall pipe for minimum 1/2-inch annular space between wall pipe and cable or raceway.
 - 2. Pack with mineral wool and seal both ends with minimum of 1/2-inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - 3. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 7 Section "Sheet Metal Flashing and Trim"
 - 4. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.
- X. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.
- Y. Concrete Slab on Grade Penetrations:
 - 1. Provide 1/2-inch thick cellular foam insulation around perimeter of raceway passing through concrete foundation. Installation shall extend to 2" above and below the concrete slab.
- Z. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or

raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2-inch of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

- AA. Exterior Wall Penetrations: Seal annular space between sleeve and raceway or duct, using joint sealant for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2-inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for material and installation.
- BB. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boottype flashing units applied in coordination with roofing work.

3.5 SLEEVE-SEAL INSTALLATION

- A. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- C. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Firestopping."

3.7 JOINT SEALERS

- A. Preparation For Joint Sealers
 - 1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.
 - 2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.
- B. Application Of Joint Sealers
 - 1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - b. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

- 2. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
- C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.8 ACOUSTICAL PENETRATIONS

- A. Do not allow direct contact of raceways with shaft walls, floor slabs and/or partitions. Sleeve, pack and seal airtight with foam rod, non-hardening sealant and/or packing material, as described herein, for all penetrations by raceway, through surfaces that encompass or are between noise critical spaces. Seal and pack with caulking for the full depth of the penetration all openings around raceways in the structure surrounding the electrical equipment and surrounding noise-critical spaces. This includes all slab penetrations and penetrations of noise critical walls.
- B. Where a raceway passes through a wall, ceiling or floor slab of a noise critical space, cast or grout a metal sleeve into the structure. The internal diameter or dimensions of the sleeve shall be 2 inches larger all of the raceways are installed in that area, check the clearances and correct, if necessary, to within 1/2-inch. Pack the voids full depth with packing material sealed at both ends, 1-inch deep, with non-hardening sealant backed by foam rod.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 05 10

SECTION 26 05 13 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Cables
 - 2. Splice Kits
 - 3. Solid Terminations
 - 4. Separable Insulated Connectors
 - 5. Arc-Proofing Materials
 - 6. Fault Indicators
- B. Related Requirements:
- 1. Section 26 00 10 "General Electrical Requirements" for general requirements and related documents that apply to this Section.
- 2. Section 26 05 33 "Raceway and Boxes for Electrical Systems" for raceways, fittings, boxes, enclosures and cabinets for electrical service.
- 3. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for underground raceways, handholes and manholes.
- 4. Section 26 05 33 "Identification for Electrical Systems" for circuit labels.
- 5. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

- A. NETA ATS: National Electrical Testing Association Acceptance Testing Specification.
- B. AHJ: Authority Having Jursdication.

1.4 ACTION SUBMITTALS

- A. General: Submit the following in accordance with division 01 and Division 26 Section "General Electrical Requirements.
- B. Product Data: Include rated nameplate data, capacities, weights and dimensions of each type of cable and accessories indicated.
 - 1. Cables
 - 2. Splice Kits
 - 3. Solid Terminations
 - 4. Separable Insulated Connectors
 - 5. Arc-Proofing Materials

- 6. Fault Indicators
- C. Samples:
 - 1. 16-inch lengths of each type of cable indicated.
- D. Qualification Data:
 - 1. For installer.
 - 2. For testing agency.
- E. Material Certificates: For each cable and accessory type, signed by manufacturers.
- F. Source quality-control test reports.
- G. Field quality-control test reports in accordance with NETA ATS.
 - 1. Shield continuity test for each power cable.
 - 2. Insulation resistance test for each power cable.
 - 3. Resistance measurements through all bolted connections.
 - 4. DC High-Potential test on all power cables.
- H. Follow-up service reports.
- I. Operation and Maintenance Data: For cable and all accessories to include in operation and maintenance manuals.
- 1.5 QUALITY ASSURANCE
 - A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable. Cable splicer shall have a minimum of 2000 hours experience with terminating and installing medium voltage cable. Furnish satisfactory proof of such experience for each employee who splices or terminates the cables. Persons listed by the Contractor may be required to perform a dummy or practice splice and termination in the presence of the Using Agency representative or Engineer before being approved as a qualified installer of medium-voltage cables.
 - B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicted, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 28 CFR 1910.7, and that is acceptable to AHJ.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
 - C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.
 - D. 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.
 - E. Comply with IEEE C2 and NFPA 70.

- F. Comply with ASTM B3 and B8.
- G. Comply with Using Agency Design Standards.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by the Using Agency or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Using Agency no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Using Agency's permission.
 - 3. Using Agency Lock-out/Tag-out procedures shall be used with Contractor controlled locks and tags.
 - 4. Comply with NFPA 70E.

1.7 QUALIFICATIONS

- A. Provide products listed and classified by Underwriters Laboratories, Inc. (UL) as suitable for the purpose specified and indicated.
- B. Material shall be manufactured by Companies specializing in the products specified in this section with minimum of 3 years documented experience.
- C. Medium voltage cables shall have a 20-year performance record in utility and industrial applications.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517). Acceptable manufacturers include:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cables:
 - a. General Cable Technologies Corporation.
 - b. Kerite Co. (The); Hubbell Incorporated.
 - c. Okonite Company (The).
 - 2. Cable Splicing and Terminating Products and Accessories:
 - a. Engineered Products Company.
 - b. G&W Electric Company.
 - c. MPHusky
 - d. Raychem Corp.; Telephone energy and Industrial division; Tyco International Ltd.
 - e. RTE Componenets; Cooper Power Systems, Inc.
 - f. Scott Fetzer Co. (The); Adalet.
 - g. Thomas & Betts Corporation.
 - h. Thomas & Betts Corporation/Elastimold.

i. 3M; Electrical Products Division.

2.2 CABLES

- A. Cable Type: Single conductor, type MV105.
- B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639/NEMA WC74, and ICEA S-97-682.
- C. Conductor: Annealed, soft drawn Copper.
- D. Conductor Stranding: Compact round, concentric lay, Class B.
- E. Strand Filling: Conductor interstices are filled with impermeable compound.
- F. Conductor Insulation: Ethylene-Propylene Rubber (EPR).
 - 1. Voltage Rating: 15 kV.
 - 2. Insulation Thickness: 133 percent insulation level.
- G. Strand Shielding: Black extruded semi-conducting thermoset copolymer applied directly over the conductor.
- H. Insulation Shield: Black extruded semiconducting thermoset copolymer applied directly over the insulation.
- I. Shielding: Provide either copper tape, 5 mils thick, helically applied with 25% overlap, over semiconducting insulation shield, or six solid copper corrugated drain wires embedded longitudinally in composite layers of semi conducting thermoset copolymer and CPE.
- J. Cable Jacket: Sunlight-resistant PVC or Chlorinated Polyethylene, CPE per ICEA and UL 1072.
- K. Identification: The following minimum legend shall be printed on the jacket and repeated at not more than two foot intervals.
 - 1. Manufacturer/plant no.
 - 2. Conductor size (AWG or kCMIL).
 - 3. CU.
 - 4. EPR.
 - 5. SHLD.
 - 6. Voltage (kV).
 - 7. Insulation level (133%).
 - 8. Insulation thickness (mils), MV-105.

2.3 SPLICE KITS

- A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.
- B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
 - 1. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer

heat-shrink jacket.

2. Pre-molded, cold-shrink-rubber, in-line splicing kit.

2.4 SOLID TERMINATIONS

- A. Multi-conductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.
 - 1. Compound-filled, cast-metal body, metal-clad cable terminator for metal-clad cable with external plastic jacket.
 - 2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
 - 3. Heat-shrink sheath seal kit with phase- and ground-conductor re-jacketing tubes, cable- end sealing boot, and sealing plugs for unused ground-wire openings in boot.
- B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
 - 1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
 - 2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer non-tracking tubes; multiple, molded, non-tracking skirt modules; and compression-type connector.
 - 3. Class 2 Terminations, Indoors: Kit with stress-relief tube, non-tracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
 - 4. Medium voltage cable terminations and splices: long barrel, 2-hole hydraulic crimp lugs.

2.5 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
- B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
- C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuouscurrent rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless- steel

mounting brackets, and attaching hardware.

- 1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
- 2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
- 3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
- 4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
- F. Tool Set: Shotgun hot stick with energized terminal indicator and carrying case.
- G. Ground Bails: Heavy-duty grounding bails shall be provided to accommodate portable grounding equipment.

2.6 ARC-PROOFING MATERIALS

- A. Tape for First Course on Metal Objects: Scotch 88, 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
- B. Arc-Proofing Tape: Scotch 77, fireproof tape, flexible, conformable, and intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.
- C. Self-fusing Silicon Tape: Scotch 70, high temperature, arc and track resistant tape composed of self-fusing, inorganic silicone rubber.
- D. Glass-Cloth Tape: Scotch 69, Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.
- 2.7 SOURCE QUALITY CONTROL
 - A. Test and inspect cables according to ICEA S-97-682 before shipping.
 - B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Minimum cable size shall be #1/0 awg.
- B. Install cables according to IEEE 576.
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values for single or multi-conductor cables.
 - 1. A strand dynamometer/tension meter shall be used during the cable installation, readings shall be recorded and a report submitted for each cable pull.
 - 2. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that

will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

- 4. Provide cable lengths with liberal allowances of slack for terminations.
- 5. Cable ends shall be moisture proofed at all times until terminations are installed.
- D. Install exposed cables in tunnels in suitable cable trays, cables shall be secured with UL listed tie wrap materials.
- E. Install underground cables in Sch. 40 PVC conduits in concrete encased ductbanks, comply with Section 26 05 43.
- F. In buildings and at road crossings, install cables in Rigid Galvanized Conduit (Heavy-wall).
- G. Provide an insulated, stranded copper ground conductor in each conduit with phase conductors.
- H. Medium voltage cables shall not be direct buried.
- I. Install permanent markers at ends of cable runs, changes in direction, and splices.
- J. Install "buried-cable" detectable, warning tape above ductbanks. Comply with Sections 26 05 43 and 26 05 53.
- K. Outdoor splices and terminations shall be performed in dry conditions only.
- L. In manholes, hand holes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables with suitable UL listed non-metallic racks, located at intervals adequate to prevent sag.
- M. Pull all cables in continuous lengths, splices shall be avoided unless necessitated by the length of the run. Locations of all splices shall be approved by the Facilities Engineering representative in writing.
- N. Install separable insulated-connector components as follows:
 - 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 - 2. Portable Feed-Through Accessory: Three.
 - 3. Standoff Insulator: Three.
- O. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, or termination materials such as transformers, switchgear, and manholes. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
 - 1. Clean cable sheath.
 - 2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
 - 3. Smooth surface contours with electrical insulation putty.
 - 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
 - 5. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) O.C.
- P. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore

original fire-resistance rating of assembly according to Division 07 Sections and Using Agency Fire Protection Group.

- 1. All penetrations shall be under constant visual surveillance until firestopping is applied unless an approved "ILSM" is in place for each location.
- 2. Products: Specified Technologies, Inc.
- Q. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- R. Identify cables according to Division 26 Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify individual phases at termination points.
 - 2. In manholes, cables shall be identified where cables enter and leave the manhole. Identify circuit number and voltage.
 - 3. Use embossed brass tags tie wrapped to cable.

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and terminations but before electrical circuitry has been connected to busses or switchgear and energized, test for compliance with requirements, including but not limited to DC high potential testing according to IEEE 400 and insulation resistance testing.
- B. Remove and replace non-compliant cable or terminations and retest as specified above.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 05 13

SECTION 26 05 19 - LOW-VOLTAGE POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Copper building wire rated 600 V or less.
 - 2. Metal-clad cable, Type MC, rated 2,000 V or less.
 - 3. Armored cable, Type AC, rated 600 V or less.
 - 4. Photovoltaic cable, Type PV, rated 2,000 V or less.
 - 5. Mineral-insulated cable, Type MI, rated 600 V or less.
 - 6. Tray cable, Type TC, rated 600 V or less.
 - 7. Connectors, splices, and terminations rated 600 V or less.
- B. Related Requirements:
 - 1. Section 26 00 10 Section "General Electrical Requirements" for general requirements and related documents that apply to this Section.
 - 2. Section 26 05 02 "Equipment Wiring Systems" for electrical connections to equipment specified under other Sections, Divisions, or furnished by the Using Agency.
 - 3. Section 26 05 05 "Selected Demolition for Electrical" for disconnection, removal and/or extension of existing electrical conductors and cables
 - 4. Section 26 05 10 "Common Work Results for Electrical" for sleeves and seals for electrical penetrations.
 - 5. Section 26 05 23 "Control-Voltage Electrical Power Cables" for control system communications cables and classes 1, 2, and 3 control cables.
 - 6. Section 26 05 26 "Grounding & Bonding for Electrical Systems" for conductors and connectors for grounding systems.
 - 7. Section 26 05 53 "Identification for Electrical Systems" for identification of products and requirements.
 - 8. Section 28 31 00 "Fire Alarm & Detection System" for fire alarm wiring.
 - 9. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

- A. PV: Photovoltaic.
- B. RoHS: Restriction of Hazardous Substances.
- C. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For each conductor and cable indicating lead content.
 - 2. Product Data: For recycled content, indicating postconsumer and pre-consumer recycled content and cost.
 - 3. Product Data: For solvents and adhesives, indicating VOC content.
 - 4. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.
- C. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.
- 1.6 QUALITY ASSURANCE
 - A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
 - B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and Test Instruments Calibration".
 - C. Testing Agency Qualifications: An independent testing agency, with experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to AHJ.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or Nation Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part-3.
 - D. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to AHJ.
 - 2. Marked for intended use.
 - E. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate electrical testing of electrical, mechanical and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- C. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 CONDUCTORS AND CABLES

- A. General:
 - 1. Manufacturers:
 - a. Advance wire and Cable
 - b. AFC Cable Systems, Inc.
 - c. Alan Wire.
 - d. ALFLEX Corporation, a Southwire Company.
 - e. American Wire Insulated Corp.; a Leviton Company.
 - f. Encore Wire Corporation.
 - g. General Cable Corporation (Flexible Cords).
 - h. Northern Cables, Inc.
 - i. Okonite Company.
 - j. Southwire Company.
 - 2. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC 70 and UL Standards 44 or 83, as applicable; solid conductor for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger and stranded for all flexible cords, cables and control wiring.
 - 3. Conductor Insulation Types:
 - a. Interior conductors: Type THHN/THHN-2 complying with ICEA S-95-658/NEMA W670 and UL83. Cables shall be rated 90 deg C in dry locations and 75 deg C in wet locations.
 - Exterior conductors: RHW-2/USE-2 complying with ICEA S-95-658/NEMA WC70, UL 854 (USE-2), UL 44 (RHW-2) and IEEE 383. Cables shall be 600 Volt, rated 90 deg C in both wet and dry locations. Cables shall be suitable for use in conduit.

c. Outdoor lighting Applications: For lighting applications, cable shall have stranded conductors, be rated for operation at 600 volts and minimum conductor size of #6 AWG.

4. Size of conductors and cables indicated or specified are American Wire Gage (Brown and

Sharpe).

- 5. Unless indicated otherwise, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.
- 6. Refer to Part 3 "Conductors Insulation and Multiconductor Cable and Wiring Methods Applications" Article for insulation type, cable construction and ratings.
- 7. Provide a neutral conductor for each circuit in a multi-circuit raceway per NEC 210.4.
- 8. Provide a green insulated grounding conductor with the phase conductors from the power source. Do not utilize the conduit as a grounding conductor.

2.3 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath for use as whips from last junction box to device or fixture. Maximum length to be 25'-0". Include green jacketed ground conductor.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Service Wire Co. or a comparable product by one of the following:
 - 1. Alpha Wire Company.
 - 2. American Bare Conductor.
 - 3. Belden Inc.
 - 4. Encore Wire Corporation.
 - 5. General Cable Technologies Corporation.
 - 6. Okonite Company (The).
 - 7. Southwire Company.
 - 8. WESCO.

C. Standards:

- 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- 2. Comply with UL 1569.
- 3. RoHS compliant.
- 4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Circuits:
 - 1. Single circuit and multicircuit with color-coded conductors.
 - 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- E. Ground Conductor: With green colored insulation unless otherwise noted.
- F. Conductor Insulation:
 - 1. Type TFN/THHN/THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.
- G. Jacket: PVC applied over armor where applicable in outdoors applications only.

2.4 ARMORED CABLE, TYPE AC

- A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath for use as whips from last junction box to device or fixture. Maximum length to be 25'-0". Include green jacketed ground conductor.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alpha Wire Company.
 - 2. American Bare Conductor.
 - 3. Belden Inc.
 - 4. Cerro Wire LLC.
 - 5. Encore Wire Corporation.
 - 6. General Cable Technologies Corporation.
 - 7. Southwire Company.
 - 8. WESCO.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Comply with UL 4.
 - 4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Circuits:
 - 1. Single circuit and multicircuit with color-coded conductors.
 - 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- F. Ground Conductor: With green colored insulation unless otherwise noted.
- G. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

2.5 PHOTOVOLTAIC CABLE, TYPE PV

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Service Wire Co. or a comparable product by one of the following:
 - 1. Encore Wire Corporation.

- 2. General Cable; General Cable Corporation.
- 3. Southwire Company.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation: Comply with UL 44 and UL 4703.
- 2.6 MINERAL-INSULATED CABLE, TYPE MI
 - A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.
 - B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. KME America, Inc.
 - 2. Pentair.
 - 3. Watlow Electric Manufacturing Company.
 - C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. UL 2196 for fire resistance.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
 - D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper.
 - E. Insulation: Compressed magnesium oxide.
 - F. Sheath: Copper.
- 2.7 TRAY CABLE, TYPE TC
 - A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket, rated 600 V.
 - B. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).

- C. Standards:
 - 1. Comply with UL 1277 or UL 1569, UL 1685, and NFPA 70 for Type TC-ER or Type MC cable.
 - 2. RoHS compliant.
 - 3. Comply with ICEA S-73-532/NEMA WC 57 for Type TC cables used for control, thermocouple extension, and instrumentation.
 - 4. Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.
 - 5. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Ground Conductor: Insulated unless otherwise noted.
- F. Conductor Insulation: Type XHHW-2. Comply with UL 44.
- G. Shield: Metallic unless otherwise noted.
- H. Shield:
 - 1. Type TC-ER or Type MC: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, double wrapped copper tape shields and three bare symmetrically applied ground wires or as directed by VFC manufacturer, and sunlight- and oil-resistant outer PVC, CPE, or Limited Smoke Zero Halogen jacket.

2.8 FLEXIBLE CORDS

- A. 600V, multi-conductor (2, 3 or 4 as indicated on the Drawings), oil-resistant black jacketed, extrahard-usage; Type SEO, SO or STO for indoor dry and damp locations, SEOW, SOW or STOW for damp, wet and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.
- B. 300V, multi-conductor (2, 3 or 4 as indicated on the Drawings), oil-resistant black jacketed, extrahard-usage; Type SJEO, SJO or SJTO for indoor dry and damp locations, SJEOW, SJOW or SJTOW for damp, wet and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

2.9 CONTROL WIRING

- A. Refer to Division 23 Section "Direct-Digital Control for HVAC".
- B. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.

2.10 VFD CABLE

A. Motor Feeder Cable:

Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

- 1. Comply with UL 1277, NEC Article 336, UL 1685, Class B Stranding per ASTM; XLPE Insulation XHHW-2 Rated Circuit Conductors; 90°C Wet/Dry; Class I & II; Division 2 Hazardous Locations and NFPA 70 for type TC-ER cable.
- 2. Type TC-ER with oversized cross-linked polyethylene insulation, overall dual spirally wrapped copper taped shields and three bare symmetrically applied ground wires providing 100% shielding, and armored VFD cable jacket with UL listed termination fittings.
- 3. Comply with UL requirements for cables in applicable applications.
- 4. Length of cable shall not exceed six (6) feet between VFD and motor.
- 5. All cables must be installed and terminated per manufacturer instructions.
- 6. Proper bending radius requirements shall be followed to avoid damage to the cable.
- 7. Connector and fittings used shall be of the same manufacturer as the motor feeder cable.

2.11 CONNECTORS

A. Manufacturers:

- 1. AMP; Tyco
- 2. FCI-Burndy
- 3. Gould
- 4. Ideal Industries, Inc.
- 5. Ilsco
- 6. NSi Industries, Inc.
- 7. O-Z Gedney
- 8. Panduit
- 9. Thomas & Betts
- 10. 3-M Electrical Products Division
- B. Compression connectors for conductors No. 8 AWG and larger; Long barreled, UL 486-listed, tinned or bare copper, compression type (Burndy "Hylug", or equal), insulated with clamp-on, cold shrink, or molded covers, or wrapped with multiple over-lapping layer of 3-M Scotch electrical tape.
 - 1. Termination fittings: 1-or 2-hole pad and inspection port.
- C. Mechanical connections for conductors No. 8 AWG and larger; UL listed, tinned or bare copper, dual rated, mechanical type, insulated with clamp-on, cold shrink, or molded covers, or wrapped with multiple over-lapping layer of 3-M Scotch electrical tape.
 - 1. Termination fittings: 1-or 2-hole pad and inspection port.
- D. Connectors for solid conductors No. 10 AWG and smaller: Insulated winged wire nuts, colorcoded for size, except use green only for grounding connections.
- E. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated- sleeve, compression type, UL-listed, with wire insulated grip. Terminations: flanged fork-tongue type.

2.12 MISCELLANEOUS PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

- 1. Minimum width: 3/16-inch (5 mm).
- 2. Tensile Strength: 50 lb (22kg), minimum.
- 3. Temperature Range: Minus 40 to plus 185 deg F (minus 40 to plus 85 deg C).
- 4. Color: Black, except where used for color-coding. Refer to Section 26 05 53 "Identification for Electrical Systems" for color-coding requirements.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 16 AWG and smaller; stranded for No. 14 AWG and larger.
- 3.2 CONDUCTOR INSULATION AND MULTI-CONDUCTOR CABLE APPLICATIONS AND WIRING METHODS
 - A. Service Entrance: Type XHHW-2, single conductors in raceway.
 - B. Exposed Feeders: Type THHN-2, THWN-2, single conductors in raceway.
 - C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-2, THWN-2, single conductors in raceway.
 - D. Feeders Concealed in Concrete, below Slabs-on-Grade, and underground: Underground feeder cable, type UF.
 - E. Feeders Installed below Raised Flooring: Type THHN-2, THWN-2, single conductors in raceway.
 - F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2, THWN-2, single conductors in raceway.
 - G. 120 Volt and Above Branch Circuits Concealed in Ceilings, Walls and Partitions: Type THHN-2, THWN-2, single conductors in metal conduit unless directed otherwise in documents to outlet box located within 10 feet of first wiring device, luminaire or utilization equipment indicated on documents served by branch circuit. Metal-clad cable, Type MC with a green color insulated grounding conductor may be used on load side of this outlet box above accessible ceilings in 25' maximum lengths if acceptable to User.
 - H. Feeder and Branch Circuits connected to Generator, Emergency or Essential Power Systems of Any Type: Type THHN-2, THWN-2, single conductors in raceway independent from all other wiring and equipment.
 - I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainlesssteel, wire-mesh, and strain relief device at terminations to suit application.
 - J. Recessed or Semi-recessed Lighting Fixture Whips: Type THHN-THWN (90 deg C), single conductors in FMC in lengths not to exceed six (6) feet.

K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- E. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems".
- F. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems" for secondary service, feeders and branch circuits.
- G. VFC Input, output, and control wiring shall each be routed in separate conduits.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
 1. Use oxide inhibitor in each splice and tap conductor.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6-inches (150 mm) of slack.

3.5 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install Sleeve and Sleeve Seal where raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies. Sleeve and Sleeve Seal materials and installation requirements are specified in Section 26 05 02 "Equipment Wiring Systems", 26 05 10 "Common Work Results for Electrical" and 26 05 44 "Sleeves and Seals for Electrical Raceways and Cabling".

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Sections and Using Agency's Fire Protection Group.

Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

- 1. All penetrations shall be under constant visual surveillance until firestopping is applied unless an approved "ILSM" is in place for each location.
- 2. Products: Specified Technologies, Inc.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [Engage] a qualified agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations connections.
- C. Perform the following tests and inspections:
 - After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.
 a. Generator and UPS.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Infrared Scanning: After substantial completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment cover so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after the date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.
- D. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Cables will be considered defective if they do not pass tests and inspections.
- F. Remove and replace non-compliant cables or wires and retest as specified above.
- G. Test Values
 - 1. Bolt-torque levels shall be in accordance with manufacturer's recommendations.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 <u>GENERAL</u>

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes grounding systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. This Section includes the following:
 - 1. Grounding Conductors
 - 2. Connector Products
 - 3. Grounding Electrodes
 - 4. Ground Bars
 - 5. Equipotential Grounding System
 - 6. Miscellaneous Grounding materials and Products.
- C. Related Requirements:
 - 1. Section 26 00 10 "General Electrical Requirements" for general requirements and related documents that apply to this Section.
 - 2. Section 26 05 19 "Low-voltage Electrical Power Conductors and Cables" for building wires, cables, connectors, splices, and terminations, rated 600V and less.
 - 3. Section 26 05 33 "Raceway and Boxes for Electrical Systems" for conduit, pull, junction, and outlet boxes, and electrical cabinets.
 - 4. Using Agency Standards for Electronic equipment, voice and data systems grounding requirements.
 - 5. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
 - 1. Product data for the following products:
 - a. Electrodes, mechanical and compression connectors, and exothermic connectors.
- B. Qualification Data: For a qualified testing and inspecting agency engaged by Contractor.
- C. Field Quality-Control Test reports: For a qualified testing and inspecting agency engaged by Contractor.
 - 1. Test procedures used.

- 2. Test results that comply with requirements.
- 3. Results of failed test and corrective action taken to achieve test results that comply with requirements.
- D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements".
 - 1. Accurately record actual locations of all exterior buried electrodes and all buried ground rings. Indicated dimensions from fixed structural elements.

1.4 **DEFINITIONS**

- A. The following apply to this and other Sections of these specifications:
 - 1. EMT; Electrical metallic tubing.
 - 2. FMC: Flexible metal conduit.
 - 3. IMC: Intermediate metal conduit.
 - 4. LFMC: Liquid-tight flexible metal conduit.
 - 5. RMC: Rigid metal conduit.
 - 6. GRS: Galvanized rigid steel conduit.
 - 7. RAC: Rigid aluminum conduit.
 - 8. RNC: Rigid nonmetallic conduit.
 - 9. PSF: Pounds per square foot.

1.5 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the product specified in this Section, for a minimum of 3 years.
- B. Testing Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration".
- C. Testing Agency Qualifications: An independent testing agency, with experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to AHJ.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or Nation Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part-3.
- D. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to AHJ.
 - 2. Marked for intended use.
- E. Comply with IEEE C2, medium-voltage underground construction.
- F. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

G. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the ranking or preference.

2.2 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:

- A. Manufacturers:
 - 1. Apache Grounding/Erico, Inc.
 - 2. Boggs, Inc.
 - 3. Chance/Hubbell.
 - 4. Copperweld Corp.
 - 5. Dossert Corp.
 - 6. Erico, Inc.; Electrical Products Group.
 - 7. FCI/Burndy Electrical.
 - 8. Galvan Industries, Inc.
 - 9. Harger Lightning Protection, Inc.
 - 10. Hastings Fiber Glass Products, Inc.
 - 11. Heary Brothers Lightning Protection Co.
 - 12. Ideal Industries, Inc.
 - 13. ILSCO.
 - 14. Kearny/Copper Power Systems.
 - 15. Korns: C.C. Korns CO.; Division of Robroy Industries.
 - 16. Lightning Master Corp.
 - 17. Lyncole XIT Grounding.
 - 18. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - 19. Panduit Corp.
 - 20. Raco, Inc.; Division of Hubbell.
 - 21. Robbins Lightning, Inc.
 - 22. Salisbury: W.H. Salisbury & Coo.
 - 23. Superior Grounding Systems, Inc.
 - 24. Thomas & Betts, Electrical.

2.3 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:

B. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).

2.4 GROUNDING CONDUCTORS

- A. For insulated conductors: comply with Division 26 Section "Common Work Results for Electrical".
- B. Material: Aluminum, copper-clad aluminum and copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Isolated Ground Conductors: Insulated with green-colored insulated with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
- F. Underground conductors: Tinned-copper conductor, No. 3/0 AWG minimum stranded, unless otherwise indicated.
- G. Bare Copper Conductors: Comply with the following:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Assembly of Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
- H. Copper Bonding Conductors: As follows:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 3. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 4. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- I. Aluminum Bonding Conductors: As follows:
 - 1. Bonding Cable: 10 strands of No. 14 AWG aluminum conductor, 1/4 inch (6 mm) in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded aluminum conductor.
 - 3. Bonding Jumper: Aluminum tape, braided conductors terminated with aluminum ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- J. Ground Conductor and Conductor for Wood Poles: As follows:
 - 1. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.

- K. Grounding Bus: UL Listed to UL467 & C22.2 respectively, 1/4 by 2 inches (6.3 by 50 mm) electrolytic, tough pitch copper bar, length as indicated on the drawings; insulators and standoffs as specified in Paragraph "Ground bars" below.
- L. Provide a green insulated grounding conductor with the phase conductors from the power source. Do not utilize the conduit as a grounding conductor.

2.5 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467, listed for use for specific types, sizes, and combinations of connectors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors.
 - 1. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:
 - a. Company symbol and/or logo.
 - b. Catalog number.
 - c. Conductors accommodated.
 - d. Installation die index number or die catalog number is required.
 - e. Underwriters Laboratories "Listing Mark".
 - f. The words "Suitable for Direct Burial", or where space is limited, "Direct Burial" or "Burial" per UL Standard ANSI/UL467 (latest revision).
 - 2. Cast Connectors: copper base alloy according to ASTM B 30 (latest revision).
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.6 GROUNDING ELECTRODES

- A. Ground Rods: UL listed:
 - 1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 13 mils.
 - 2. Size: 3/4-inch by 10 feet in diameter. Provide sectional types when longer rods are indicated.
- C. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a bare conductor sized, at a minimum, for the size of the connecting grounding electrode conductor.
- D. Ground Plates: UL-listed, rectangular, bare solid copper plate; minimum 0.032-inch thick.

2.7 GROUND BARS

- A. Rectangular Ground Bars: UL & cUL Listed to UL467 & C22.2 respectively, bare, 1/4-inch thick, 2-inch wide electrolytic, tough pitch copper bar, length as indicated on the Drawings.
- B. Supports: Maximum of 30-inches between bolts, 1-1/2-inch insulator and 1-inch offset mounting brackets. Maximum 24-inch AFF and supported 1-inch from the wall.

2.8 EQUIPOTENTIAL GROUNDING SYSTEM

- A. Operating and Delivery room ground modules: Post-Glover #RRP4-26 with 6 ground jacks, 2 twist-lock receptacles and ground bus in a single housing with stainless steel trim.
- B. Ground modules in locations, other than Operating and Delivery rooms: Post-Glover #GIP-3-06 with 6 ground jacks and a ground bus in a single housing with stainless steel trim.

2.9 MISCELLANEOUS

A. Test Wells:

- 1. Traffic Areas: Polymer concrete reinforced with heavy weave fiberglass; H-20 load rating, minimum 24-inches deep.
- 2. Non-traffic Areas: High density polyethylene: 350 PSF minimum load rating; minimum 10.25 inches deep.
- B. Ground Enhancing Backfill: Provide low-resistivity, ground-enhancing backfill material recommended by the electrode manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

- A. Examine areas and conditions under which electrical grounding connections are to be made and notify Architect/Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Provide all material, labor and equipment for an electrical grounding system in accordance with applicable portions of the NEC and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.
- C. Accomplished grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.

3.2 APPLICATIONS

- A. Comply with NFPA 70, Article 250, for type, sizes and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and branch circuits. Do not utilize conduit as equipment grounding conductor.
- C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.

- 2. Lighting circuits.
- 3. Receptacle circuits.
- 4. Single-phase motor and appliance branch circuits.
- 5. Three-phase motor and appliance branch circuits.
- 6. Flexible raceway runs.
- 7. Armored and metal-clad cable runs.
- 8. Feeders and branch circuits installed in non-metallic raceways.
- D. Separately Derived Systems: Bond the derived neutral (grounded) conductor of all separately derived system (e.g., transformers, generators, UPS) to the nearest available grounding electrode, or back to the service grounding electrode if no approved electrodes are readily available. Size the grounding electrode conductor and bonding jumpers as indicated on the drawings or as required by NFPA 70 Table 250-66, whichever is larger.
- E. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- F. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- G. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- H. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- I. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct- mounted electrical devices operating at 120 V 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.
- J. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install 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.
- K. Signal and Communications Systems: For telephone, alarm, voice and data and other communications systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ground bar. Size 1/4-by-2-by-12-inch or as indicated on the drawings.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

- L. Cable trays shall be grounded and bonded in accordance with N.E.C. requirements.
- M. Raised floors: Provide bonding of all raised floor components.
- N. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- O. Outdoor metallic fences around electrical equipment shall be grounded.
- P. Common Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in PVC conduit.

3.3 COUNTERPOISE

A. Ground the steel framework of the building with a buried electrode at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductors not less than No. 2/0 AWG for counterpoise and for tap to building steel. Bury counterpoise not less 18-inches below grade, or 6-inches below the official frost line, whichever is greater. And 24-inches from building foundations.

3.4 INSTALLATION

- A. Ground Rods: Install at least three grounds rods spaced at least one-rod length from each other and located at least the same distance from the other grounding electrodes.
 - 1. Drive rods until tops are 12 inches (100 mm) below finished floor or final grade unless otherwise indicated.
 - 2. Interconnect ground rods with grounding electrode conductors below grade and as otherwise indicated. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
 - 3. Verify that final backfill and compaction has been completed before driving rod electrodes.
- B. Bonding Straps and Jumpers: Install bonding so vibration is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations; unless a disconnect-type connection; then, use a bolted clamp. Bond straps directly to basic structure, taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- C. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

- D. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
- E. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- G. 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.
- H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- I. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank as part of duct-bank installation. Bury detectable warning tape approximately 6 inches above grounding conductors. Warning tape shall comply with Section 260553.
- J. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- K. Grounding Bus: Install in electrical rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
- L. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Exothermic welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Exothermic welded connectors.

3.5 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulting tape, heat-shrinkable insulting tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:
 - 1. Connecting conductors together.
 - 2. Connecting conductors to ground rods, except at attest wells.
 - 3. Connecting conductors to building steel.
 - 4. Connecting conductors to plates.
- C. Compression Fittings: Permanent compression-type fittings may be used for the following rather than exothermic connections:
 - 1. Connecting conductors together.
 - 2. Connecting conductors to building steel.
 - 3. Connecting conductors to ground rods, except at test wells.
- D. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:
 - 1. Connecting conductors to ground rods at test wells.
 - 2. Connecting conductors to pipes.
- E. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- F. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- G. Connections at Test Wells: Use compression-type connectors on conductors and make bolted-

and clamped-type connections between conductors and ground rods.

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

3.6 SYSTEM GROUNDING

- A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 6 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise encircling the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade, or 6 inches below the official frost line, whichever is greater, and 6 inches from the foundation.

3.7 FIELD QUALITY CONTROL

- A. Testing: Also see section 01 91 13 "General Commissioning Requirements" for commissioning requirements.
- B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
- C. Testing: Perform the following field quality-control testing:
 - 1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level

is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing nature ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.

- 3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- 4. Test Values:
 - a. The resistance between the main grounding electrode and earth ground shall be no greater than 10 ohms.
 - b. Equipment Rated 500 kVA and Less: 10 ohms.
 - c. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - d. Equipment Rated More than 1000 kVA: 3 ohms.
 - e. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - f. Manhole Grounds: 10 ohms.
- 5. Perform point-to-point megohimmeter tests to determine the resistance between the main ground system and all major electrical equipment frames, system neutral, and/or derived neutral points.
- 6. Minimum system neutral-to-ground insulation resistance: one megohm.
- 7. Investigate point-to-point resistance values that exceed 0.5 ohms.
 - a. Check for loose connections.
 - b. Check for absent or broken connections.
 - c. Check for poor quality welds.
 - d. Consider other reasons.
- 8. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.

3.8 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, non-shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2/0 for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 12 inches (300 mm) from the foundation.

3.9 UTILITY GROUNDING

A. Provide grounding and bonding at Utility Company's metering equipment in accordance with Utility Company's requirements.

3.10 LABELING

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.
- 3.11 GRADING AND PLANTING
 - A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 31 and 32. Maintain restored surfaces. Restore disturbed paving as indicated.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

- 4.1 GENERAL
 - A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 05 26

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SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Requirements:
 - 1. Section 26 00 10 "General Electrical Requirements" for general requirements and related documents that apply to this Section.
 - 2. Section 26 05 10 "Common Work Results for Electrical" for concrete pads and pad mounted service transformers.
 - 3. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 **DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 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 for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.

- 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. All products shall be UL labeled for their intended use.
- C. Comply with NFPA 70.
- D. Comply with Using Agency Design Standards.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories".

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517). Approved manufacturers include:
 - 1. Allied Tube & Conduit.
 - 2. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 3. Hilti Inc.
 - 4. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5. MKT Fastening, LLC.
 - 6. Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 7. Empire Tool and Manufacturing Co., Inc.
- B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

- 1. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- 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.
- 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
- 5. Channel Dimensions: Selected for applicable load criteria.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 - 1. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 2. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 - 3. Rated Strength: Selected to suit applicable load criteria.
- D. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- E. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- H. 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. Mechanical-Expansion Anchors: Insert-wedge-type, 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.
 - 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.

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 Division 05 Sections 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.
- B. 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 (6 mm) in diameter.
- C. 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 single-bolt conduit clamps or singlebolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. Fire pump feeders that are run exposed shall have conduit supported every five feet from a twohour rated structure with UL listed components.

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 (90 kg).
- 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 (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) 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.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Sections 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 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit and four inches high, and so anchors will be a minimum of 10 bolt diameters from edge of the base. Edges shall be chamfered.
- B. Use fiber reinforced 3000-psi(20.7-MPa) 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Concrete Sections.
- C. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
- D. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately

after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

- 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 Painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A-780.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

- 4.1 GENERAL
 - A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Requirements:
 - 1. Section 26 00 10 "General Electrical Requirements" general requirements and related documents that apply to this Section.
 - 2. Section 26 05 10 "Common Work Results for Electrical" for limited scope general construction materials and methods.
 - 3. Section 26 05 02 "Equipment Wiring Systems" for electrical connections to equipment specified under other Sections, Divisions, or furnished by Owner.
 - 4. Section 26 05 26 "Grounding & Bonding for Electrical Systems" for conductors and connectors for grounding systems.
 - 5. Section 26 05 29 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.
 - 6. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
 - 7. Section 26 05 53 "Identification for Electrical Systems" for identification of products and requirements.
 - 8. Section 26 27 26 "Wiring Devices" for devices installed in boxes, power poles, and multioutlet assemblies.
 - 9. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.
- D. EMT: Electrical metallic tubing.
- E. ENT: Electrical nonmetallic tubing.
- F. EDPM: Ethylene-propylene-diene terpolymer rubber.

- H. LFMC: Liquidtight flexible metal conduit.
- I. LFNC: Liquidtight flexible nonmetallic conduit.
- J. NBR: Acrylonitrile-butadiene rubber.
- K. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical requirements".
 - 1. Product data for the following products:
 - a. Surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
 - 2. Shop Drawings for:
 - a. Detailed fabrication and installation of custom enclosures.
- B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical requirements".
 - 1. Accurately record actual routing of all exterior buried raceways and all interior raceways 3inches and larger. Indicate dimensions from fixed structured elements.
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- D. Qualification Data: For professional engineer.
- E. Source quality-control reports.

1.5 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in the Section, for a minimum of 3 years.
- B. Electrical components, Devices and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100 by an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to AHJ.
 - 2. Mark for intended use.
- C. Comply with NFPA 70.

D. Comply with Using Agency Design Standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517). Acceptable manufacturers include:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit.
 - 3. Anamet Electrical, Inc.
 - 4. Electri-Flex Company.
 - 5. O-Z/Gedney.
 - 6. Picoma Industries.
 - 7. Republic Conduit.
 - 8. Robroy Industries.
 - 9. Southwire Company.
 - 10. Thomas & Betts Corporation.
 - 11. Western Tube and Conduit Corporation.
 - 12. Wheatland Tube Company.

2.2 METAL CONDUITS, TUBING, AND FITTINGS

- B. Manufacturers: Subject to compliance with requirements, products of all manufacturers are acceptable provided they have a smooth interior, are UL listed and labeled as defined in NFPA 70 for the intended location and application and are electro-galvanized steel (EMT) or hot dipped galvanized steel inside and out (GRC). Conduit and fittings shall be obtained from the same manufacturer:
- C. 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.
- D. GRC: Comply with ANSI C80.1 and UL 6.
- E. ARC: Comply with ANSI C80.5 and UL 6A.
- F. IMC: Comply with ANSI C80.6 and UL 1242.
- G. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating thickness: 0.040-inch, minimum.
- H. EMT: Comply with ANSI C80.3 and UL 797.
- I. FMC: Comply with UL 1; zinc-coated steel or aluminum.
- J. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

- K. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Compression insulated throat.
 - 3. FMC shall be steel/malleable iron insulated throat.
 - 4. 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.
 - 5. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040-inch with overlapping sleeves protecting threaded joints.
- L. Joint Compound for IMC, GRC, or ARC: 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.

2.3 NON-METALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, products of all manufacturers are acceptable provided they are sunlight resistant and UL listed and labeled as defined in NFPA 70 and marked for intended location and application. Conduit and fittings shall be obtained from the same manufacturer:
- B. 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.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-40-PVC under sod, schedule 80 under pavement or concrete, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. LFNC: Comply with UL 1660.
- F. Rigid HDPE: Comply with UL 651A.
- G. Continuous HDPE: Comply with UL 651B.
- H. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
- I. RTRC: Comply with UL 1684A and NEMA TC 14.
- J. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- K. Fittings for LFNC: Comply with UL 514B.
- L. 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).

M. Solvent cements and adhesive primers shall comply with the testing and product requirements of the 'Illinois Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250 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.
- C. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways shall be UL listed and labeled as defined in NFPA 70 and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect. Provide dividers as required to separate systems of different voltages. Sizes as noted on the drawings.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Wiremold/Legrand.
 - b. Mono-Systems, Inc.
 - c. Panduit Corp.
 - 2. Types, sizes and channels as indicated and required for each application, with fittings that match and mate with raceways.
 - a. Single Channel for Power Locations: One-piece latching raceway with matching device boxes, fittings and all components necessary for a complete raceway system. Utilize either 17/32-inch x 3/4-inch or 21/32-inch x 3/4-inch raceways to meet fill requirements.
 - b. Single Channel for Data and Power/Telecommunication Locations: Two-piece latching raceway with matching device boxes, fittings and all components necessary for a complete raceway system. Utilize 3/4-inch x 19/32-inch raceway to meet fill requirements.
 - c. Dual Channel, for Power or Data Outlet Locations: Two-piece construction, manufactured of steel. Raceway and device brackets shall be provided mounting standard devices in-line with raceway. Devices shall be low profile mounting. Provide all components necessary for a complete raceway system. Utilize 1-17/32-inch x 2-3/4-inch raceway to meet fill requirements.
 - d. Dual Channel, for Power and Data Outlet Locations: Two-piece construction, manufactured of steel. Raceway and device brackets shall be provided mounting standard devices in-line with raceway. Devices shall be low profile mounting. Provide all components necessary for a complete raceway system. Utilize 1-3/4-inch x 4-3/4-inch raceway to meet fill requirements.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics. Provide dividers as required to separate systems of different voltages. Sizes as noted on the drawings.

2.6 TELEPHONE/POWER SERVICE POLES

- A. Listing and Labeling: Poles shall be UL listed and labeled as defined in NFPA 70 and marked for intended location and application.
 - 1. Poles: Height adequate to extend from floor to a least 6-inches above ceiling, and separate channels for power and signaling wiring.
 - 2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports, and pole foot with carpet pad attachment.
 - 3. Finishes: One of manufacturers standard finish and trim combinations, including painted and satin anodized-aluminum finishes.
 - 4. Wiring: Sized for 14 No. #12 AWG power and ground conductors, 3IUTP Category 5 rated data cables.
 - 5. Power Receptacles: Two-single; 20-A; heavy duty; NEMA WD 6, Configuration 5-20R units.
- B. 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.

2.7 TRENCH DUCT

- A. Trench-type, under floor raceways used for routing of power, data, and signal cables.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D; Schneider Electric.
 - 2. Thomas & Betts Corporation; Steel City Division.
 - 3. Raceway Solutions, Inc.
 - 4. Walker Systems, Inc.; a Wiremold /Legrand Company.
- C. Trench: Include the following features:
 - 1. UL listed.
 - 2. Galvanized steel, 14-gauge factory welded.
 - 3. Non-Ferrous Metal Raceways for use in MRI scan rooms or similar: Aluminum.
 - 4. Slab Depth Adjustment: Minimum of minus 1/8 inch to plus 5/8 inch before and during concrete placement.
 - 5. Cover Supports: Height adjustable, with leveling screws to rigidly support cover assembly.
 - 6. Screed Strip: Extruded aluminum along both edges at proper elevation without requiring shim material.
 - 7. Trim Strip: Select to accommodate floor finish material.

- 8. Partitions: Arranged to separate channels and isolate wiring of different systems.
- 9. Grommeted openings in service raceways.
- 10. Manufacturer's standard corrosion-resistant finish, applied after fabrication.
- D. Cover Plates: Removable, steel plates, 1/4 inch thick, with full gasket attached to side units. Fabricate covers with appropriate depth recess to receive indicated floor finish.
- E. Dimensions: coordinate with Medical Equipment Supplier's approved site installation drawings.

2.8 POKE THRU ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
 - 3. Thomas & Betts Corporation.
 - 4. Wiremold Company (The).
- B. Poke-Thru Assemblies:
 - 1. Factory-fabricated and -wired assembly of below-floor junction box with multi- channeled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
 - 2. Poke-thru box fittings shall maintain a minimum two-hour fire rating.
 - 3. Comply with UL 514 scrub water exclusion requirements.
 - 4. Service Outlet Assembly: Flush type with services indicated.
 - 5. Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
- 2.9 BOXES, ENCLOSURES, AND CABINETS
 - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Adalet.
 - 2. Cooper Technologies Company; Cooper Crouse-Hinds.
 - 3. EGS/Appleton Electric.
 - 4. FSR Inc.
 - 5. Hoffman; a Pentair company.
 - 6. Hubbell Incorporated; Killark Division.
 - 7. Kraloy.
 - 8. Milbank Manufacturing Co.
 - 9. Mono-Systems, Inc.
 - 10. O-Z/Gedney; a brand of EGS Electrical Group.
 - 11. RACO; a Hubbell Company.
 - 12. Spring City Electrical Manufacturing Company.
 - 13. Stahlin Non-Metallic Enclosures.
 - 14. Thomas & Betts Corporation.
 - 15. Wiremold / Legrand.
 - B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets

installed in wet locations shall be listed for use in wet locations.

- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Nonmetallic Floor Boxes: Nonadjustable.
 - 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. Luminaires Outlet Boxes: Nonadjustable, designed for attachment of luminaires 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. Paddle Fan Outlet Boxes: Non-adjustable, designed for attachment of paddle fan weight 70lb.
 - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. Small Sheet Metal Pull and Junction Boxes 100 cu. in. and smaller: NEMA OS 1.
- J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, with gasketed cover.
- K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- L. Device Box Dimensions: 4-inches square by 2-1/8 inches deep.

2.10 FLOOR BOXES

- A. General:
 - 1. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified in the tables below. Manufacturers and model numbers listed are used only to represent the characteristics required and are not intended to restrict the use of other Manufacturers listed above and models that meet the specified criteria.
 - Floor boxes used for power: Include a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle unless noted or scheduled otherwise on the Drawings. Wiring device color: Refer to Division 26 Section "Wiring Devices", or as indicated on the Drawings.
 - 3. Floor boxes utilized for telephone, data, or both: Include provisions for mounting telephone/data outlets in accordance with the requirements of the telephone/data systems provider.
 - 4. UL514A listed for scrub water exclusion for all floor types.

- A. Floor Boxes, Slab on Grade, Multi-service, Extra Large Capacity: Provide extra large capacity multi-service cast iron recessed floor box, fully adjustable and device brackets for power, data, and A/V devices. First choice: Hubbell 2 gang CFB metal concrete 2FB2G25 series floor box and accessories. Second choice: FSR #FL-600P-SLP-6 with pour pan FL-GRD4 or equal.
- B. Floor Boxes, Slab on Grade, Multi-service, Extra Large Capacity: Provide cast iron recessed floor box, fully adjustable with tunnels and device brackets for power and data devices.
- C. Floor Boxes, concrete toppings greater than 2.5-inches non slab on grade applications: Provide multi-service shallow stamped steel recessed floor box, fully adjustable with tunnels and device brackets for power and data devices.
- D. Floor Boxes, concrete toppings less than 2.5-inches: Provide multi-service poke-through assembly with four 20 amp receptacle and four (4) data activations. Provide with slide covers for dead front protection. Flipup lids are not allowed.
- E. Floor Boxes, concrete toppings less than 2.5-inches, furniture feed: Provide multi-service poke-through assembly with one (1) 3/4-inch trade size screw plug opening and one (1) concentric two (2) 1.25-inch trade size screw plug opening. Provide with slide covers for dead front protection. Flip-up lids are not allowed.

2.11 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: Molded of a dry mix of gravel, sand and bounded with polyester resin, and reinforced with fiberglass cloth.
 - 1. Standard: Comply with ANSI/SCTE 77, Telecordia GR-902, ASTM C 857, WUC Guide 3.6.
 - 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, "ELECTRIC" or other custom logo and lettering.
 - 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 7. Handholes 11-inches Wide by 18-inches Long (279 mm Wide by 457 mm Long) up to 48-inches Wide by 48-inches Long (1219 mm Wide by 1219 mm Long).
- C. Polymer-Composite Handholes and Boxes: Molded of polymer composite material, with covers of polymer composite.
 - 1. Standard: Comply with ANSI/SCTE 77.
 - 2. Color of Box and Cover: Gray.
 - 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load

rating consistent with enclosure and handhole location.

- 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- 6. Cover Legend: Molded lettering, "ELECTRIC" or other custom logo and lettering.
- 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- 8. Handholes 10-inches Wide by 15-inches Long (254 mm Wide by 381 mm Long) up to 17-inches Wide by 30-inches Long (431 mm Wide by 762 mm Long).
- D. HDPE Plastic Handholes and Boxes: Molded HDPE material, with covers of HDPE plastic.
 - 1. Standard: Comply with ANSI/SCTE 77, Telecordia GR-902, ASTM C 857, WUC Guide 3.6.
 - 2. Color of Box and Cover:
 - a. Box: Black.
 - b. Cover: Green.
 - 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 6. Cover Legend: Molded lettering, "ELECTRIC" or other custom logo and lettering.
 - 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 8. Handholes 10-inches Wide by 15-inches Long (254 mm Wide by 381 mm Long) up to 36inches Wide by 60-inches Long (931 mm Wide by 1524 mm Long).
- E. Composite Handholes and Boxes: Molded of Composite and Sheet Molding Compound material, with covers of Composite and Sheet Moulding Compound material.
 - 1. Standard: Comply with ANSI/SCTE 77.
 - 2. Color of Box and Cover:
 - a. Box: Gray.
 - b. Cover: Gray.
 - 4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 - 5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - 6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 7. Cover Legend: Molded lettering, "ELECTRIC" or other custom logo and lettering.
 - 8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 9. Handholes 10-inches Wide by 15-inches Long (254 mm Wide by 381 mm Long) up to 36inches Wide by 60-inches Long (931 mm Wide by 1524 mm Long).
- F. Plastic Handholes and Boxes: Molded of HDPE material, with covers of Polymer Concrete or Steel.
 - 1. Standard: Comply with ANSI/SCTE 77.
 - 1. Color of Box and Cover:
 - a. Box: Gray.
 - 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

- 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- 5. Cover Legend: Molded lettering, "ELECTRIC" or other custom logo and lettering.
- 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- Handholes 10-inches Wide by 15-inches Long (254 mm Wide by 381 mm Long) up to 36inches Wide by 60-inches Long (931 mm Wide by 1524 mm Long).
- G. Concrete Handholes and Boxes: Molded or Concrete material, with covers of Concrete.
 - 1. Standard: Comply with ASTM C 857.
 - 2. Color of Box and Cover:
 - a. Box: Gray.
 - b. Cover: Gray.
 - 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 6. Cover Legend: Molded lettering, "ELECTRIC" or other custom logo and lettering.
 - 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - Handholes 10-inches Wide by 15-inches Long (254 mm Wide by 381 mm Long) up to 36inches Wide by 60-inches Long (931 mm Wide by 1524 mm Long).

2.13 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handholes and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with ANSI/SCTE 77. Strength test shall be for specified tier ratings of product supplied.
 - 1. Test materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have a current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC where subject to abuse, otherwise RNC, Type EPC-40-PVC.
 - 2. Concealed Conduit, Aboveground: RNC, Type EPC-40-PVC.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC under sod or sidewalk, schedule 80 PVC under pavement.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): Indoors: LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250 Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:

- 1. Exposed, Not Subject to Physical Damage: EMT.
- 2. Exposed, Not Subject to Severe Physical Damage: EMT.
- 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
 - e. Electrical Rooms.
- 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
- 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
- 6. All feeders under 600 V: GRC.
- 7. All feeders over 600 V: GRC.
- 8. Damp or Wet Locations: GRC.
- 9. Tunnels: GRC.
- 10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Mixing different types of conduits indiscriminately in the same system is prohibited.
- E. 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. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer. PVC is only to be provided in outdoors, buried or above roof locations to avoid off-gassing.
 - 3. EMT: Use compression with insulated throat, steel fittings. Comply with NEMA FB 2.10.
 - 4. Flexible Conduit: Use only steel fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- F. Install nonferrous conduit or tubing for circuits operating above 60Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- G. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- H. Do not install any conduit below floor slab unless shown or as directed by the Architect/Engineer. Install surface raceways only where indicated on Drawings.
- I. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:

- 1. Concealed interior locations above ceilings and in hollow steel studded partitions.
- 2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
- 3. Direct contact with concrete except slab on grade.
- 4. Recessed in stud wall of kitchens and laundries.
- B. Cast boxes shall be used in:
 - 1. Exterior locations, in general all areas of this project are considered "exterior".
 - 2. Exposed interior locations within 8' of the highest platform level.
 - 3. Hazardous locations.
 - 4. Direct contact with earth.
 - 5. Direct contact with concrete in slab on grade.
 - 6. Wet locations.
 - 7. Kitchens and laundries when exposed on wall surface.

3.3 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 (150 mm) away from parallel runs of flues and steam or hotwater pipes. Install horizontal raceway runs above water and steam piping.
- C. Installation of all new conduits must be minimum 12 inches from ceiling grid except where approved by Using Agency.
- D. Complete raceway installation before starting conductor installation.
- E. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- F. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- G. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.
- H. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- I. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- J. Raceways Embedded in Slabs (only where noted on the drawings):
 - 1. Run conduit larger than 1-inch (27-mm) trade size, 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 maximum10-foot (3-m) intervals.

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- 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- 3. Arrange raceways to keep a minimum of 1-inch of concrete cover in all directions.
- 4. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location. Fittings shall be concrete tight.
- 5. Change from ENT to GRC before rising above floor.
- K. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- L. 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.
- M. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- N. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- P. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- R. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- T. 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.
 - 3. Provide caulk between surface raceway and wall. Color as selected by Architect/Engineer.
- U. Trench Duct:

- 1. Coordinate with Equipment Supplier's approved site installation drawings.
- 2. Obtain approval of equipment supplier's field representative prior to purchase and installation of all materials.
- 3. Provide necessary accessories to accommodate medical equipment cabling.
- V. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- W. 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.
- X. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- Y. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 - 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 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) 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 deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal 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.
- Z. 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.
- 3. Use a maximum of 72 inches of FMC for recessed and semi-recessed luminaires.
- 4. Final connections to motors or equipment subject to vibration, noise transmission, or movement shall use FMC not exceeding four feet in length.
- 5. Short lengths of FMC shall be used for final primary and secondary connections to Low Voltage transformers (<600V).
- AA. 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 bottom of box unless otherwise indicated.
- BB. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- CC. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation in non-firerated walls. Provide minimum 24-inch horizontal separation in acoustic-rated walls.
- DD. Boxes shall be secured between two studs. Boxes connected to one stud are not permitted.
- EE. Locate boxes so that cover or plate will not span different building finishes.
- FF. 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.
- GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- HH. Set cast and metal floor boxes level and flush with finished floor surface.
- II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.4 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6-inches in nominal diameter.
 - 2. Install backfill as specified in Section 312000 "Earth Moving".
 - 3. After installing conduit, backfill and compact. Start 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 the process. Firmly hand tamp and backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12-inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving".

- 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
- 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete for a minimum of 12-inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60-inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
- 6. Warning Planks: Bury warning planks approximately 12-inches above direct-buried conduits but a minimum of 6-inches below grade. Align planks along centerline of conduit.
- 7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems".

3.5 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1-inch above finished grade.
- D. Install handholes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Sections and Using Agency Fire Protection Group.

- 1. All penetrations shall be under constant visual surveillance until firestopping is applied unless an approved "ILSM" is in place for each location.
- 2. Products: Specified Technologies, Inc.

3.8 IDENTIFICATION

- A. Junction boxes of different systems shall be identified by colors indicated below. Box and cover shall be painted prior to attaching identification labels.
- B. Provide permanent nameplates for all pull and junction boxes identifying circuits, voltage, and source.
- C. Raceways and couplers of different systems shall be identified by color. Raceways up to 2" shall have factory applied finish.
 - 1. Raceways larger than 2" shall be identified by permanent snap-on color bands installed within six inches of any pull or junction box, enclosure, fitting, and every thirty feet of run.
- D. Colors: System:
 - 1. Red: Fire Alarm.
 - 2. Yellow: Critical Emergency Branch.
 - 3. Purple: Life Safety Emergency Branch.
 - 4. Orange: Equipment Emergency Branch.
 - 5. Green: Normal power.
 - 6. Blue: Communications.
 - 7. Black: Low Voltage.

3.9 **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 coatings or paint finishes with matching touchup coating recommended by manufacturer.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 05 33

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SECTION 26 05 36 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.2 SUMMARY

- A. Section Includes:
 - 1. Ladder cable trays.
 - 2. Wire mesh cable trays.
 - 3. Single-rail cable trays.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 2. Vertical and horizontal offsets and transitions.
 - 3. Clearances for access above and to side of cable trays.
 - 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2. Component Importance Factor: 1.0.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAYS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Description:
 - 1. Configuration: Two side rails with transverse rungs welded to side rails.
 - 2. Rung Spacing: 9 inches.
 - 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: 4 inches.
 - 8. Straight Section Lengths: 12 feet except where other lengths are required to facilitate tray assembly.
 - 9. Width: 9 inches unless otherwise indicated on Drawings.
 - 10. Fitting Minimum Radius: 12 inches.

- 11. Class Designation: Comply with NEMA VE 1.
- 12. Splicing Assemblies: Bolted type using serrated flange locknuts.

2.4 WIRE-MESH CABLE TRAYS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Legrand/Cablofil; Wire Mesh Cable Trays or comparable product by one of the following:
 - 1. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 2. Chalfant Manufacturing Company.
 - 3. Cooper B-Line, Inc.

B. Description:

- 1. Configuration: Wires are formed into a standard 2-by-4-inch wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
- 2. Materials: High-strength-steel longitudinal wires with "T" weld.
- 3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
- 4. Sizes:
 - a. Straight sections shall be furnished in standard 118-inch lengths.
 - b. Wire-Basket Depth: 2-inch usable loading depth by 8 inches wide unless otherwise directed.
 - c. Wire-Basket Depth: 4-inch usable loading depth by 8 inches wide unless otherwise directed.
- 5. Connector Assemblies: Listed Snap in couplers or factory assembled bolted couplers that mechanically join adjacent tray wires to splice sections together or to create horizontal fittings.

2.6 CABLE TRAY ACCESSORIES

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

2.7 WARNING SIGNS

- A. Lettering: 1-1/2-inch high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."
- 2.8 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

- 3.1 CABLE TRAY INSTALLATION
 - A. Install cable trays according to NEMA FG 1.
 - 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. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
 - D. Remove burrs and sharp edges from cable trays.
 - E. Join aluminum cable tray with splice plates; use rib-neck carriage bolts and locknuts.
 - F. Fasten cable tray supports to building structure.
 - G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems.
 - H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
 - I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
 - J. Support bus assembly to prevent twisting from eccentric loading.
 - K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
 - L. Locate and install supports according to NEMA FG 1. Do not install more than one cable tray splice between supports.
 - M. 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.
 - N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.
 - O. Make changes in direction and elevation using manufacturer's recommended fittings.

- P. Make cable tray connections using manufacturer's recommended fittings.
- Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- S. Install cable trays with enough workspace to permit access for installing cables.
- T. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- U. Install permanent covers, on vertical tray runs as required by NFPA 70, after installing cable. Install cover clamps according to NEMA VE 2.
- V. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- W. 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 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. Cable trays with powder-coat paint should have coating mask completely removed at factory supplied grounding location and splice with listed connectors as recommended by manufacturer. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

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. Install cable ties with a tool that includes an automatic pressure-limiting device.
- 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. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

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 the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 - 7. Check for improperly sized or installed bonding jumpers.
 - 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 - 9. 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.
- B. Prepare test and inspection reports.

3.6 **PROTECTION**

- A. Protect installed cable trays and cables.
 - 1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

- 2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
- 3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 26 05 36

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SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Raceways, fittings, boxes, handholes, manholes, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
- B. Related Requirements:
 - 1. Section 26 00 10 "General Electrical Requirements" for general requirements and related documents that apply to this Section.
 - 2. Section 26 05 10 "Common Work Results for Electrical" for limited scope general construction materials and methods.
 - 3. Section 26 05 26 "Grounding and Bonding for Electrical Systems".
 - 4. Section 26 05 53 "Identification for Electrical Systems".
 - 5. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITION

- A. Terminology used in this specification is as defined below:
 - 1. GRS: Galvanized Rigid Steel Conduit
 - 2. RMC: Rigid Metal Conduit
 - 3. RNC: Rigid Nonmetallic Conduit

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, handholes, boxes, and other utility structures.
 - 4. Warning tape.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Shop drawings shall be sealed by a Professional Engineer. Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.

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- 2. Reinforcement details.
- 3. Frame and cover design and manhole frame support rings.
- 4. Ladder details.
- 5. Grounding details.
- 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
- 7. Joint details.
- C. Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- 1.5 INFORMATIONAL SUBMITTALS
 - A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
 - C. Qualification Data: For professional engineer.
 - D. Source quality-control test reports.
 - E. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Material shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Electrical Components, Devices and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to AHJ.
 - 2. Marked for intended use.
- C. Comply with NFPA 70 and ANSI C2.
- D. Test and inspect pre-cast concrete utility structures according to ASTM C 1037.
- E. Non-concrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be specified tier ratings of products supplied.
- 1. Test of materials shall be performed by an independent testing agency.
- 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
- 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store pre-cast and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings, if present, are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Using Agency or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Using Agency no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Using Agency's written permission.
 - 3. Using Agency Lock-out/Tag-out procedures shall be used with Contractor controlled locks and tags.
 - 4. Comply with NFPA 70E.

1.9 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the Using Agency.

PART 2 - PRODUCTS AND MATERIALS

2.1 All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).

2.2 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517). Acceptable manufacturers include:
 - a. AFC Cable Systems, Inc.
 - b. Alflex Corporation, a Southwire Company.
 - c. Anamet Electrical, Inc.; Anconda Metal Hose.
 - d. Electri-Flex Co. Indalex.
 - e. Manhattan/CDT/Cole-Flex.
 - f. O-Z/Gedney; Unit of General Signal (Fittings).
 - g. Republic Raceway.
 - h. Tyco International; Allied Tube & Conduit Division.
 - i. Wheatland Tube Co.

2.3 RACEWAYS AND FITTINGS

- A. Metal Conduit and Tubing:
 - 2. Rigid Metallic Conduit:
 - a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6.
 - 3. Plastic-Coated GRS and Fittings: NEMA RN 1, NRTL listed. Coating thickness of 0.40-inches (1 mm), minimum.
 - 4. Fittings: NEMA FB 1; compatible with raceway and tubing materials.
- B. Rigid Non-metallic Conduit:
 - 1. RNC: Schdule 40 (type EPC-40-PVC, NEMA TC 2, UL 651).
 - a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6 and UL 651. As applicable.
- C. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line warning tape specified in Division 26 Section 26 05 53 "Identification for Electrical Systems."

2.4 PRE-CAST CONCRETE HANDHOLES AND BOXES

A. Comply with ASTM C858 for design and manufacturing process.

- 1. Acceptable manufacturers include:
 - a. Garder Concrete Products.
 - b. Christy Concrete Products.
 - c. Elmhurst-Chicago Stone Co.
 - d. Oldcastle Pre-cast Group.
 - e. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - f. Utility Concrete Products, LLC.
 - g. Utility Vault Co.
 - h. Wausau Tile, Inc.
 - i. Quazite, Hubbell Power Systems.
 - j. Armorcast Products Company.
 - k. Carson Industries, LLC.
 - I. CDR Systems Corporation.
 - m. Newbasis.
 - n. Strongwell.
- B. Pre-cast concrete handholes and boxes shall be factory-fabricated, reinforced concrete monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have a load rating consistent with that of the handhole or box.
 - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 2. The cover finish shall be minimum coefficient of friction of 0.50.
 - 3. The cover shall have the following legend lettering molded into the cover:
 - a. "CATV"
 - b. "COMMUNICATIONS"
 - c. "CONTROLS"
 - d. "ELECTRIC"
 - e. "FIBER OPTICS"
 - f. "LIGHTING"
 - 4. Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 - 5. Extensions and slabs shall be designed to mate with bottom of enclosure and shall be same material as enclosure.
 - a. Extension shall provide increased depth of 12-inches.
 - b. Lab shall be same dimension as bottom of enclosure, and arranged to provide closure.
 - 6. Windows shall be included as pre-cast openings in walls arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12-inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 - 7. Duct entrances into handhole walls shall have cast and bell or duct terminating fittings in the wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.

- b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cables.
- 8. Handholes 12-inches wide by 24-inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 HANDHOLES AND BOXES OTHER THAN PRE-CAST CONCRETE

- A. General:
 - 1. Description: Comply with SCTE 77.
 - 2. Color of Frame and Cover: Gray where installed in concrete or other paved areas. Green where installed in grass areas.
 - 3. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 - 4. Load Ratings:
 - a. Boxes and covers installed in sidewalks and other areas not subject to normal vehicular traffic shall be rated for a design load of 8,000 lbs. minimum.
 - b. Boxes and covers installed in driveways, parking lots and other off-roadway applications shall be rated for a design load of 15,000 lbs. minimum.
 - c. Boxes and covers installed in roadways and other high vehicular traffic areas shall be rated for a design load of 28,800 lbs. minimum.
 - 5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - 6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 7. Cover Legend: Molded lettering, applicable logo from the following:
 - a. "CATV"
 - b. "COMMUNICATIONS"
 - c. "CONTROLS"
 - d. "ELECTRIC"
 - e. "FIBER OPTICS"
 - f. "LIGHTING"
 - 8. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 - 9. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 10. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- C. Fiberglass Handholes and Boxes with Polymer-Concrete frame and cover: Sheet-Molded fiberglass reinforced polyester resin enclosure joined to polymer concrete top ring or frame.

D. Fiberglass Handholes and Boxes: Molded fiberglass reinforced polyester resin with covers of polymer concrete.

E. High-Density Plastic Boxes: Injection molded of high-density polyethylene of copolymer-

polypropylene. Cover shall be polymer concrete.

2.6 PRE-CAST MANHOLES

- A. Pre-cast concrete manholes shall be furnished in sizes indicated on the drawings and as specified herein. Pre-cast manholes shall be constructed of reinforced concrete, complete with all appurtenances and accessories required.
- B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.
 - 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 - 2. Duct Entrances in Manhole Walls: Cast end-bell or duct terminating fitting in wall for each entering duct.
- C. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.
- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.7 CAST-IN-PLACE MANHOLES

- A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panel for concrete entrance and sleeve for ground rod.
- B. Materials: Comply with ASTM C858 and with Division 03 Section "Cast-In-Place Concrete".

2.8 MANHOLE ACCESSORIES

- A. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches (737 mm).
 - 1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 2. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
- B. Cover Legend Cast in. Selected to suit system.

- 1. "CATV"
- 2. "COMMUNICATIONS"
- 3. "CONTROLS"
- 4. "ELECTRIC"
- 5. "FIBER OPTICS"
- 6. "LIGHTING"
- C. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - 1. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
- D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
 - 1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000- lb (58-kN) minimum tension.
- F. Pulling Eyes in Non-Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 1-1/4-inch diameter eye rated 2500-lbf minimum tension.
- G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
- H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.
- I. Expansion anchors for installation after Concrete is cast: Zinc-plated, carbon steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- J. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglassreinforced polymer.
 - 1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.
 - 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in

lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.

- K. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- L. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.
- M. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N). Two required.
- 2.9 SOURCE QUALITY CONTROL
 - A. Test and inspect precast concrete utility structures according to ASTM C 1037.
 - B. Non-concrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Minimum conduit/duct size for underground installations shall be one inch.
- B. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-40 PVC, minimum 5-inch, in concrete-encased duct bank, unless otherwise indicated.
- C. Ducts for Service Entrance Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40 PVC, minimum 5-inch, in concrete- encased duct bank, unless otherwise indicated.
- D. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40 PVC, in direct-buried duct bank, unless otherwise indicated.
- E. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40 PVC, in direct-buried duct bank, unless otherwise indicated.
- F. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 PVC, in concrete-encased duct bank, unless otherwise indicated.

- G. Underground Ducts Crossing Paved Paths, Walks, Driveways and Roadways: RNC, NEMA Type EPC-40 PVC, encased in reinforced concrete.
- H. A nylon pull cord shall be installed and tied off in each duct, including spares. The nylon pull cord shall have a minimum tensile strength of 200 pounds.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20; Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10, Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced Polyester, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
- B. Manholes: Precast concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with earth moving sections in Division 31 Specifications, but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top-soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with plantings Sections in Division 32 Specifications.
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to appropriate Division 01 Sections.

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

- 1. Water intrusion into buildings through ducts is not acceptable.
- 2. This Contractor shall be fully responsible for corrective action necessary to insure water infiltration is eliminated.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius per local power utility, both horizontally and vertically, at other locations, unless otherwise indicated.
 - 1. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- C. Duct Entrances to Manholes and Polymer Concrete Handholds: Use end bells spaced approximately 10 inches (250 mm) O.C. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- D. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- E. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- F. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.
- G. Concrete-Encased Ducts: Support ducts on duct separators.
 - Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 2. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Concrete Sections.
 - 3. Concreting Sequence: Place each run of concrete envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the concrete placement. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one concrete placement is necessary, terminate each in a vertical plane

and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

- 4. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Red dye shall be added to the top of the concrete during the placement.
- 5. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth, road crossings and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
- 6. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be placed without soil inclusions; otherwise, use forms.
- 7. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 12 inches (300 mm) between power and signal ducts.
- 8. Depth: Depth: Install top of duct bank at 36 inches (900 mm) below finished grade, unless otherwise indicated.
- 9. Stub-Ups: Use manufactured PVC elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated for circuit conductors smaller than No. 1/0 AWG and under 600 volts. Extend concrete encasement throughout the length of the elbow.
- 10. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor for all circuit conductors over 600 volts and circuits under 600 volts with conductor size No. 1/0 AWG or larger.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
- 11. Warning Tape: Comply with Section 26 05 53. Bury detectable warning tape approximately 18 inches (450 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.
- H. Direct-Buried Duct Banks:
 - 1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - 2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
 - 3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in earth moving sections in Division 31 Specifications for pipes less than 6 inches (150 mm) in nominal diameter.
 - 4. Install backfill as specified in earth moving sections in Division 31 Specifications.

- 5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in earth moving sections in Division 31 Specifications.
- 6. Install ducts with a minimum of 3 inches (75 mm) between ducts.
- 7. Depth: Install top of duct bank at 36 inches (900 mm) below finished grade, unless otherwise indicated.
- 8. Set elevation of bottom of duct bank below the frost line.
- 9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
- 10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
- 11. Warning Tapes: Comply with Section 26 05 53. Bury detectable warning tape approximately 18 inches (450 mm) above all duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Cast-in-place Concrete Manhole Installation:
 - 1. Finish interior surfaces with a smooth-troweled finish.
 - 2. Windows for future duct connections: form and pour concrete knockout panels 1-1/2 to 2-inches thick, arrange as indicated.
 - 3. Cast-in-place concrete, formwork and reinforcement are specified in Division 03 Section "Cast-IN-Place Concrete".
- B. Precast Concrete Handhole and Manhole Installation:
 - 1. Comply with ASTM C 891, unless otherwise indicated.
 - 2. Install unit level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevations:
 - 1. Manhole Roof: Install with rooftop at least 18 inches (450 mm) below finished grade.

- 2. Manhole Frame: In paved areas and traffic-ways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
- 3. Install hand holes with bottom below the frost line.
- 4. Handhole Covers: In paved areas and traffic-ways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- 5. Where indicated, cast handhole cover frame integrally with handhole structure.
- D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 - 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days. Joint between manhole and chimney shall be sealed with a flexible epoxy or EPDM rubber seal.
- G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms as required for installation and support of cables and conductors and as indicated.
- H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and traffic-ways, set so cover surface will be flush with finished

grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

- D. Install handholes and boxes with bottom below the frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and concrete and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Concrete Sections with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- 3.8 INSTALLATION ACCEPTANCE
 - A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-ofround duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
 - B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 05 43

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceways and metal-clad cable.
 - 2. Identification for conductors, communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.
- B. Related Requirements:
 - 1. Section 26 00 10 "General Electrical Requirements" for general requirements and related documents that apply to this Section.
 - 2. Section 26 05 73 "Overcurrent Protective Device Coordination" for additional labeling requirements related to this Section.
 - 3. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 SUBMITTALS

- A. Product Data: Submit the following in accordance with division 01 and Division 26 Section "General Electrical Requirements" for each electrical identification product indicated:
 - 1. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
 - 2. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions and graphic features of identification products.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100 by an NRTL as defined by OSHA in 29 CFR 1910.7 and that are acceptable to authorizes having jurisdiction.
 - 2. Marked for intended use.
- B. Comply with ANSI A13.1 and IEEE C2.

C. Comply with International Building Code (IBC). CDB 040-010-115 Page 1 New Nursing Home and Domiciliary 26 05 53 Quincy Veterans' Home, Adams County

- D. Comply with NFPA 70 (NEC).
- E. Comply with 29 CFR 1910.145.
- F. Comply with ANSI Z535.4 for safety signs and labels.
- G. Comply with Using Agency Design Standards.
- H. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS AND MATERIALS

2.1 All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).

2.2 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at more than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-(75-mm-) high letters.
- C. Colors for Raceways Carrying Circuits at 600 V or Less and conduits larger than two inches:
 - 1. Power Circuits: Black letters on orange field.
 - 2. Emergency Circuits: White letters on a red field.
 - 3. Communications: White letters on a blue field.
 - 4. Controls: Blue letters on a white field.
 - 5. Legend: Indicate system or service and voltage, if applicable.

- D. 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.
- E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less and conduits larger than two inches: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Colors for Raceways Carrying Circuits at 600 V or Less and conduits two inches and less: A. Factory applied color finish, comply with Section 260533.

2.3 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tapes not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- D. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.6 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.7 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 4. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - 5. Overall Thickness: 5 mils (0.125 mm).
 - 6. Foil Core Thickness: 0.35 mils (0.00889 mm).
 - 7. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
 - 3-Inch (75-mm) Tensile According to ASTM D 882: 70lbf (311.3 N), and 4600 psi (31.7 MPa).
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.8 WIRING DEVICES

- A. Self-adhesive Labels: Label machine printed clear with black letters, pressure-sensitive adhesive labels, configured for display on top of device cover, unless otherwise indicated. Provide a single line of text with 1/4-inch-high letters on 1/2-inch-high label; where two lines of text are required, use labels 1 inches high or two, stacked labels.
- 2.9 WARNING LABELS AND SIGNS
 - A. Comply with NFPA 70 and 29 CFR 1910.145. Attachment method shall be acceptable to the

manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.

- B. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches (180 by 250 mm).
- C. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches (250 by 360 mm).
- D. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER ELECTRICAL SHOCK HAZARD EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - Workspace Clearance Warning: "WARNING OSHA REGULATION AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
 - 3. Workspace Clearance Warning: "WARNING OSHA REGULATION AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES (1220 MM)."
- E. Arc-Flash Warning Labels: Arc-Flash warning labels per NEC 110.16 and NFPA 70E furnished as part of Section 26 05 73 "Overcurrent Protective Device Coordination Study".
- F. Available Fault Current Labels: Arc-Flash warning labels per NEC 110.24 furnished as part of Section 26 05 73 "Overcurrent Protective Device Coordination Study".

2.10 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. 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 (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- 2.11 EQUIPMENT IDENTIFICATION NAMEPLATES

- A. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Nameplate: Adhesive backed with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm). Refer to Drawings for Nameplate Details.
- C. Stenciled Legend: In non-fading, waterproof, red ink or paint. Minimum letter height shall be 1-inch (25mm).

2.12 CABLE TIES

- A. General-Purpose Cables-Ties: Fungus insert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16-inch.
 - 2. Tensile Strength at 73 dig F, According to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one-piece, self-locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16-inch.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black except where used for color-coding.
- C. Plenum-Rated Cable Ties: self-extinguishing, UV stabilized, one-piece, self-locking.
 - 1. Minimum Width: 3/16-inch.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 7,000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Color: Black.

2.13 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Paint: Paint materials and application requirements are specified as follows:
 - 1. Interior Ferrous Metal:
 - Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior ferrous-metal primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
 - 2. Interior Zinc-Coated Metal:
 - Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior zinc-coated metal primer.

- 2) Finish Coats: Interior semi-gloss acrylic enamel.
- C. 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.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways Larger than Two Inches: Each colorcoding band shall completely encircle conduit. Locate bands at changes in direction, at penetrations of walls and floors, at 30-foot maximum intervals in straight runs, and within six inches of pull or junction boxes.
- F. System Identification Labels for Raceways carrying circuits above 600V: Locate labels at changes in direction, at penetrations of walls and floors, at 30-foot maximum intervals in straight runs, and within six inches of pull or junction boxes.
- G. System Identification Labels for Raceways carrying circuits 600V and less: Locate labels at changes in direction, at penetrations of walls and floors, at 30-foot maximum intervals in straight runs, and within six inches of pull or junction boxes.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 18 inches overall. Comply with Section 260543.
- I. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend, system voltage, and panel/circuit number. System legends shall comply with Section 260533.
 - 1. Normal power.
 - 2. Critical branch power.
 - 3. Life safety power.

- 4. Equipment branch power.
- 5. UPS.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - a. Color shall be factory applied.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
 - e. For new work in existing buildings, the existing identification method shall be used for new conductors provided it meets all requirements of this Section and the NEC.
- C. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.
- D. Emergency Sources: A sign shall be placed at the service entrance equipment indicating the type and location of on-site emergency power sources per NEC Art. 700.
- E. Disconnects/Motor Starters: Provide "Fed From" signs indicating the location of the supply side OCPD for each power source.
- F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- G. 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.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- I. 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.

- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Bakedenamel warning signs or Metal-backed, butyrate warning signs.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 - c. Other equipment as indicated on the Drawings.
- 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 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer and load shedding.
- M. Receptacle Identification Labels: On each power receptacle, install unique designation label that states the panel and circuit breaker source. Clean device cover prior to installing label.
- N. Equipment Identification Nameplates: On each unit of equipment, install unique designation nameplate that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply nameplates to Switchgears, Switchboards, Distribution Panels, Panelboards, Motor Control Centers, Transformers, Individual Starters, Contactors, Disconnect Switches, Transfer Switches, Control Panels and Similar Equipment. Systems include power, lighting, and control systems unless equipment is provided with its own identification.
 - 1. Colors for equipment nameplates:
 - a. NORMAL power system: white letters on black background.
 - b. CRITICAL EMERGENCY power system: white letters on red background.
 - c. LIFE SAFETY power system: white letters on red background.
 - d. EQUIPMENT EMERGENCY power system: white letters on red background.
 - e. STANDBY EMERGENCY power system: (dead bus under normal conditions) black letters on yellow background.
 - f. FIRE ALARM system: white letters on red background.
 - g. SECURITY system: white letters on green background.
 - h. INTERCOM, PUBLIC ADDRESS, NURSE CALL systems: black letters on orange background.
 - i. CLOCK system: black letters on light blue background.
 - j. CATV system: black letters on yellow background.
 - k. COMMUNICATION (VOICE/DATA) systems: white letters on blue background.
 - 2. Labeling Instructions:
 - a. Identify the piece of equipment, the source, voltage characteristics, and the load

served.

- b. Indoor Equipment: Engraved, laminated acrylic or melamine nameplate. Unless otherwise indicated on the drawings, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
- c. Outdoor Equipment: Engraved, laminated acrylic or melamine nameplate. Unless otherwise indicated on the drawings, provide a single line of text with one-inch- (26-mm-) high letters on 3-inch- (76-mm-) high label; where two lines of text are required, use labels 4 inches (100 mm) high.
- d. Elevated Components: Increase sizes of nameplates and letters to those appropriate for viewing from the floor.
- e. Fasten nameplates with appropriate stainless steel screws that do not change the NEMA or NRTL rating of the enclosure. Stick-on or adhesives are not acceptable unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.
- 3. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Transformers.
 - e. Emergency system boxes and enclosures.
 - f. Disconnect switches.
 - g. Enclosed circuit breakers.
 - h. Motor starters.
 - i. Push-button stations
 - j. Power transfer equipment.
 - k. Contactors.
 - 1. Battery inverter units.
 - m. Voice and data cable terminal cabinet.
 - n. Master clock and program equipment.
 - o. Intercommunication and call system master and staff stations.
 - p. Television/audio components, racks and controls.
 - q. Fire-alarm control panel and annunciators.
 - r. Security and intrusion-detection control stations, control panels, terminal cabinets and racks.
 - s. Monitoring and control equipment.
 - t. Uninterruptible power supply equipment.
 - u. Terminals, racks and patch panels for voice and data communications and for signal and control functions.
 - v. Remote lighting equipment, power supplies, transformers, and drivers.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

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SECTION 26 05 72 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.2 SUMMARY

A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
 - 1. Short-circuit study input data, including completed computer program input data sheets.
 - 2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
 - b. Revised single-line diagram, reflecting field investigation results and results of shortcircuit study.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Short-Circuit Study Specialist.
- B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Short-Circuit Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Comply with IEEE 399 and IEEE 551.
- C. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-currentcharacteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary.

- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Comments and recommendations for system improvements, where needed.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.
- G. Short-Circuit Study Output:
 - 1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 - 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 - 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.

- c. Fault-point X/R ratio.
- d. No AC Decrement (NACD) ratio.
- e. Equivalent impedance.
- f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
- g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Obtain all data necessary for the conduct of the study.
 - 1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
 - 2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance at the service.
 - 3. Power sources and ties.
 - 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - 5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 - 6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 - 7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 - 8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 - 9. Motor horsepower and NEMA MG 1 code letter designation.
 - 10. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Incoming switchgear.
 - 3. Unit substation primary and secondary terminals.
 - 4. Low-voltage switchgear.
 - 5. Motor-control centers.
 - 6. Control panels.
 - 7. Standby generators and automatic transfer switches.
 - 8. Branch circuit panelboards.
 - 9. Disconnect switches.

3.3 ADJUSTING

A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 DEMONSTRATION

A. Train Owner's operating and maintenance personnel in the use of study results.

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SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes computer-based, fault-current studies, overcurrent protective device coordination studies, and arc-flash analysis. Protective devices shall be set based on results of the protective device coordination study.
 - 1. The AIC ratings indicated on the drawings are preliminary and will be finalized based on the results of the fault current study. Device ratings for furnished equipment shall be as required by the results of the fault current study at no additional cost. Use of Series rated equipment is strictly prohibited
- B. Related Requirements:
 - 1. Section 26 00 10 "General Electrical Requirements" for general requirements and related documents that apply to this Section.
 - 2. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Coordination-Study Report.
 - 3. Equipment evaluation report.
 - 4. Arc-Flash Hazard Analysis.
 - 5. Setting report.
- E. Record Drawings: Submit record drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Accurately record on the One-Line Diagram actual ratings and settings for all overcurrent devices, both adjustable and non-adjustable, including all changes made during construction, due to the study, or both.

F. Electronic files, in an SKM-compatible format, of the time-current characteristic curves for every different overcurrent device used in the reports.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.
- E. Comply with IEEE 1584 and NFPA 70E for arc-flash hazards calculations.

PART 2 - PRODUCTS AND MATERIALS

- 2.1 All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- 2.2 COMPUTER SOFTWARE DEVELOPERS

2.3 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-currentcharacteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Zero-Sequence current.
 - 2. Arcing faults.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
- B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.
- C. Fault current study and coordination study to be performed prior to the final submittals for any piece of electrical equipment which has an AIC rating or an over-current protective device so that correct equipment gets ordered for the project conditions.
- D. Arc Flash Study must be performed after conductors and equipment have been installed and after the project's utility company confirms the available fault current. A final coordination study with all device settings shall be submitted with an Arc Flash Study. The goal of the revised settings is to minimize the arc flash while maintaining reasonable coordination and selectivity. For emergency system components, full selectivity must be maintained.

3.2 SYSTEM COMPONENTS TO BE INCLUDED IN STUDIES

- A. Study shall begin with the utility overcurrent device(s) serving the Project and end at the last branch circuit overcurrent protective device.
- B. Components include, but are not limited to:
 - 1. Switchgear
 - 2. Switchboards
 - 3. Distribution Panelboards
 - 4. Panelboards

3.3 POWER SYSTEM DATA FOR STUDIES

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.

- f. Busway ampacity and impedance.
- g. Motor horsepower and code letter designation according to NEMA MG 1.
- 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes RMS symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes RMS symmetrical.

3.4 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes RMS symmetrical at circuitbreaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Utility's supply termination point.
 - 2. Incoming Medium-voltage switchgear.
 - 3. Medium-voltage controllers.
 - 4. Unit substation primary and secondary terminals.
 - 5. Low voltage switchgear and switchboards.
 - 6. Motor-control centers.
 - 7. Distribution panelboards.
 - 8. Branch circuit panelboard.
 - 9. Generators and automatic transfer switches.
- B. Study electrical distribution system from normal and alternate power sources through electrical distribution system. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
 - 1. Transformers:

- a. ANSI C57.12.10.
- b. ANSI C57.12.22.
- c. ANSI C57.12.40.
- d. IEEE C57.12.00.
- e. IEEE C57.96.
- 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
- 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
- 4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

- 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
 - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.5 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) shortcircuits currents.
 - 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 242 recommendations for fault currents and time intervals.
- C. Comply with NEC Article 700 requirements for selective coordination of overcurrent protective devices in the supply side of emergency system.
- D. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
- 2. Device settings shall protect transformers according to IEEE C57.12.00 for fault currents.
- E. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- F. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- G. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for medium and low voltage fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
 - h. Medium voltage equipment relays.
- H. Completed data sheets for setting of overcurrent protective devices.

3.6 ARC FLASH HAZARD ANALYSIS

- A. Determine arc-flash incident energy levels and flash protection boundary distances based on the results of the Short-Circuit and Coordination studies. Perform the analysis under worst-case arc-flash conditions for all modes of operation.
- B. Identify all locations and equipment to be included in the arc-flash hazard analysis:
 - 1. Include a copy of the facility one-line in the report.
 - 2. Identify the possible system operating modes including tie-breaker positions, and parallel generation.
 - 3. Calculate the arcing fault current flowing through each branch for each fault location.
 - 4. Determine the time required to clear the arcing fault current using the protective device settings and associated trip curves.

Section 26 05 73 - Overcurrent Protective Device Coordination Study

- 5. Select the working distances based on system voltage and equipment class.
- 6. Calculate the incident energy at each fault location at the prescribed working distance.
- 7. Determine the hazard/risk category (HRC) for the estimated incident energy.
- 8. Calculate the flash protection boundary at each fault location.
- 9. Document the assessment in reports and one-line diagrams.
- 10. Provide labels to be placed on each piece of equipment analyzed. Label shall show the calculated incident energy and hazard/risk category for the calculated incident energy.
- C. Results of the arc-flash study shall be summarized in a final report containing the following:
 - 1. Basis, method of hazard assessment, description, purpose, scope, and date of the study.
 - 2. Tabulations of the data used to model the system components and a corresponding one-line diagram.
 - 3. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate equipment ratings.
 - 4. Tabulations of equipment incident energies, hazard risk categories, and flash protection boundaries. The tabulation shall identify and clearly note equipment that exceeds allowable incident energy ratings.
 - 5. Required arc-flash labeling and placement of labels.
 - 6. Conclusions and recommendations.

3.7 COORDINATION OF WORK

A. The Division 26 Contractor shall be responsible to ensure proper AIC ratings for protection of electrical equipment. Adjustment of protective device equipment to meet the approved coordination study submittal shall be the responsibility of the Division 26 Contractor at no additional cost to the Using Agency.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

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SECTION 26 05 74 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

- A. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. SCCR: Short-circuit current rating.
- D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Arc-Flash Study Specialist.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

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1.6 CLOSEOUT SUBMITTALS

- A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
- B. Operation and Maintenance Procedures: In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Comply with IEEE 1584 and NFPA 70E.
- B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- 2.2 ARC-FLASH STUDY REPORT CONTENT
 - A. Executive summary.
 - B. Study descriptions, purpose, basis and scope.
 - C. One-line diagram, showing the following:

- 1. Protective device designations and ampere ratings.
- 2. Cable size and lengths.
- 3. Transformer kilovolt ampere (kVA) and voltage ratings.
- 4. Motor and generator designations and kVA ratings.
- 5. Switchgear, switchboard, motor-control center and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Fault Current Study" Article in Section 26 05 73 "Overcurrent Protective Device Coordination Study."
- F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 26 05 73 "Overcurrent Protective Device Coordination Study."
- G. Arc-Flash Study Output:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc-flash boundary.
 - 5. Working distance.
 - 6. Incident energy.
 - 7. Hazard risk category.
 - 8. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

- 1. Location designation.
- 2. Nominal voltage.
- 3. Flash protection boundary.
- 4. Hazard risk category.
- 5. Incident energy.
- 6. Working distance.
- 7. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies:
 - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
 - 2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."
- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
 - 2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.
- F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take

into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

- 1. Fault contribution from induction motors should not be considered beyond three to five cycles.
- 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of Architect.
 - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

3.4 LABELING

- A. Apply one arc-flash label for 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:
 - 1. Motor-control center.
 - 2. Low-voltage switchboard.
 - 3. Switchgear.
 - 4. Control panel.

3.5 APPLICATION OF WARNING LABELS

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.
- 3.6 DEMONSTRATION
 - A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 26 05 74

SECTION 26 09 13 - ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.2 SUMMARY

- A. This Section includes the following:
 - Metering, communications, and visualization requirements for a modular, scalable Webbased Electrical Power Monitoring and Control System. The goal of this system is to provide the user the ability to monitor and manage their power system with the user only requiring a browser to access the system. This system shall allow the user to directly connect to the web enabled equipment and to software-based system designed to aggregate data from multiple devices and provide a system level view of both real time information and advanced power and system analytics.
 - a. The EPMCS shall comply with new construction installations utilizing web-based components to function independently or to co-exist with other Eaton Cutler-Hammer INCOM or Power-Net system components or other Modbus RTU communicating devices in a heterogeneous environment
 - b. Section includes the following for monitoring and control of electrical power system:
 - 1) Software, remote devices for metering, monitoring, control and protection, a network time server, all Ethernet communications gateways, interface modules, a server class computer, software, intercommunication wiring, ancillary equipment, startup and training services, and ongoing technical support
- B. Related Requirements:
 - 1. Those Sections specifying power distribution components that are monitored or controlled by power monitoring and control equipment.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
- B. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.

2. Block Diagram: Show interconnections between components specified in this Section and
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devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

- 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and manufacturer.
- B. Field quality-control reports.
- C. Other Informational Submittals:
 - 1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition, the following:
 - 1. Operating and applications software documentation.
 - 2. Software licenses.
 - 3. Software service agreement.
 - 4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware.
 - 5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard copy submittal.
- B. Software and Firmware Operational Documentation:
 - 1. Self-study guide describing the process for setting equipment's network address; setting options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
 - 2. Software operating and upgrade manuals.
 - 3. Software Backup: On compact discs or portable memory sticks.
 - 4. Device address list and the set point of each device and operator option, as set in applications software.
 - 5. Graphic file and printout of graphic screens and related icons, with legend.
- C. Software Upgrade Kit: For Using Agency use in modifying software to suit future power system revisions or power monitoring and control revisions.
- D. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful inservice performance.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with Using Agency Design Standards.

1.7 COORDINATION

- A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of specified functions.
- B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).

2.2 FUNCTIONAL DESCRIPTION

- A. The EPMCS shall provide a web browser-based monitoring and management system for all communicating devices in the power system.
- B. The EPMCS shall communicate to all devices over an industry standard Ethernet communication backbone. For devices that cannot communicate directly on Ethernet, a gateway shall be

provided.

- C. The EPCMS shall identify power system anomalies and measure, display, and record trends and alarms.
- D. The EPCMS shall provide a database for recording of equipment ratings and characteristics with capability for graphic display on monitors.
- E. The EPCMS shall report equipment status and power system control.
 - a. Display circuit-breaker and switch status and allow circuit-breaker control.

2.3 APPLICATIONS SOFTWARE

- A. The software system shall provide a real time, web-based visualization system to allow the user to easily view the key operational characteristics of the system. These features of the system shall not require any custom screen development to provide the following functions:
 - 1. The software shall provide the ability to view the current value of all operational variables available from a device. The user shall be able to organize and view this attributes in easy to understand groupings.
 - 2. The software shall not require specific knowledge of a device to be able to display information from that device. Instead, the software shall have the ability to query the device for its operational capabilities and automatically set up web-based pages to display the information:
 - a. The software shall support the ability to automatically establish a connection to any device added to a gateway without the user doing any configuration in the software.
 - 3. The software shall automatically build a navigation tree of all connected devices so the user can easily find a device and display the data for that device.
 - 4. The software shall provide the ability trend one or more variables (volts, amps, kW, kWh, etc.) from one or more devices on a web-based trend graph.
 - 5. The software shall support displaying of the waveform data collected by the power monitoring devices that can capture waveforms. The waveform display shall be fully accessible via the web browser.
 - 6. The software shall provide time stamped sequential order of events for trips, analog alarms, motor start profiles, and operator actions based on the information received from the actual devices. The software shall support ordering the events based on timestamps up to 1ms in accuracy.
 - 7. The software shall have the ability to manage alarm and event conditions detected by the devices. Alarm management shall include:
 - a. Ability to acknowledge and close alarms via the web interface.
 - b. Ability to color code alarms and events based on severity and state.
 - c. Ability to separate Alarms and Events on separate tabs of the display to reduce information clutter.
 - d. Ability to sort and analyze alarms by time, device and other key characteristics.
 - e. Ability to install a small "system tray" applet to provide notification that an alarm has been raised even if the browser session is not active.
 - f. Ability to send an email, page or text message for selected sets or alarm conditions.
- B. The software shall provide a web-based editing environment that allows the user to extend the

software visualization capabilities by developing custom animated graphic pages. Examples of typical pages include one-line diagrams, elevation views and plan layouts.

- C. The software system shall be easy to operate and manage. It shall also be scalable such that the system can be expanded without requiring the user to reconfigure a new system.
- D. The software system shall be scalable such that the system can be expanded without requiring the user to reconfigure a new system.
 - 1. The software shall allow users to be granted privileges based on their user ID and password, to perform various functions in the system. The software shall support, at a minimum 2 levels of access with one supporting read only access and the other provide full Administration access.
- E. The software shall provide a data warehouse-based reporting option that allows the user to analyze long term (years) system performance and operational issues.
 - 1. The reporting system shall be able to connect to one or more real time systems to provide the ability to analyze local or enterprise power system performance.
 - 2. The reporting system shall allow the user to subscribe to a report such that the report is run with a pre-defined set of selections at a pre-defined time and the output is email to the user, saved as a file to a directory or sent to a printer. A subscription shall be at to be set up such that it reoccurs on a regularly scheduled basis.
 - 3. The reporting system shall allow the user to define a reporting hierarchy such that the report output can provide high level summary information and also support "drill down" into the key operational information (current, voltage, kWh, etc) for different levels in the reporting hierarchy.
 - 4. The reporting system will support a variety of output formats including, but not limited to interactive web pages, Excel files, pdf files, csv files, and XML files.
- F. Summary Web pages shall be provided to display the following information for each communicating device within the power equipment lineup:
 - a. Circuit Summary Page: Circuit name, three-phase average RMS current, power (kW), power factor, and breaker status.
 - b. Transformer Page: Transformer tag, coil temperatures, and cooling fan status.
 - c. Specific Device Pages: Each individual communicating device shall display detailed, real-time information, as appropriate for device type.
- G. Graphics: Interactive color-graphics platform with pull-down menus and mouse-driven generation of power system graphics, in formats widely used for such drafting; to include the following:
 - a. Site plan.
 - b. Floor plans.
 - c. Equipment elevations.
 - d. Single-line diagrams.

2.4 SYSTEM REQUIREMENTS

- A. Monitoring and Control System: As the EPMCS is a web enabled system; the computer that runs the software shall be set up and managed as a server. This server computer will provide access to the system for any authorized user via a standard internet browser. The computer shall be placed on the Using Agency's data transmission network and configured as a server that others can access.
- B. The server shall consist of a server class computer with the following components:
 - 1. Processor with RAM and hard disk drive.
 - 2. CD-RW Drive.
 - 3. Ethernet 10/100 card.
 - 4. Auto-reboot capability after power failure.
 - 5. Windows based server.
 - 6. The end user computers require Internet Explorer and Windows.
- C. All web enabled devices in the EPMCS shall provide any authorized user access to the critical data listed below with the user requiring only a supported Internet browser on their own computer.
- D. RMS Real-Time Measurements:
 - 1. Current: Each phase, neutral, ground, and average of three phases.
 - 2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases.
 - 3. Power: Per phase and three-phase total.
 - 4. Demand.
 - 5. Power Factor: Per phase and three-phase total.
 - 6. Frequency.
 - 7. THD: Current and voltage.
 - 8. Harmonics to the 127th level.
- E. Events screen providing:
 - 1. Latest events.
 - 2. Enabled Triggers.
 - 3. Historical Events.
 - 4. Real time and historical wave form capture with simultaneous display of voltage and current for all phases.
 - 5. Real time and historical THD display.
 - 6. Real time and historical harmonic display.
- F. The web enabled power monitoring hardware shall connect to the power system using Web enabled gateways that communicate to the power system devices for viewing of power monitoring and equipment status information over device specific communication links.
- G. Network Configuration: The web-enabled power monitoring hardware and gateways shall support multiple protocols over Ethernet to ensure the system can easily be integrated into the EPCMS software system as well as existing systems. These protocols shall include:
 - 1. Modbus TCP/IP to support integration into third party systems.

- 2. BacNet Web Services to support integration into third party systems.
- 3. SNMP to support integration into Data Center management system.
- 4. Manufacturer's standard protocols.
- H. The web enabled gateways to support devices listed below.
- I. The devices connected to the Web enabled gateway shall communicate using the protocols described above over a local area network interconnected with twisted pair shielded cable in raceway, interconnecting all breaker trip units, protective relays, drives, and metering devices equipped with communications.
- J. All web enabled power monitoring hardware that is connected directly to Ethernet shall support the ability to synchronize their time clock using NTP. The purpose for this support is to ensure all device clocks are accurate so that event sequences can be adequately analyzed.
- K. The web enabled power monitoring hardware shall provide support for configuration of all web enabled meters and gateways directly via the web pages on the device.
 - 1. To support the configuration of legacy devices on the device networks connected to the gateway, the gateway shall support a "pass thru mode" to allow the legacy configuration software to connect from any computer on the users' network to the device via the gateway.

2.5 MICROPROCESSOR BASED METERING EQUIPMENT

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Provide microprocessor- b as e d power quality meters consisting of a meter base(s) with an integrally mounted display. Comply with UL 1244.
- C. Basis of Design Products: provide Eaton "Power X-pert Meter Series" products or equal by General Electric or Square D.
- D. Accuracy:
 - 1. For meters that are circuit-breaker accessories, metering accuracy at full-scale shall not be less than the following:
 - a. Current: Plus or minus 2.5 percent.
 - b. Voltage: Plus or minus 1.5 percent.
 - c. Energy, Demand, and Power: Plus or minus 4.0 percent.
- E. Current inputs for each channel shall be from standard instrument current transformers.
- F. Voltage inputs for each channel shall allow for connection into circuits with the following parameters:
 - 1. Input range up to 600V L-L, direct connected.
 - 2. PT primary input of 120 volts to 500,000 volts.

- G. The Metering shall be capable of monitoring, displaying, and communicating true RMS information. The Metering shall be suitable for installation in single phase, two or three wire systems or in three phase, three or four wire systems.
 - 1. AC current in A, B and C phase, 3-phase average, Neutral (N) and Ground (G).
 - 2. AC voltage for A-B, B-C and C-A, phase average, A-N, B-N and C-N, average phase to N, and N to G.
 - 3. Real Power (Watts), Reactive Power (VARS), Apparent Power (VA), for each phase and system.
 - 4. Accumulated, Incremental and conditional measurement for Real Energy (WH), Reactive Energy (VARH), Apparent Energy (VAH) for each phase and system.
 - 5. Frequency (Hz) Accuracy +/- 0.01 hertz.
 - 6. Demand values including present, running average, last complete interval and peak for System Current (Amperes).
 - 7. Power Factor for both 60-cycle fundamental Watts to VA and Apparent total Watts to total VARS including harmonics for A, B and C phase and 3 phase average.
 - 8. Current percent Total Harmonic Distortion (THD) in A, B and C phase and N.
 - 9. K-Factor (sum of the squares of harmonic currents times the square of their harmonic numbers).
- H. Meters shall have a digital Input/Output (I/O) card which shall include eight (8) digital inputs and three (3) relay outputs.
 - 1. Output Relay Control: Normally open and normally closed contacts, field configured.
- H. Onboard Data Logging:
 - 1. Store logged data, alarms, events, and waveforms in onboard nonvolatile memory.
- J. Alarms.
 - 1. User Options: Define pickup, dropout, and delay.
- K. Display:
 - 1. Back-lighted LCD to display metered data with touch-screen selecting device.
 - 2. Capable of being mounted to the Meter base unit or remote mounting of display up to 2000 ft away with capability of displaying up to 16 base units or complete Meters.
- L. The Meter(s) shall be provided with multiple communications ports and shall be permanently connected to communicate via standard protocols.

2.6 ETHERNET SWITCHES

- A. A single web access point: 4 or 6 ports Ethernet switch shall be provided in the equipment to allow a single access point for the user and the ability to connect more than one network device directly on the Using Agency's Ethernet Local Area Network (LAN).
- B. Ethernet switch shall support standard copper RJ45 connectors and/or 100BaseFX Fiber-Optic via ST connectors.

2.7 LAN CABLES

- A. Comply with Using Agency ITD Standards.
- 2.8 LOW-VOLTAGE WIRING
 - A. Comply with Section 26 05 23 "Control-Voltage Electrical Power Cables."

PART 3 - EXECUTION

3.1 CABLING

- A. Comply with NECA 1.
- B. Install cables and wiring according to requirements in the Using Agency ITD Standards.
- C. Wiring Method: Install wiring in raceway except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

3.2 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
- B. Label each power monitoring and control module with a unique designation.

3.3 GROUNDING

A. Comply with Section 26 05 26 "Grounding and Bonding of Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Electrical Tests: Use caution when testing devices containing solid-state components.
 - 2. Continuity tests of circuits.
 - 3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities.
 - a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
 - b. Test LANs according to requirements in the Using Agency ITD Standards.
 - c. System components with battery backup shall be operated on battery power for a

period of not less than 10 percent of calculated battery operating time.

- d. Verify accuracy of graphic screens and icons.
- e. Metering Test: Load feeders, measure loads on feeder conductor with an RMS reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
- f. Record metered values, control settings, operations, time intervals, and functional observations and submit test reports.
- C. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
- F. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible party and representative.
- G. Reports: Written reports of test and observations. Record defective materials and workman-ship and unsatisfactory test results. Record repairs and adjustments.
- H. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain systems.
 - 1. Train Using Agency's maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 12 hours' training.
 - 2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

3.6 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

- 4.1 GENERAL
 - A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 09 13

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SECTION 26 09 43 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.0 SECTION INCLUDES

- A. Network lighting control system and components:
 - 1. Touch panel controls
 - 2. Lighting management panels
 - 3. Lighting management modules
 - Low voltage wall stations
 Power interfaces

 - 6. Wired sensors

RELATED DOCUMENTS 1.1

- A. Section 262726 Wiring Devices
- B. Section 260923 Lighting Control Devices
- C. Section 265119 LED Interior Lighting
- D. Section 01 91 13 General Commissioning Requirements

1.2 **SUMMARY**

- A. The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.
- B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed). Specific dimmers will be capable of "dimming lights to off".
- C. All system devices shall be networked together, enabling digital communication between devices, and shall be individually addressed.
- D. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity, even if network connectivity to the greater system is lost.
- E. The system architecture shall facilitate remote operation via a computer connection.
- F. The system shall not require any centrally hardwired switching equipment.
- G. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.

1.3 **SUBMITTALS**

- A. Product Datasheets (general device descriptions, dimensions, electrical specifications, wiring details, nomenclature).
- B. Riser Diagrams typical per room type (detailed drawings showing device interconnectivity of devices).
- C. Other Diagrams as needed for special operation or interaction with other system(s).

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- D. Example Contractor Startup/Commissioning Worksheet must be completed prior to factory start-up.
- E. Hardware and Software Operation Manuals.
- F. Other operational descriptions as needed.

1.4 PROJECT CLOSEOUT DOCUMENTATION

- A. Provide a factory published manual
 - Warranty
 Technical
 - 2. Technical support contact
 - 3. Electronic manual on manufacturer's website for free download

1.5 QUALITY ASSURANCE

- A. All steps in sensor manufacturing process shall occur in North America; including population of all electronic components on circuit boards, soldering, programming, wiring, and housing.
- B. All components and the manufacturing facility where product was manufactured must be RoHS compliant.
- C. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.
- D. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

1.6 PROJECT CONDITIONS

- A. Only install equipment after the following site conditions are maintained:
 - 1. Ambient Temperature 14 to 105 degrees F (-10 to 40 degrees C)
 - 2. Relative Humidity less than 90% non-condensing
- B. Standard electrical enclosures are permanently installed.
- C. Equipment is protected from dust, debris and moisture.
- 1.7 WARRANTY
 - A. Five (5) year 100% parts replacement.

1.8 MAINTENANCE & SUSTAINABILITY

- A. Provide new parts, upgrades, and/or replacements available for a minimum of 5 years available to the end user.
- B. Provide free telephone technical support.

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PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517). This spec was developed utilizing Acuity brand products as a method of relating a design function and level of quality. Acceptable platforms include:
 - 1. Acutiy (nLight) networked lighting controls
 - 2. Hubbell (NX) control solutions
 - 3. Legrand /WattStopper (Equinox) lighting control system
 - 4. Eaton /Cooper (Greengate) lighting controls

PART 3 - EXECUTION

3.1 SYSTEM REQUIREMENTS

- A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time-based operation.
- B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
- C. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see *Networked LED Luminaire* section).
- D. Intelligent lighting control devices shall communicate digitally, require <7 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
- E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher-level network backbone.
- F. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
- G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
- H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
- I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, controls enabled luminaires, or from the network backbone. Standalone "bus power supplies" shall not be required in all cases.

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- J. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
- K. System shall have one or more primary wall mounted network control "gateway" devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
- L. System shall use "bridge" devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.
- M. System shall be capable of wirelessly connecting a lighting zone to a WiFi (802.11n) wireless data network for purposes of eliminating the "bridge" devices and all cabling that connects zones to bridge devices.
- N. WiFi enabled devices shall be able to detect when WiFi network is down and revert to a user directed default state.
- O. WiFi-enabled devices shall be capable of current monitoring.
- P. WiFi-enabled devices shall utilize WPA2 AES encryption.
- Q. WiFi-enabled devices shall be able to connect to 802.11b/g/n WiFi networks.
- R. WiFi-enabled devices shall have two local RJ-45 port for communicating with non WiFi-enabled system devices.
- S. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control schedules and profiles.
- T. Individual lighting zones shall be capable of being segmented into several "local" channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.
- U. Devices located in different lighting zones shall be able to communicate occupancy, photocell (non-dimming), and switch information via either the wired or WiFi backbone.
- V. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week, utilization of a space. Note: Operating modes should be utilized only in manners consistent with local energy codes.
 - 1. Auto-On / Auto-Off (via occupancy sensors)
 - a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
 - b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - c. Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.
 - 2. Manual-On / Auto-Off (also called Semi-Automatic)
 - a. Pushing a switch will turn lights on.
 - b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.

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- 3. Manual-On to Auto-On/Auto-Off
 - a. Pushing a switch will turn lights on.
 - b. After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
 - c. Sequence can be reset via scheduled (ex. daily each morning) events.
- 4. Auto-to-Override On
 - a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
 - b. Zone lighting then goes into an override on state for a set amount of time, or until the next time event returns the lighting to an auto-off style of control.
 - c. Sequence can be reset via scheduled (ex. daily each morning) events.
- 5. Manual-to-Override On

 - a. Pushing a switch will turn lights on.b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
 - c. Sequence can be reset via scheduled (ex. daily each morning) events.
- 6. Auto On / Predictive Off
 - a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
 - b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - c. Pressing the switch will turn the lights off and a short "exit timer" begins. After the timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.
- 7. Multi-Level Operation (multiple lighting levels per manual button press)
 - a. Operating mode designed specifically for bi-level applications.
 - b. Enables the user to cycle through up to four potential on/off/dim low/dim high lighting states using only a single button.
 - c. Eliminates user confusion as to which of two buttons controls which load.
 - d. Three different transition sequences are available in order to comply with energy codes or user preference).
 - e. Mode available as a setting on all devices that have single manual on/off switch (ex. nPODM, nPOM-DX, nWSX LV).
 - f. Depending on the sequence selected, every button push steps through relay/dimming states according to below table.
 - g. In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to "step" in a sequence that achieves bi-level operation is present.

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		State of load after each pushbutton press			
MLO Mode		1st Press	2nd Press	3rd Press	4th Press
2-State (Alternating)	Load A	On	Off	Off	1 - e- 1
	Load B	Off	On	Off	
2-State (Both On, A First)	Load A	On	On	Off	CERES.
	Load B	Off	On	Off	i
2-State (Both On, B First)	Load A	Off	On	Off	
	Load B	On	On	Off	(- 4)
3-State	Load A	On	Off	On	Off
	Load B	Off	On	On	Off
A and B On ¹	Load A	On	Off		1.00
	Load B	On	Off	1.2	1.14
A On Only ¹	Load A	On	Off		1 A 1
	Load B	Off	Off		
A and B On & Dim High ¹	Load A	High	Off	9	1.181.1
	Load B	High	Off		8-4-5
Dim Low /High	Load A	Low	High	Off	(
Dim Low / High	Load A	High	Low	Off	

NOTE 1: Modes for use only when Auto-On state of Load A & B is different than first MLO state

W. A taskbar style desktop application shall be available for personal lighting control.

- X. An application that runs on "smart" handheld devices (such as an Apple® IPhone®) shall be available for personal lighting control.
- Y. Control software shall enable logging of system performance data and presenting thisl information in a web-based format and downloadable to .CSV files.
- Z. Control software shall enable integration with a BMS via BACnet IP, although a hardware BACnet IP integration solution is also available.
- AA. System shall provide the option of having pre-terminated plenum rated CAT-5e cabling supplied with hardware.

3.2 INDIVIDUAL DEVICE SPECIFICATIONS

- A. Control module (gateway)
 - 1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet network.
 - 2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.

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- 3. Control device shall have three RJ-45 ports for connection to the graphic touch screen, other backbone devices bridges) or directly to lighting control devices (up to 128 per port).
- 4. Device shall automatically detect all devices downstream of it.
- Device shall have a standard and astronomical internal time clock.
 Device shall have one RJ-45 10/100 BaseT Ethernet connection.
 Device shall have a USB port

- 8. Each control gateway device to be capable of linking 1500 devices to the management software, with memory capable of supporting up to 400 devices.
- 9. Device shall be capable of using a dedicated static or DHCP assigned IP address.
- 10. Network Control Gateway device shall be nLight model Series: nGWY2
- B. Networked system occupancy sensors
 - 1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
 - 2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
 - 3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional "dual" technology shall be used.
 - 4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
 - 5. All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave sensing technologies are unacceptable.
 - 6. Sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
 - 7. Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.
 - 8. Sensors shall be available in multiple lens options which are customized for specific applications.
 - 9. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 - 10. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
 - 11. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
 - 12. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
 - 13. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
 - 14. Sensors shall be equipped with an automatic override for 100-hour burn-in of lamps. This feature must be available at any time for lamp replacements.
 - 15. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.

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- 16. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
- 17. Wall switch sensors shall have optional features for photocell/daylight override, and low temperature/high humidity operation.
- 18. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)
- 19. Wall switch sensors shall be available with raise/lower dimming controls.
- 20. Wall switch sensors shall be the following nLight model numbers, with device color and optional features as specified:

nWSX (PIR, 1 Relay)
nWSX PDT (Dual Tech, 1 Relay)
nWSX LV (PIR, No Relay)
nWSX PDT LV (Dual Tech, No Relay)
nWSX LV NL (PIR w/ Night Light, No Relay)
nWSX PDT LV NL (Dual Tech w/ Night Light, No Relay)
nWSX LV DX (PIR, No Relay, Raise/Lower Dim Ctrl)
nWSX PDT LV DX (Dual Tech, No Relay, Raise/Lower Dim Ctrl)

- 21. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.
- 22. Embedded sensors shall be capable of both PIR and Dual Technology detection.
- 23. Embedded sensors shall have an optional photocell
- 24. Embedded sensors shall be the following nLight model number: nES 7 (PIR, No Relay) nES 7 ADCX (PIR w/ Photocell, No Relay) nES PDT 7 (Dual Technology, No Relay) nES PDT 7 ADCX (Dual Technology w/ Photocell, No Relay)
 25. Network to have ceiling, fixture, recessed, & corner mounted sensors available.
- 26. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.
- 27. Sensors to be the following nLight model numbers, with specified options:

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Model # Series	Occupancy Poles	# of Relays	Lens Type	Detection Technology
nCM(B) 9	1	-	Standard	PIR
nCM(B) 9 2P	2	-	Standard	PIR
nCM 9 RJB	1	-	Standard	PIR
nCM 9 2P RJB	2	-	Standard	PIR
nCM(B) PDT 9	1	-	Standard	Dual
nCM(B) PDT 9 2P	2	-	Standard	Dual
nCM PDT 9 RJB	1	-	Standard	Dual
nCM PDT 9 2P RJB	2	-	Standard	Dual
nCM(B) 10	1	-	Extended	PIR
nCM(B) 10 2P	2	-	Extended	PIR
nCM 10 RJB	1	-	Extended	PIR
nCM 10 2P RJB	2	-	Extended	PIR
nCM(B) PDT 10	1	-	Extended	Dual
nCM(B) PDT 10 2P	2	-	Extended	Dual
nCM PDT 10 RJB	1	-	Extended	Dual
nCM PDT 10 2P RJB	2	-	Extended	Dual
nRM 9	1	-	Standard	PIR
nRM PDT 9	1	-	Standard	Dual
nRM 10	1	-	Extended	PIR
nRM PDT 10	1	-	Extended	Dual
nRM 6	1	-	High Bay	PIR
nRM 50	1	-	Aisle Way	PIR
nWV 16	1	-	Wide View	PIR
nWV PDT 16	1	-	Wide View	Dual
nHW13	1	-	Hallway	PIR
nCM(B) 6	1	-	High Bay	PIR
nCM 6 RJB	1	-	High Bay	PIR

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- C. Networked system daylight (photocell and/or dimming) sensors
 - 1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
 - 2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
 - 3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
 - 4. Photocell and dimming sensors shall be equipped with an automatic override for100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto setpoint" setting.)
 - 5. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
 - 6. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.
 - 7. Sensor shall be the following nLight model numbers, with device options as specified:
 - nCM(B) PC (RJB) (on/off)
 - nCM(B) PC DZ (RJB) (on/off control, dual zone)

nCM(B) ADCX (RJB) (remote automatic dimming control photocell)

nCM(B) ADCX DZ (RJB) (remote automatic dimming control photocell, dual zone) nRM PC (on/off)

- **nRM PC DZ** (on/off, dual zone)
- **nRM ADCX** (remote automatic dimming control photocell)
- **nRM ADCX DZ** (remote automatic dimming control photocell, dual zone)
- 8. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
- 9. Embedded sensors shall be the following nLight model number: **nES ADCX** (Dimming Photocell)
- D. Networked System Power (Relay) Packs
 - 1. Power Packs shall incorporate one Class 1 relay, a 0-10 VDC dimming output, and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
 - 2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
 - 3. All devices shall have two RJ-45 ports.
 - 4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
 - 5. Power Pack shall securely mount to junction location through a threaded ¹/₂ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.

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- 6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
- 7. Power Packs and Power Supplies shall be available that are WiFi enabled.
- 8. Power Packs (Secondary) shall be available that provide up to 16 Amp switching of all lighting load types.
- 9. Power Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
- 10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
- 11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
- 12. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
- 13. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
- 14. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
- 15. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
- 16. Power (Secondary) Packs shall be available that provide up to 20 Amps switching of general purposed receptacle (plug-load) control.

17. Power (Relay) Packs and Supplies shall be the following nLight model numbers: **nPP16** (Power Pack w/ 16A relay) **nPP16 D** (Power Pack w/ 16A relay and 0-10VDC dimming output) nPP16 WIFI (Power Pack w/ 16A relay, WIFI enabled) nEPP5 D (Power Pack w/ 5A relay and 0-10VDC dimming output) **nSP16** (Secondary Pack w/ 16A relay) nPP16 ER (UL924 Listed Secondary Pack w/ 16A relay for switching emergency power circuits) nPP16 D ER UL924 Listed Secondary Pack w/ 16A relay and 0-10VDC dimming output for switching/dimming emergency power circuits) nSP5 PCD 2W (Secondary Pack w/ 5A relay and incandescent dimming or 2 wire line voltage fluorescent dimming output) nSP5 PCD 3W (Secondary Pack w/ 5A relay and 3-wire line voltage fluorescent dimming output) nSP5 PCD MLV (Secondary Pack w/ 5A relay and magnetic low voltage dimming output) nSP5 PCD ELV 120 (Secondary Pack w/ 4A relay and electronic low voltage dimming output) nSP5 2P LVR (Louver/Damper Control Pack nSHADE (Pulse On/Off Control Pack nPP20 PL (Secondary Pack w/ 20A relay for general purpose receptacle load) **nPS 80** (Auxiliary Bus Power Supply) nPS 80 WIFI (Auxiliary Bus Power Supply, WiFi enabled) nAR 40 (Low voltage auxiliary relay pack)

- E. Networked System Relay & Dimming Panels
 - 1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
 - 2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.

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- 3. Panel shall provide one 0-10VDC dimming output paired with each relay.
- 4. Panel shall power itself from an integrated 120/277 VAC supply.
- 5. Panel shall be capable of operating as either two networked devices or as one.
- 6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
- 7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection.
- Power (Relay) Packs and Supplies shall be the following nLight model numbers: **nPANEL 4** (Panel w/ four 120/277 VAC relays and four 0-10 VDC dimming outputs) **nPANEL 2 480** (Panel w/ two dual phase relays (208/240/480 VAC) and two 0-10 VDC dimming outputs)
- F. Networked Auxiliary Input / Output (I/O) Devices
 - 1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ¹/₂" knockout.
 - 2. Devices shall have two RJ-45 ports
 - 3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 - 4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current.
 - 5. Specific I/O devices shall have an input that reads a 0-10 VDC signal from an external device.
 - 6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event (toggle the lighting load) or run a local/remote control profile.
 - 7. Specific I/O devices shall sense state of low voltage outdoor photocells.
 - 8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
 - 9. Specific I/O devices shall sense momentary and maintained contact closures, and either toggle a connected load after a momentary contact or ramp the load high/low during a maintained contact (stopping when the contact releases).
 - 10. Auxiliary Input/Output Devices shall be the following nLight model numbers:

nIO D (I/O device with 0-10 dimming output)

nIO 1S or **nIO RLX** (I/O device with contact closure or 0-10VDC dimming input) **nIO NLI** (Input device for detecting state of low voltage outdoor photocell; sold in **nIO PC KIT** only)

nIO X (Interface device for communicating with RS-232 enabled AV Touch Screens

- G. Networked LED Luminaires
 - 1. Networked LED luminaire shall have a mechanically integrated control device
 - 2. Networked LED luminaire shall have two RJ-45 ports available (via control device directly or incorporated RJ-45 splitter)
 - 3. Networked LED luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers)
 - 4. Networked LED luminaire shall provide low voltage power to other networked control devices (excluding EMG versions)
 - 5. System shall be able to turn on/off specific LED luminaires without using a relay, if LED driver supports "sleep mode"

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- 6. System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by varying the input control power (and thus saving up to 20% power usage).
- 7. System shall indicate (via a blink warning) when the LED luminaire has reached its expected life (in hrs).
- 8. Integrated control devices shall be the following nLight model series:



- 9. Provide LED Luminaires per the lighting fixture schedule factory enabled with the nLight control devices in order to function with nLight sensors, dimmers and switches.
- H. Networked System Wall Switches & Dimmers
 - 1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
 - 2. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 - 3. All devices shall have two RJ-45 ports.
 - 4. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
 - 5. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
 - 6. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
 - 7. Devices with mechanical push-buttons shall be made available with custom button labeling
 - 8. Devices with a single "on" button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.
 - 9. Wall switches & dimmers shall be the following nLight model numbers, with device options as specified:

nPODM (single on/off, push-buttons, LED user feedback)

nPODM DX (single on/off, single dimming raise/lower, push-buttons, LED user feedback)

nPODM 2P (dual on/off, push-buttons, LED user feedback)

nPODM 2P DX (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)

nPODM 4P (quad on/off, push-buttons, LED user feedback)

nPODM 4P DX (quad on/off, quad dimming raise-lower, push-buttons, LED user feedback)

- I. Networked System Graphic Wall Station
 - 1. Device shall have a 3.5" full color touch screen for selecting up to 16 programmable lighting control preset scenes or acting as up to 16 on/off/dim control switches.
 - 2. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
 - 3. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
 - 4. Device shall enable user supplied .jpg screen saver image to be uploaded.
 - 5. Device shall surface mount to single-gang switch box.
 - 6. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.

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- 7. Device shall have a micro-USB style connector for local computer connectivity.
- 8. Device shall have two RJ-45 ports for communication

9. Device shall be the following nLight model number: nPOD GFX

- J. Networked System Scene Controllers
 - 1. Device shall have two, three, four, or eight buttons for selecting programmable lighting control profiles or acting as on/off switches.
 - 2. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
 - 3. Device shall recess into single-gang switch box and fit a standard GFI opening.
 - 4. Devices shall provide LED user feedback.
 - 5. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 - 6. All devices shall have two RJ-45 ports.
 - 7. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
 - 8. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
 - 9. Device shall have LEDs indicating current selection.

10. Scene Selector device shall be the following nLight model number:

nPODM 2S (2 Scene, push-button) nPODM 4S (4 Scene, push-button) nPODM 4S DX (4 Scene, push-button, On/Off/Raise/Lower) nPODM 2L (2 Adjustable Preset Levels, push-button, On/Off) nPODM 2L AB (2 Scene, push-button, On/Off/High/Low) nPODM 4L DX (4 Adjustable Preset Levels, push-button, On/Off/Raise/Lower)

- K. Communication Bridges
 - 1. Device shall surface mount to a standard 4" x 4" square junction box.

 - Device shall have 8 RJ-45 ports.
 Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
 - 4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.
 - 5. Device shall be capable of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.
 - 6. Communication Bridge devices shall be the following nLight model numbers: nBRG 8 (8 Ports)

3.3 LIGHTING CONTROL PROFILES

- A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.
- B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

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- C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.
- D. Specific device parameters (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.
- E. All lighting control profiles shall be stored on the network control gateway device, with a system backup on the software's host server.
- F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.
- G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
- H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.
- I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.
- J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

3.4 MANAGEMENT SOFTWARE

- A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software
- B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).
- C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
- D. A printable network inventory report shall be available via the software.
- E. A printable report detailing all system profiles shall be available via the software.
- F. Software shall require all users to login with a User Name and Password.
- G. Software shall provide at least three permission levels for users.
- H. All sensitive stored information and privileged communication by the software shall be encrypted.
- I. All device firmware and system software updates must be available for automatic download and installation via the internet.

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J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

3.5 BMS COMPATIBILITY

- A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software.
- B. BACnet IP connection shall also be available utilizing JACE-600 hardware unit.
- C. BACnet IP hardware shall be capable of supporting up to 1500 total devices across up to 5 total Gateways
- D. BACnet IP connection shall communicate information gathered by networked system to other building management systems.
- E. BACnet IP connection shall translate and forward lighting relay and other select control commands from BMS system to networked control devices via profiles stored in the system Gateway. All system devices shall be available for polling for devices status.
- F. BACnet IP hardware device shall be the following nLight model name: **nBACnet**
- 3.6 SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE
 - A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.
 - B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.
 - C. An "Energy Scorecard" shall be display that shows calculated energy savings in dollars, KWHr, or CO2.
 - D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).
 - E. Energy savings data shall be calculated for the system as a whole or for individual zones.
 - F. A time scaled graph showing all relay transitions shall be presented.
 - G. A time scaled graph showing a zones occupancy time delay shall be presented
 - H. A time scaled graph showing the total light level shall be presented.
 - I. User shall be able to customize the baseline run-time hours for a space.
 - J. User shall be able to customize up to four time-of-day billing rates and schedules.
 - K. Data shall be made available via a .CSV file
- 3.7 START-UP & SUPPORT FEATURES

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- A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.
- B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
- C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
- D. All system devices shall be capable of being given user defined names.
- E. All devices within the network shall be able to have their firmware upgraded remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
- F. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

END OF SECTION 26 09 43

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SECTION 26 11 16 - SECONDARY UNIT SUBSTATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes Indoor and outdoor secondary unit substations, each consisting of the following:
 - 1. Primary incoming section.
 - 2. Transformer.
 - 3. Secondary distribution section(s).
- B. Related Requirements:
 - 1. Section 26 05 73 "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
 - 2. Section 26 43 13 "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for transient voltage surge suppressors for low-voltage power, control, and communication equipment located in the secondary section.
 - 3. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- 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. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Dimensioned plans and elevations showing major components and features.

- 3. One-line diagram.
- 4. List of materials.
- 5. Nameplate legends.
- 6. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
- 7. Short-time and short-circuit current ratings of secondary unit substations and components.
- 8. Ratings of individual protective devices.
- C. Time-Current Characteristic Curves: For overcurrent protective devices.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Dimensioned concrete base, outline of secondary unit substation, conduit entries, and ground rod locations.
 - 2. Location of structural supports for structure-supported raceways.
 - 3. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.
- B. Product Certificates: For secondary unit substations, signed by product manufacturer.
- C. Material Test Reports: For secondary unit substations.
- D. Factory test reports.
- E. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated.
- C. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL and marked for intended use.
- D. Comply with IEEE C2.
- E. Comply with IEEE C37.121.
- F. Comply with NFPA 70.

G. Comply with FM Global requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
- B. Coordinate delivery of secondary unit substations to allow movement into designated space.
- C. Store secondary unit substation components so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.
- D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.10 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components and/or products of the secondary unit substation that fail in materials or workmanship within the specified warranty period. Select and modify conditions below and specified features required to provide satisfactory service.
- B. Warranty Period: Cost to repair or replace any parts or product for one year from date of Substantial Completion.

1.11 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.
- B. Products Selection for Restricted Space: Drawings indicate maximum dimensions for secondary unit substations including clearances between substations and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.12 COORDINATION

- A. Coordinate sensor-communication module package with data network and with monitoring equipment specified in Division 26 Section "Electrical Power Monitoring and Control" for successful transmission and remote readout of remote monitoring data specified in this Section.
- B. Coordinate layout and installation of secondary unit substations with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517). Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Corp. Electrical Group.
 - 2. General Electric Company; GE Consumer & Industrial Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.

2.2 MANUFACTURED UNITS

- A. Indoor Unit Arrangement: Single assembly.
- B. Outdoor Enclosure Finish: Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.
- 2.3 INCOMING SECTION
 - A. Refer to section 262413, Switchboards, paragraph 2.3, "disconnecting and overcurrent devices".
- 2.4 TRANSFORMER SECTION
 - A. Description: IEEE C67.12.01, DRY-TYPE TRANSFORMER C57.12.51, NEMA ST 20, and drytype 2-winding, secondary unit substation transformer. Transformer shall comply with DOE Standards and NEMA TP 1 efficiency levels.
 - B. Enclosure: Indoor, ventilated, vacuum-pressure, impregnated type and with insulation system rated at 200 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
 - C. Cooling System: Class AA, air cooled, complying with IEEE C57.12.01.
 - 1. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicated lights, alarm, and alarm silencing relay.
 - 2. Include mounting provision for fans.
 - D. Insulation Materials: IEEE C57.12.01, rated 220 deg C.
 - E. Insulation Temperature Rise: 80 deg C, maximum rise above 40 deg C.
 - F. Basic Impulse Level: 95 kV.
 - G. Coil Assembly. The coils shall be wound with copper or aluminum and shall be vacuumimpregnated. The cores shall be constructed of high grade, grain-oriented, non-aging silicon steel having high magnetic permeability and low hysteresis and eddy current losses. Core laminations shall be step-lap miter cut at the corners.
 - H. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.

- I. Primary Connection: Close couple transition between primary circuit breaker and transformer primary terminals. Coupling shall be by properly supported copper bar or copper conductor.
- J. Secondary Connections: Close coupled between the transformer and the secondary distribution gear. Coupling shall be by properly supported copper bar or copper conductor.
 - 1. Impedance: 5.75 percent.
- K. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

2.5 SECONDARY DISTRIBUTION SECTION

- A. Secondary Terminal Compartment: Bus bars mounted on standoff insulators.
- B. Secondary Distribution: Low-voltage switchboard as specified in Division 26 Section "Switchboard."

2.6 IDENTIFICATION DEVICES

A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with stainless steel screws. Nameplates and label products are specified in Division 26 Section 260533 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.
- B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
 - 1. Resistance measurements of all windings on the rated voltage connection an on tap extreme connections.
 - 2. Ratios on the rated voltage connection and on tap extreme connections.
 - 3. Polarity and phase relation on the rated voltage connection.
 - 4. No-load loss at rated voltage on the rated voltage connection.
 - 5. Exciting current at rated voltage on the rated voltage connection.
 - 6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
 - 7. Applied potential.
 - 8. Induced potential.
 - 9. Temperature Test: If a transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class FA rating.
 - a. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.
 - 10. Owner will witness all required factory tests. Notify Architect at least 14 days before date of tests and indicated their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.
- D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install secondary unit substations in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
 - 1. Anchor secondary unit substations to concrete bases according to manufacturer's written instructions and requirements in Division 26 Section "Hangers and Supports for Electrical Systems".
 - 2. Interior Location: Mount secondary unit substations on concrete bases of dimensions indicated, but not less than 4 inches (100-mm) larger in both directions than supported unit and 4 inches (100-mm) high with chamfered edges.
 - a. Use 3000-psi (20.7-MPa) 28-day compressive-strength concrete and reinforcement as specified in Division 03 Sections.
 - b. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 - c. Install epoxy-coated anchor bolts for anchoring equipment to the concrete base.
 - d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Verify tightness and torque all accessible bolted electrical connections to manufacturer's specified values using a calibrated torque wrench. Provide a list of all torqued connections and values.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections, do not use compressed air.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
 - 2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
 - 3. Perform phasing check on double-ended switchgear to insure correct bus phasing from each source.
 - 4. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
 - 5. Set field-adjustable circuit-breaker trip ranges according to results in Division 26 Section "Overcurrent Protective Device Coordination Study." Post a durable copy of the "as-left" settings and fuse ratings in a convenient location within the switchgear
 - a. Remove and replace malfunctioning units and retest as specified above.
- C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each unit substation, include primary, transformer, and distribution sections. Remove front and rear panels so joints and connections are accessible to portable scanner.

- 1. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 2. Record of Infrared Scanning: Prepare a certified report that identifies equipment checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial actions taken, and observations after remedial action.

3.7 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Using Agency, but not more than six months after Final Acceptance, perform the following voltage monitoring:
 - 1. During a period of normal load cycles as evaluated by Using Agency, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
 - 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Adjust transformer taps.
 - b. Rebalance loads.
 - c. Prepare written request for voltage adjustment by electric utility.
 - 3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
 - 4. Report: Prepare a written report covering monitoring performed and corrective action taken.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain systems. Comply with Division 01 requirements.

END OF SECTION 26 11 16

SECTION 26 12 13 – LIQUID-FILLED MEDIUM VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of transformers with medium-voltage primaries:
 - 1. Liquid-filled distribution and power transformers that form a part of unit substation assemblies.
 - 2. Stand Alone, Pad-mounted, Liquid-filled transformers.
- B. Related Requirements:
 - 1. Section 26 11 16 "Secondary Unit Substations" for requirements for transformers that form a part of a unit substation.
 - 2. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.
- B. Material Safety Data Sheet (MSDS) for insulating fluid.
- C. Shop Drawings: Diagram power, signal, and control wiring.
- D. Seismic Performance: Transformer shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means the unit will remain in place without separation of parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Underground primary and secondary conduit stub-up location.
 - 2. Dimensioned concrete base, outline of transformer, and required clearances.
 - 3. Ground rod and grounding cable locations.

- B. Source quality-control test reports.
- C. Field quality-control test reports.
- D. Follow-up service reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated.
 - 1. Product Selection for Restricted Spaces: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C2.
- D. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.
- E. Comply with NFPA 70.
- F. Comply with FM Global requirements.
- G. Comply with Using Agency Design Standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.9 PROJECT CONDITIONS

- A. Service Conditions: IEEE C37.121, usual service conditions except for the following:
 - 1. Altitudes from sea level to 1000 feet (300 m).
 - 2. Ambient Temperature: Minus 15 to plus 50 deg C.
 - 3. Relative Humidity: 0 to 95 percent.
 - 4. Unusual transportation or storage conditions.
 - 5. Unusual grounding-resistance conditions.
 - 6. Unusual space limitations.

1.10 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Weg Transformers USA.
 - 2. Eaton Cutler-Hammer. (IL)
 - 3. Cooper Industries; Cooper Power Systems Division.
 - 4. Square D; Schneider Electric.
 - 5. GE Electrical Distribution & Control, GE Consumer & Industrial Electrical Distribution.

2.2 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

- A. Description: ANSI C57.12.13, ANSI C57.12.26, IEEE C57.12.00, for pad-mounted, 2-winding transformers, stainless-steel tank base, cabinet, and sills, typically installed outdoors.
- B. Insulating Liquid: Less flammable, silicone-based dielectric and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be FM approved and have low toxicity and be nonhazardous.
- C. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.
- D. Basic Impulse Level: 95 for 15 kV.
- E. Impedance: 3 5 . 7 5 % (+/- 7-1/2%).
- F. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- G. High-Voltage Switch: Separately mounted 15 kV metal-enclosed fused interrupter switch complying with Section 26 13 00.
- H. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment.

- I. High-Voltage Terminations and Equipment: Live front with externally clamped, wet process, porcelain bushings and cable connectors suitable for terminating primary cable.
- J. Accessories:
 - 1. Drain Valve: 1 inch (25 mm), with sampling device.
 - 2. Dial-type thermometer.
 - 3. Liquid-level gage.
 - 4. 1 inch upper filter press and filling plug.
 - 5. Pressure-vacuum gage.
 - 6. Pressure Relief Device: Self-sealing with an indicator.
 - 7. ANSI tank grounding provisions shall be furnished in both compartments.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90, for liquid filled transformers.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformes will be installed.
- D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install pad mounted transformers on concrete bases designed by the Structural Engineer.
- B. Install transformers on minimum 4-inch high concrete housekeeping pads.
 - 1. Anchor transformers to concrete pads according to manufacturer's written instructions

and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."

- 2. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Sections.
- 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Verify tightness and torque all accessible bolted electrical connections to manufacturer's specified values using a calibrated torque wrench. Provide a list of all torqued connections and values.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
 - 2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Test Reports: Prepare written reports to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

A. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 12 13

SECTION 26 13 00 - MEDIUM VOLTAGE SWITCHGEAR

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes metal-enclosed interrupter switchgear assembly consisting of outdoor self-supporting multi-bay assembly containing interrupter switches and fuses all completely factory assembled and operationally checked with the following optional components, features, and accessories:
 - 1. Copper, silver-plated main bus at connection points.
 - 2. Communication modules.
 - 3. Instrumentation.
 - 4. Protective Relays and current transformers.
 - 5. Surge arresters.
 - 6. Provisions for future devices.
 - 7. Control battery system.
 - 8. Power Operators.
- B. Related Requirements:
 - 1. Section 26 09 13 "Electrical Power Monitoring and Control" for interfacing communication and metering.
 - 2. Section 26 11 16 "Secondary Unit Substations" for medium voltage fused interrupter switchgear used as incoming primary equipment.
 - 3. Section 26 13 01 "Medium Voltage Pad Mounted Switchgear" for medium voltage fused switchgear used as power distribution to buildings.
 - 4. Section 26 05 72 "Overcurrent Protective Device Short-Circuit Study".
 - 5. Section 26 05 73 "Overcurrent Protective Device Coordination Study".
 - 6. Section 26 05 74 "Overcurrent Protective Device Arc-Flash Study" for short-circuit rating of devices and for setting of overcurrent protective devices and protective relays.
 - 7. Electrical drawings, particularly sheet S-E102 Single Line Diagram.
 - 8. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. GFCI: Ground-Fault Circuit Interrupter.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully

operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of switchgear and related equipment, include the following:
 - 1. Rated capacities, operating characteristics, furnished specialties, and accessories for individual interrupter switches and overcurrent protective devices.
 - 2. Time-current characteristic curves for overcurrent protective devices.
- B. Shop Drawings: For each type of switchgear and related equipment, include the following:
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
 - a. Tabulation of installed devices with features and ratings.
 - b. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
 - c. Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
 - d. Floor plan drawing showing locations for anchor bolts.
 - e. Current ratings of buses.
 - f. Short-time and short-circuit ratings of switchgear assembly.
 - g. Nameplate legends.
 - h. Mimic-bus diagram.
 - i. Utility company's metering provisions with indication of approval by utility company.
 - 2. Wiring Diagrams: For each type of switchgear and related equipment, include the following:
 - a. Power, signal, and control wiring.
 - b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
 - c. Schematic control diagrams.
 - d. Diagrams showing connections of component devices and equipment.
 - e. Schematic diagrams showing connections to remote devices including power monitoring and control devices.
- C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Identify field measurements.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals. In addition, include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL and marked for intended use.
- D. Comply with IEEE C2.
- E. Comply with Using Agency Design Standards.
- 1.7 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver in sections of lengths that can be moved past obstructions in delivery path as indicated.
 - B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
 - C. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
 - 1. Ambient temperature not exceeding 122 deg F (50 deg C).
 - 2. Altitude: Sea level to 1000 feet (300 m).
 - 3. Wind resistant up to 150 MPH.
- B. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Using Agency or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Using Agency no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Using Agency's written permission.
 - 3. Using Agency Lock-out/Tag-out procedures shall be used with Contractor controlled

locks and tags.

4. Comply with NFPA 70E.

1.9 COORDINATION

- A. Coordinate sensor-communication module package with data network and with monitoring equipment specified in Section 26 09 13 "Electrical Power Monitoring and Control" for successful transmission and remote readout of remote monitoring data specified in this Section.
- B. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- C. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering in a spare fuse rack for storage and identified with labels describing contents.
 - 1. Fuses: Six of each type and rating used. Include spares for future transformers, control power circuits, and fusible devices.
- B. Maintenance Tools: Furnish tools and miscellaneous items required for switchgear test, inspection, maintenance, and operation. Include the following:
 - 1. Fuse-handling tool.
 - 2. Extension rails, lifting device, transport dolly or mobile lift, and all other items necessary to remove overcurrent protective device from housing and transport to remote location.
 - 3. Racking handle to move overcurrent protective device manually between connected and disconnected positions, and a secondary test coupler to permit testing of overcurrent protective device without removal from switchgear.
 - 4. Remote operated, motor driven, racking device.
 - 5. Provide owner with labeled keys for all switchgear.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Available Manufacturers:
 - 1. S & C Custom Metal Enclosed Switchgear
 - 2. Eaton Corp. Electrical Group "MVS, or equal.
 - 3. Square D; a brand of Schneider Electric.
 - 4. General Electric Company; GE Consumer & Industrial Electrical Distribution.

2.2 MANUFACTURED UNITS

- A. Description: Factory assembled and tested.
- B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.
 1. Rated 13.8 kV Nominal, 95 kV BIL.
- C. System Voltage: 12.47 kV nominal; 15 kV maximum.
- D. Main-Bus Rating: 600A, continuous; 600MVA Short Circuit.

2.3 METAL-ENCLOSED SWITCHGEAR

- A. Meet or exceed the applicable requirements of ANS/IEEE C37.20.3 for Metal-Enclosed Interrupter Switchgear.
- B. Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated by the power utility.
- C. Interrupter Switches: Stationary, 3-pole, gang-operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.
 - 1. Rating: The momentary and duty-cycle fault-closing ratings of switches, momentary rating of bus, and interrupting ratings of fuses shall equal or exceed the short-circuit ratings of the metal-enclosed switchgear.
 - 2. Extra auxiliary switch, coupled to switch operator.
 - 3. Copper terminals and adapters on switches.
 - 4. Duty-Cycle, Fault Closing: 40,000 asymmetrical A.
 - 5. Switch Action: No external arc or significant ionized gas released into the enclosure.
 - 6. Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
 - 7. The speed of opening and closing the switch shall be independent of the operator, and it shall be impossible to "tease" the switch into any intermediate position under normal operation.
 - 8. A maintenance provision for slow closing the switch to check switch blade engagement and slow opening the switch to check operation of the arc interrupting contacts.
 - 9. Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
 - 10. Protective Shields: Cover live components and terminals.
 - 11. Fuses: De-energized if switch is open.
 - 12. Distribution Class Surge Arrestors on load side of fuse.
 - 13. Ground Ball Studs shall be provided on all phase, neutral and ground bus to allow for apparatus grounding clamps during maintenance.
- D. Mechanical Interlock Power Operators: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open to function in conjunction with fused switches in bays as indicated in the Components Part of this specification section.
 - 1. Green-OPEN, Red-CLOSED switch position indicators (FLAGS) with the words "Open" and "Closed" in French, Spanish and English.
 - 2. Keyed interlock, locks switch operator open, prevents electrical paralleling.
- E. Network Communications Equipment: Microprocessor-based unit suitable for three- or fourwire systems with the following features:

- 1. The communication system network shall be as described in Section 260913.
- 2. Each load interrupter switch position (open and closed), where shown, shall communicate via an addressable relay. This relay shall communicate over the network. The relay shall monitor an auxiliary switch contact that monitors the primary switch position and shall be rated for the application. Each relay shall have a unique address so that it is possible to "call up" and "read" each load interrupter switch's position from a host computer.
- 3. A blown high voltage fuse condition on each set of three (3) fuses shall be monitored by an addressable relay. Any blown fuse operation shall be communicated immediately over the network via the monitoring addressable relay. Each relay shall have a unique address so that it is possible to "call up" and "read" a fuse blown operation for a set of fuses with the communication system.
- F. Window: Minimum 8-inch x 16-inch high-impact viewing window that permits full view of the position of all three switch blades through the closed door. The window shall not be more than 58-inches above the switch pad level to allow ease of inspection.
- G. Key Interlocks: Arranged for interlocking schemes indicated.
- H. Padlocking Provisions: For installing at least three padlocks on each switch to secure its enclosure and prevent movement of drawout mechanism. Provisions shall be included for padlocking in the open or closed position.
- I. Power Fuses: Comply with the following and with applicable requirements in NEMA SG 2:
 - 1. Indicator: Integral with each fuse to indicate when it has blown.
 - 2. Mounting: Positively held in position with provision for easy removal and replacement from front without special tools.
 - 3. Current-Limiting, E-rated Fuses: Full-range, fast-replaceable, current-limiting type rated for not less than 50-kA RMS symmetrical current-interrupting capacity that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.
 - 4. Spares: Include three fuses in use and three spare fuses in storage clips in each switch

2.4 FABRICATION

- A. Enclosure: NEMA Type 3R, galvanized steel, listed for installation outdoors.
 - 1. Each compartment shall have the following features:
 - a. Structural design and anchorage adequate to resist loads imposed by 150-mph wind.
 - b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
 - c. Aisle-less construction, full height doors in front of basic weatherproof equipment, rear hinged doors for each section, all with provisions for padlocking. Downward, rearward sloping roof. Integral structural steel base frame with factory-applied undercoating.
 - d. Interior light with switch.
 - e. Weatherproof GFCI duplex receptacle.
 - f. Power for heaters, lights, automatic power operators and receptacles to be provided by control power transformer.
 - g. Ventilation louvers equipped with insect and rodent screen and filter, and arranged to permit air circulation while excluding rodents and exterior dust.
- B. Finish: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

- C. Bus Transition Unit: Arranged to suit bus and adjacent units.
- D. Incoming-Line Unit: Arranged to suit incoming line.
- E. Outgoing Feeder Units: Arranged to suit distribution feeders.
- F. Auxiliary Compartments: Arranged to house customer metering, relays, controls, and auxiliary equipment; isolated from medium-voltage components.
- G. Inspection windows, 4" diameter, in front/rear panels of each cubicle, to permit thermal imaging of terminations, with sliding cover.

2.5 COMPONENTS

- A. Main Bus: Copper, silver plated at connection points; full length of switchgear.
- B. Ground Bus: Copper, silver plated or copper, tin plated; minimum size 1/4 by 2 inches (6 by 50 mm); full length of switchgear.
- C. Bus Insulation: Covered with flame-retardant insulation.

D. Enclosure design:

Bay 1	Entrance Module Switch-Fuse - Power Op with the following optional features: outdoor construction – olive green finish dustproof construction for outdoor bay 600 a copper bus with silver-plated bus joints switch operator type ms-2 extra auxiliary switch, coupled to switch operator copper terminals and adapters on mini-rupter switches distribution class surge arresters, 3 kv micro-at source-transfer control remote indication for micro-at communications card for micro-at supervisory control for common-bus micro-at 2 fused vt's ph-ph with aux. xfmr - for l.h. entrance bay key interlock, locks switch open, prevents electrical paralle	Switch Type: Mini-Rupter Fuse Type: SM-40 eling
Bay 2	Entrance Module Switch-Fuse - Power Op with the following optional features: outdoor construction - olive green finish dustproof construction for outdoor bay 600 a copper bus with silver-plated bus joints switch operator type ms-2 extra auxiliary switch, coupled to switch operator copper terminals and adapters on mini-rupter switches terminal adapters for 2 cables per phase - cu distribution class surge arresters, 3 kv 2 fused vt's ph-ph - for r.h. entrance bay	Switch Type: Mini-Rupter Fuse Type: SM-40

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key interlock, locks switch operator open key interlocks, lock switch open, prevents electrical paralleling Bay 3 Tie-Metering Module Through Bus From Left with the Switch Type: None following optional features: Fuse Type: None outdoor construction - olive green finish dustproof construction for outdoor bay 600 a copper bus with silver-plated bus joints mounting provisions only - 3 customer-installed wound ct's 3 fused vt's connected phase-to-ground Switch Type: Mini-Rupter Feeder Module Switch-Fuse - Power Op with the following Bay 4 optional features: Fuse Type: SM-5S outdoor construction - olive green finish dustproof construction for outdoor bay 600 a copper bus with silver-plated bus joints switch operator type ms-10 digital multi-meter located in saginaw box - tbd provisions for digital multi-meter three window ct's rated 400:5 copper terminals and adapters on mini-rupter switches spd open-phase detector for use with 3 voltage sensors (included) single cylinder superior key interlock on switch handle - locks switch open Bay 5 Feeder Module Switch-Fuse - Power Op with the following Switch Type: Mini-Rupter optional features: Fuse Type: SM-5S outdoor construction - olive green finish dustproof construction for outdoor bay 600 a copper bus with silver-plated bus joints switch operator type ms-10 digital multi-meter located in saginaw box - tbd provisions for digital multi-meter three window ct's rated 400:5 copper terminals and adapters on mini-rupter switches spd open-phase detector for use with 3 voltage sensors (included) single cylinder superior key interlock on switch handle - locks switch open Feeder Module Switch-Fuse - Power Op with the following Bay 6 Switch Type: Mini-Rupter optional features: Fuse Type: SM-5S outdoor construction - olive green finish dustproof construction for outdoor bay 600 a copper bus with silver-plated bus joints switch operator type ms-10 digital multi-meter located in saginaw box - tbd provisions for digital multi-meter three window ct's rated 400:5 copper terminals and adapters on mini-rupter switches spd open-phase detector for use with 3 voltage sensors (included) single cylinder superior key interlock on switch handle - locks switch open

Bay 7 Feeder Module Switch-Fuse - Power Op with the following Switch Type: Mini-Rupter

Fuse Type: SM-5S

optional features:

outdoor construction - olive green finish dustproof construction for outdoor bay 600 a copper bus with silver-plated bus joints switch operator type ms-10 digital multi-meter located in saginaw box - tbd provisions for digital multi-meter three window ct's rated 400:5 copper terminals and adapters on mini-rupter switches spd open-phase detector for use with 3 voltage sensors (included) single cylinder superior key interlock on switch handle - locks switch open

- E. Provide insulating boots on all cable terminations.
- F. Instrument Transformers: Comply with IEEE C57.13.
 - 1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 - 2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.
- G. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or fourwire systems, listed and labeled by an NRTL, and with the following features:
 - 1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 - 2. Switch-selectable digital display with the following features:
 - 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. Three-Phase Real Power: Plus or minus 2 percent.
 - e. Three-Phase Reactive Power: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
 - 3. Mounting: Display and control unit that is flush or semi-flush mounted in instrument compartment door.
- G. Network Communications: Coordinate remote monitoring communication module package with power monitoring equipment specified in Division 26 Section "Electrical Power Monitoring and Control" for successful transmission and remote readout of monitoring data.
 - 1. Connect remote monitoring communication module to Using Agency's data network through appropriate network interface unit.
 - 2. The manufacturer shall wire between all communications capable devices within the switchgear, including electronic meters with the same protocol and wire to a set of easily accessible terminal blocks suitable for remote monitoring of meter quantities and functions.
 - a. Control power shall be 120 volts, 60 Hz available from a fused control transformer.
- H. Protective Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and

plugs.

- I. Surge Arresters: Distribution class B, 3KV, metal-oxide-varistor type. Comply with ANSI C37.90.1 and NEMA LA 1.
 - 1. Install in cable termination compartments in each phase of circuit.
 - 2. Coordinate rating with circuit voltage.
- J. Control Power Supply: Control power transformer supplies 120-V control circuits through secondary disconnect devices. Include the following features:
 - 1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
 - 2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main switch for M-T-M arrangements.
 - a. Secondary windings connected through relay(s) to control bus to affect an automatic transfer scheme.
 - b. Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
 - 3. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.
- K. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
 - 1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
 - 2. Conductors sized according to NFPA 70 for duty required.

2.6 CONTROL BATTERY SYSTEM

- A. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded.
- B. Battery: Lead-calcium, maintenance-free type in sealed, clear plastic or glass containers, complete with electrolyte, fully charged and arranged for shipment with electrolyte in cells. Limit weight of each container to not more than 70 lb (32 kg) and cells per container to not more than 3. System batteries shall be suitable for service at an ambient temperature ranging from minus 18 to 25 deg C. Limit variation of current output to 0.8 percent for each degree below 25 deg C down to minus 8 deg C. For outdoor installations: Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article.
- C. Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads.
- D. Accessories:
 - 1. Thermometers with specific-gravity correction scales.
 - 2. Hydrometer syringes.
 - 3. Set of socket wrenches and other tools required for battery maintenance.

- 4. Wall-mounting, nonmetallic storage rack fitted to store above items.
- 5. Set of cell numerals.
- E. Charger: Provide products by La Marche. Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz. Other features of charger include the following:
 - 1. DC ammeter.
 - 2. DC Voltmeter: Maximum error of 5 percent at full-charge voltage; operates with toggle switch to select between battery and charger voltages.
 - 3. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by normally open push-button contact.
 - 4. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
 - 5. Charging-Rate Switch: Manually operated switch provides for transferring to higher charging rate. Charger operates automatically after switch operation until manually reset.
 - 6. AC power supply is 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3-Hz variation in frequency. After loss of ac power supply for any interval, charger automatically resumes charging battery. Charger regulates rate of charge to prevent damage due to overload and to prevent fuses or circuit breakers from opening.
 - 7. Protective Feature: Current-limiting device or circuit, which limits output current to rating of charger but does not disconnect charger from either battery or ac supply; to protect charger from damage due to overload, including short circuit on output terminals.
 - 8. Electrical Filtering: Reduces charger's audible noise to less than 26 dB.

2.7 UTILITY COMPANY EQUIPMENT

- A. Provide separate cubicles for utility metering equipment. Utility metering vertical section shall contain provisions for minimum (3) wound current transformers and voltage transformers connected phase to ground as required by the Utility. The construction shall conform to the Utility Company's metering standards. It shall also conform to the general electrical and construction design of the switchgear specified above.
- B. Provide suitable arrangements within the utility primary metering cubicles for mounting metering equipment, including drilling or tapping the bus. Obtain the Utility's approval of the cubicle arrangements prior to fabrication of the switchgear.
- C. This Contractor shall be responsible for coordinating the installation of utility metering equipment by utility personnel.

2.8 SPACE FOR FUTURE DEVICES

A. Where indicated on the Drawings, "space" shall mean fully provisioned space ready for inserting a circuit breaker at a future date without any future modifications. Provide current transformers sized according to the breaker frame size. A blank door shall close off the front of the compartment.

2.9 IDENTIFICATION

- A. Materials: Refer to Section 26 05 53"Identification for Electrical Systems." Identify units, devices, controls, and wiring.
- B. Mimic Bus: Continuous mimic bus applied to front of switchgear, arranged in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram.
 - 1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
 - 2. Medium: Painted graphics, contrasting color to factory-finish as approved.
- 2.10 SOURCE QUALITY CONTROL
 - A. Before shipment of equipment, perform the following tests and prepare test reports:
 - 1. Production tests on circuit breakers according to ANSI C37.09.
 - 2. Production tests on completed switchgear assembly according to IEEE C37.20.2.
 - B. Assemble switchgear and equipment in manufacturer's plant and perform the following:
 - 1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
 - 2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.
 - C. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

2.11 FACTORY FINISHES

A. Finish: Manufacturer's standard olive green finish applied to equipment before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Anchor switchgear assembly to concrete base and attach by bolting.
 - 1. Interior location: Concrete base 4 inches high, reinforced, with chamfered edges. Extend base no less than 3 inches in all directions beyond the maximum dimensions of switchgear, unless otherwise indicated. Construct concrete bases according to Division

26 Section "Hangers and Supports for Electrical Systems."

- 2. Exterior location: Mount switchgear on concrete slabs. Unless otherwise indicated, the slab shall be at least 8 inches thick, reinforced with a 6 by 6 inch No. 6 mesh placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. The top of the concrete slab shall be approximately 4 inches above the finished grade. Edges shall be chamfered. The slab shall be of adequate size to project at least 8 inches beyond the equipment.
 - a. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Division 03 Sections.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

3.3 DOCCUMENTATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Diagram and Instructions:
 - 1. Provide to owner with maintenance manual:
 - a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
 - b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
 - 2. Storage for Maintenance: Include a rack or holder, with the maintenance manual.

3.4 CONNECTIONS

- A. Cable terminations at switchgear are specified in Division 26 Section "Medium-Voltage Cables."
- B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values using a calibrated torque wrench. Provide a list of all torqued connections and values.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Sections "Low-Voltage Electrical Power Conductors and Cables" and "Medium-Voltage Cables."
- E. Provide all communications wiring between remote monitoring communication modules and the Using Agency's data network. Verify that each circuit breaker's address for microprocessor-communication packages corresponds to Division 26 Section "Electrical Power Monitoring and Control Systems" requirements.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.

- 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect switchgear, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
 - 2. Assist in field testing of equipment.
 - 3. Report results in writing.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
 - a. Switchgear.
 - b. Circuit breakers.
 - c. Protective relays.
 - d. Instrument transformers.
 - e. Metering and instrumentation.
 - f. Ground-fault systems.
 - g. Battery systems.
 - h. Surge arresters.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchgear lineup. Remove front and rear panels so joints and connections are accessible to portable scanner.
 - 1. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial actions taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics according to results in Division 26 Section "Overcurrent Protective Device Coordination Study." Post a durable copy of the "as-left" relay settings and fuse ratings in a convenient location within the switchgear.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturers' stipulated service conditions.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain switchgear.

PART 4 CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 13 00

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SECTION 26 13 01 – MEDIUM VOLTAGE PAD MOUNTED GEAR

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The pad-mounted model 9 gear shall consist of a single self-supporting enclosure, containing two interrupter switches and power fuse compartments with the necessary accessory components, all completely factory-assembled and operationally checked. The interrupter switches and fuses shall be enclosed within an inner grounded steel compartment for electrical isolation and for protection from contamination. Switch terminals shall be equipped with bushings rated 600 amperes continuous, and fuse terminals and bus terminals shall be equipped with bushing wells rated 200 amperes continuous to provide for elbow connection. Bushings and bushing wells shall be mounted on the walls of the inner compartment and shall extend into termination compartments. Provide with a termination compartment shall be provided for each three-phase switch, each three-phase set of fuses, and each three-phase set of bus terminals. Switchgear to be furnished with power operators to function in conjunction with fused switches in bays as indicated in the Components Part of this specification section. A mechanical interlock is to be included to prevent opening of the switchgear door when the main switch is closed. Also, closing of the main switch must be performed manually when the switchgear door is closed. Provide within lockable, gasketed, minimum 11 gauge steel cover to prevent tampering and provide owner with keys.

B. Related Requirements:

- 1. Section 26 13 00 "Medium Voltage Switchgear" for medium voltage fused interrupter switchgear used as incoming primary equipment.
- 2. Section 26 05 72 "Overcurrent Protective Device Short-Circuit Study".
- 3. Section 26 05 73 "Overcurrent Protective Device Coordination Study".
- 4. Section 26 05 74 "Overcurrent Protective Device Arc-Flash Study" for short-circuit rating of devices and for setting of overcurrent protective devices and protective relays.
- 5. Electrical drawings, particularly sheet S-E102 Single Line Diagram.
- 6. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. GFCI: Ground-Fault Circuit Interrupter.
- C. CDB: Capital Development Board

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any partsCDB 040-010-115Page 1New Nursing Home and Domiciliary26 13 00Quincy Veterans' Home, Adams CountyBridging Documents

from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of switchgear and related equipment, include the following:
 - 1. Rated capacities, operating characteristics, furnished specialties, and accessories for individual interrupter switches and overcurrent protective devices.
 - 2. Time-current characteristic curves for overcurrent protective devices.
- B. Shop Drawings: For each type of switchgear and related equipment, include the following:
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
 - a. Tabulation of installed devices with features and ratings.
 - b. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
 - c. Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
 - d. Floor plan drawing showing locations for anchor bolts.
 - e. Current ratings of buses.
 - f. Short-time and short-circuit ratings of switchgear assembly.
 - g. Nameplate legends.
 - h. Mimic-bus diagram.
 - i. Utility company's metering provisions with indication of approval by utility company.
 - 2. Wiring Diagrams: For each type of switchgear and related equipment, include the following:
 - a. Power, signal, and control wiring.
 - b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
 - c. Schematic control diagrams.
 - d. Diagrams showing connections of component devices and equipment.
 - e. Schematic diagrams showing connections to remote devices including power monitoring and control devices.
- C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Identify field measurements.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals. In addition, include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL and marked for intended use.
- D. Comply with IEEE C2.
- E. Comply with Using Agency Design Standards.

1.7 DELIVERY, STORAGE, AND HANDLING

- D. Deliver in sections of lengths that can be moved past obstructions in delivery path as indicated.
- E. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- F. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
 - 1. Ambient temperature not exceeding 122 deg F (50 deg C).
 - 2. Altitude: Sea level to 1000 feet (300 m).
 - 3. Wind Resistant to 150 MPH.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Using Agency or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify CDB no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without CDB's written permission.
 - 3. CDB Lock-out/Tag-out procedures shall be used with Contractor controlled locks and tags.
 - 4. Comply with NFPA 70E.
1.9 COORDINATION

- A. Coordinate sensor-communication module package with data network and with monitoring equipment specified in Section 26 09 13 "Electrical Power Monitoring and Control" for successful transmission and remote readout of remote monitoring data specified in this Section.
- B. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- C. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Six of each type and rating used. Include spares for future transformers, control power circuits, and fusible devices.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Available Manufacturers:
 - 1. S & C Custom Metal Enclosed Switchgear
 - 2. Eaton Corp. Electrical Group "MVS, or equal.
 - 3. Square D; a brand of Schneider Electric.
 - 4. General Electric Company; GE Consumer & Industrial Electrical Distribution.

2.2 MANUFACTURED UNITS

- A. Description: Factory assembled and tested.
- B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.
- C. System Voltage: 12.47 kV nominal; 15 kV maximum.

2.3 METAL-ENCLOSED, PAD MOUNTED GEAR

- A. Comply with ANSI C57.12.28.
- B. Comply with NEC 710.21(e).

2.4 COMPONENTS

A. Main Bus: Copper, silver plated at connection points; full length of gear.

Mini-Rupter

SM-20

- B. Ground Bus: Copper, silver plated or copper, tin plated; minimum size 1/4 by 2 inches (6 by 50 mm); full length of gear.
- C. Bus Insulation: Covered with flame-retardant insulation.
- D. Enclosure Design.
- a. Feeder Module Switch-Fuse Power Op with (2) fused switches per enclosure and the following:
- b. Switch Type:
- c. Fuse Type:
- d. Outdoor construction PME Dead front; olive green finish
- e. Dustproof construction for outdoor bay
- f. 600 a copper bus with silver-plated bus joints
- g. Copper terminals and adapters on mini-rupter switches

h. Key interlocks that provide an open loop scheme which does not allow all of the switches in the loop to be closed at the same time as well as providing fuse access which requires all switches within the individual pad-mount to be open to allow access to the fuses within that unit.

- E. Provide insulating boots on all cable terminations.
- G. Protective Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.
- H. Surge Elbow Arresters: Distribution class B, 3KV, metal-oxide-varistor type. Comply with ANSI C37.90.1 and NEMA LA 1.
 - 1. Install in cable termination compartments in each phase of circuit.
 - 2. Coordinate rating with circuit voltage.

2.5 IDENTIFICATION

A. Materials: Refer to Section 26 05 53"Identification for Electrical Systems." Identify units, devices, controls, and wiring.

2.6 SOURCE QUALITY CONTROL

- A. Before shipment of equipment, perform the following tests and prepare test reports:
 - 1. Production tests on circuit breakers according to ANSI C37.09.
 - 2. Production tests on completed switchgear assembly according to IEEE C37.20.2.
- B. Assemble switchgear and equipment in manufacturer's plant and perform the following:
 - 1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
 - 2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.
- C. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.

2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

2.7 FACTORY FINISHES

A. Finish: Manufacturer's standard color finish applied to equipment before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Anchor switchgear assembly to concrete base and attach by bolting.
 - Interior location: Concrete base 4 inches high, reinforced, with chamfered edges. Extend base no less than 3 inches in all directions beyond the maximum dimensions of switchgear, unless otherwise indicated. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
 - 2. Exterior location: Mount switchgear on concrete slabs. Unless otherwise indicated, the slab shall be at least 8 inches thick, reinforced with a 6 by 6 inch No. 6 mesh placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. The top of the concrete slab shall be approximately 4 inches above the finished grade. Edges shall be chamfered. The slab shall be of adequate size to project at least 8 inches beyond the equipment.
 - a. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Division 03 Sections.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

3.3 DOCUMENTATION

- A. Diagram and Instructions:
 - 1. Frame under clear acrylic plastic inside front cover of switchgear.
 - a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
 - b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

3.4 CONNECTIONS

- A. Cable terminations at switchgear are specified in Division 26 Section "Medium-Voltage Cables."
- B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values using a calibrated torque wrench. Provide a list of all torqued connections and values.

- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Sections "Low-Voltage Electrical Power Conductors and Cables" and "Medium-Voltage Cables."
- E. Provide all communications wiring between remote monitoring communication modules and the Using Agency's data network. Verify that each circuit breaker's address for microprocessor-communication packages corresponds to Division 26 Section "Electrical Power Monitoring and Control Systems" requirements.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect switchgear, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
 - 2. Assist in field testing of equipment.
 - 3. Report results in writing.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
 - a. Switchgear.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchgear lineup. Remove front and rear panels so joints and connections are accessible to portable scanner.
 - 1. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial actions taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics according to results in Division 26 Section "Overcurrent Protective Device Coordination Study." Post a durable copy of the "as-left" relay settings and fuse ratings in a convenient location within the switchgear.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train CDB's maintenance personnel to adjust, operate, and maintain gear.

PART 4 CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 13 01

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600V and less, with capacities up to 1500 kVA:
 - 1. Distribution transformers.
 - 2. Drive Isolation Transformers.
 - 3. Buck-boost transformers.
 - 4. Control and Signal Transformers.
- B. Related Requirements:
 - 1. Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables".
 - 2. Section 26 05 26 "Grounding and Bonding for Electrical Systems".
 - 3. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- 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. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Transformer ratings including:
 - a. kVA
 - b. Primary and secondary voltage
 - c. Taps
 - d. Basic impulse level (BIL) for equipment over 600 volts
 - e. Design impedance
 - f. Insulation class and temperature rise
 - g. Sound level

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer: Submit certification that transformers, accessories, and components will withstand seismic forces to indicate that the unit will be fully operational after the seismic event."

- 1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For testing agency.
- C. Source quality-control test reports.
- D. Field quality-control test reports.
- E. Submit Letter of Compliance with NEMA TP-1 and DOE 2016.
- F. Submit certification of sound level compliance.
- 1.5 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.
- 1.6 QUALITY ASSURANCE
 - A. Source Limitations: Obtain each transformer type through one source form a single manufacturer.
 - B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - C. Comply with IEEE C57.12.91, "Testing Code for Dry-Type Distribution Transformers and Power Transformers".
 - D. Comply with International Building Code (IBC).
 - E. Comply with NFPA 70 (NEC).
 - F. Comply with FM Global requirements.
- 1.7 DELIVERY, STORAGE, AND HANDLING
 - A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchorbolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03. B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical, Inc. Cutler-Hammer Products.
 - 2. General Electric Company; GE Consumer & Industrial Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and tested, air-cooled units for 60-Hz service.
- B. Cores: One leg per phase. Cores shall be constructed of high grade, non-aging silicon steel. The core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The complete core and coil shall be bolted to the base of the enclosure but isolated by means of rubber, vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor or strap sized in accordance with UL and NEC requirements. The neutral shall be brought to a stud to facilitate the required external grounding of the secondary.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.
- D. Connections to the transformer shall be by flexible metal conduit and using flexible couplings.
- E. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.
- F. Wiring Terminations:
 - 1. Recommended external cable shall be rated 90 deg C (sized at 75 deg C ampacity) for encapsulated and 75 deg C for ventilated designs.
 - 2. Conductors should be selected on the basis of type and cable size used to wire the specific transformer.
 - 3. Lug kits shall be provided by the Manufacturer of the transformer.

2.3 DISTRIBUTION TRANSFORMERS

- A. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Test according to NEMA TP 2.
- B. Furnish with nameplate, color shall be per the specification.
- C. Comply with NEMA ST 20 and list and label as complying with UL 1561.
- D. Enclosures: Unless otherwise specified, transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. Enclosures shall be baked polyester powdered coat finish-gray in color and suitable for interior or exterior applications. Enclosures shall be constructed so that there are no exposed live parts. Enclosures shall have a removable front cover to allow access to internal parts and wiring terminations.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
 - 2. Transformer locations:
 - a. Dry locations:
 - 1) Ventilated
 - 2) NEMA 250, Type 2.
 - b. Damp or wet:
 - 1) Ventilated. Provide weather shields over ventilation openings.
 - 2) NEMA 250, Type 3R.
 - c. Corrosive locations:
 - 1) Totally enclosed, non-ventilated
 - 2) NEMA 250, Type 4X, stainless steel.
 - 3. The maximum temperature of the enclosure shall not exceed 90 deg C.
 - 4. The maximum temperature of the top of the enclosure shall not exceed 50 deg C rise above a 40 deg C ambient.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
- F. Taps for Three-phase Transformers smaller than 24 kVA and all single-phase transformers: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- G. Taps for Three-phase Transformers 25 kVA through 500 kVA: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- H. Taps for Three-phase Transformers 501 kVA and larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- 1. Insulation Class for Transformers less than 15 kVA: 185 degree C, UL-component-recognized insulation system with a maximum of 115 degree rise above 40 deg C ambient temperature.
- J. Insulation Class for Transformers 15 kVA and Larger: 220 degree C, UL-component-recognized insulation system with a maximum of 115 degree rise above 40 deg C ambient temperature.

- K. K-Factor Rating. Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
- L. Low Sound Level Units: NEMA ST20 Standard sound levels when factory tested according to IEEE Standard C57.12.91. "Test Code for Dry-Type Distribution and Power Transformers".
- M. Accessories: The following accessory items are required where indicated:
 - 1. Surge Arrestors: NEMA Standard LA 1, low voltage type, factory installed and connected to (high-voltage) (low-voltage) terminals.
 - 2. Electrostatic Shielding: Insulated metallic shield between primary and secondary windings.
 - a. Connect shield to terminal marked "Shield" for grounding connection.
 - b. Capacitance: Arrange shield to provide a maximum of 33 picoarads primary-to-secondary capacitance over a frequency range of 20Hz to 1MHz.
 - 3 Wall Brackets: Manufacturer's standard *brackets* [up to 75 kVA only].
- O. Mounting Methods:
 - 1. Transformers 75 kVA and larger shall be floor mounted unless indicated otherwise. Transformers 45 kVA and smaller may be wall mounted where the wall construction is suitable for the load. Floor mounted transformers shall be securely bolted to a 4-inch housekeeping pad with vibration isolation pads. Wall-mounted or suspended transformers shall have means of isolating the vibration from the support.
 - 2. Transformers up through 1000 kVA shall be mounted on elastomeric vibration isolation pads. Pads shall be constructed of neoprene, rubber, glass fiber or a combination thereof. Pads shall be "ribbed" or "waffled" in texture. Pads shall be selected for smallest durometer (hardness), preferably less than 50. Deflection of pad shall be .25" static minimum. Stack pads until desired deflection is achieved.
 - 3. Wall Mounting: Manufacturers standard brackets.
 - 4. Suspended Mounting: Refer to transformer detail on drawings.
- P. Fungus Proofing: Permanent fungicidal treatment for coil and core.
- Q. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound when factory tested according to IEEE C57.12.91.
- R. Low-Sound-Level Requirements: Maximum sound levels (NEMA ST 20) standard sound when factory tested according to IEEE C57.12.91, as follows:
 - 1. 9 kVA and Less: 40 dBA.
 - 2. 30 to 50 kVA: 45 dBA.
 - 3. 51 to 150 kVA: 50 dBA.
 - 4. 151 to 300 kVA: 55 dBA.
 - 5. 301 to 500 kVA: 60 dBA.
 - 6. 501 to 700 kVA: 62 dBA.
 - 7. 701 to 1000 kVA: 64 dBA.
 - 8. 1001 to 1500 kVA: 65 dBA.
- 2.4 DRIVE ISOLATION TRANSFORMERS

- A. Comply with NEMA Standard ST 1 "Specialty Transformers: and UL Standard 506 "Specialty Transformers", except where specified below.
- B. Capacity rating: Continuous duty. Where rating is not indicated, provide capacity as recommended by the drive manufacturer.
- C. Type: Self-cooled, 2-winding, dry-type, designed for the specific application required. Include special coil bracing to withstand the electromechanical forces that may occur. Three-phase units use one coil per phase in primary and secondary.
- D. Features and Ratings; As follows:
 - 1. Enclosure: Indoors, ventilated. Drip-proof or Totally enclosed where indicated.
 - 2. Enclosure: Exterior, rain-tight, NEMA 3R. Totally enclosed where indicated.
- E. Insulation Class: Per Section 2.3, item H of this specification section.
- F. Taps: Two 5-percent, full capacity taps, 1 above and 1 below rated high voltage.
- G. Temperature Sensing Device: Thermistor embedded in coil with leads brought out to terminal board.
- 2.5 BUCK-BOOST TRANSFORMERS
 - A. Comply with NEMA Standard ST 1 "Specialty Transformers: and UL Standard 506 "Specialty Transformers", except where specified below.
 - B. Capacity Rating: Continuous duty.
 - C. Type: Self-cooled, dry-type, connected as autotransformers to provide the percentage of buck or boost indicated.
 - D. Enclosure: Ventilated, NEMA 250, Type 2, Suitable for the location where installed.
 - 1. Finish Color: ANSI 61 gray.
 - E. Low Sound Level Units: Minimum of 3dBA less than NEMA ST 1 standard for transformer of type and size indicated.

2.6 CONTROL AND SIGNAL TRANSFORMERS

- A. Comply with NEMA Standard ST 1 "Specialty Transformers: and UL Standard 506 "Specialty Transformers", except where specified below.
- B. Ratings: Continuous duty. Where ratings are not indicated, provide capacity exceeding peak load by 50 percent minimum.
- C. Type: Self-cooled, 2-winding, dry-type.

D. Enclosure: Suitable for the location where installed.

2.7 IDENTIFICATION DEVICES

- A. Manufacturer's Nameplates: Nameplates (minimum of two required) for each transformer shall be permanently affixed to the left and right side of each transformer enclosure so that the transformer remains permanently identified when front or back covers are removed. The placement of a single manufacturer nameplate on the front cover of the enclosure is unacceptable.
- B. Identification Nameplates: Engraved, laminated-plastic or metal nameplate for each [filter] [drive isolation] [distribution] transformer shall be used to identify the transformer name, kVA rating, source name, load name and feeder size for both primary and secondary. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.
- 2.9 FACTORY TESTING
 - A. The following standard factory tests shall be performer on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
 - 1. Ratio tests at rated voltage connection and at all tap connections.
 - 2. Polarity and phase relation test on the rated voltage connection
 - 3. Applied potential tests.
 - 4. Induced potential test.
 - 5. No-load and excitation current at rated voltage on the rated voltage connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Wall mount transformers 15 kVA or less, suspend transformers larger than 15 kVA and in sizes up to and including 75 kVA from the structure overhead. Utilize trapeze hanger arrangement for the purpose. Floor mount all transformers larger than 75 kVA.
- C. Coordinate location of ceiling suspended transformers with building structure and with equipment in closet so as to insure accessibility and working clearances. If necessary, to so insure, floor mount transformers in lieu of suspending them. Modify closet layout accordingly.
- D. Floor or wall supported transformers shall be resiliently suspended by means of neoprene in shear hanger rod isolators providing a minimum static deflection of 3/8-inch.
- E. Ceiling supported transformers shall be resiliently isolated from the building structure by means of neoprene in shear isolators providing a minimum static deflection of 3/8-inch.
- F. Construct concrete bases 4-inches high for floor mounted transformers and anchor transformers to pad according to manufacturer's written instructions and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
- G. Do not install transformers in ceiling cavities.

3.3 CONNECTIONS

- A. Connection to Transformers: Flexible Metallic Conduit (FMC), primary and secondary.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
 - 1. External cable shall be rated 90 degrees C (sized at 75 degrees C ampacity) for encapsulated and 75 degrees C for ventilated designs. Connectors should be selected on the basis of the type and cable size used to wire the specific transformer.
 - 2. Verify tightness and torque all accessible bolted electrical connections to manufacturer's specified values using a calibrated torque wrench.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. 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.

- C. 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.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- E. Remove and replace units that do not pass tests or inspections and retest as specified above.
- F. Infrared Scanning: After Substantial Completion, but prior to beneficial occupancy, perform an infrared scan of all transformer connections.
 - 1. Uses an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. 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.

3.6 CLEANING

- A. Remove paint splatters and other spots, dirt, debris. Repair scratches and mars on finish to match original finish.
- B. Clean components internally using methods and materials recommended by manufacturer.
- C. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 22 00

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Indoor service and distribution switchboards rated 600 V and less.
 - a. Service and distribution switchboards rated 600V and less
 - b. Surge suppression devices.
 - c. Disconnecting and overcurrent protective devices.
 - d. Instrumentation.
 - e. Control power.
 - f. Accessory components and features.
 - g. Identification.
 - h. Concrete housekeeping pads for all Switchboards.

1.3 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 1. Section 26 05 73 "Overcurrent Protective Device Coordination Study".
 - 2. Section 26 43 13 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" for transient voltage surge suppressors for low-voltage power, control, and communication equipment located in the switchgear.
 - 3. Section 26 05 73 "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
 - 4. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, surge suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings,

accessories, and finishes.

- 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. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detailed short-circuits current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - 6. Include evidence of NRTL listing for series rating of installed devices.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
 - 9. Include schematic and wiring diagrams for power, signal, and control wiring.
- C. Qualification Data: For qualified Installer.
 - 1. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

1.6 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces to include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition, include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.

- 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- 3. Submit time-current coordination curves for each type and rating of overcurrent protective device included in switchboards on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: One of each size and type.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
- C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by UL and marked for intended location and application.
- F. Use of series rated equipment is prohibited.
- G. Comply with NEMA PB 2.
- H. Comply with International Building Code (IBC).
- I. Comply with NFPA 70 (NEC).
- J. Comply with UL 891.
- K. Comply with FM Global requirements.
- 1.10 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
 - B. Remove loose packing and flammable materials from inside switchboards and install temporary

electric heating (250W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1 and NECA 400.

1.11 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).
- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Using Agency or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Using Agency no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Using Agency's written permission.
 - 4. Using Agency Lock-out/Tag-out procedures shall be used with Contractor controlled locks and tags.
 - 5. Comply with NFPA 70E.

1.12 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate with work of other trades so that piping, ductwork, or any other equipment foreign to the electrical installation is not located directly above switchboards
- C. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-

bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One 1 year from date of Substantial Completion.

1.14 EXTRA MATERIALS

- A. Furnish extra materials and match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Potential Transformer Fuses: Equal to 10 Percent of quantity installed for each size and type.
 - 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Circuit breakers: Three of each size and type.
 - 4. Fuses for Power-Circuit Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 5. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517). Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Corp. Electrical Group., DS Series.
 - 2. General Electric Company; GE Consumer & Industrial Electrical Distribution., Spectra Series.
 - 3. Siemens Energy & Automation, Inc., SB2 Series.
 - 4. Square D; a brand of Schneider Electric., 2700 QED-2 Series.
- B. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- C. Nominal System Voltage: 480Y/277 V as shown on the drawings.
- D. Main-Bus Continuous: as shown on the drawings.

- E. Indoor Enclosures: Steel, NEMA 250, Type 1.
- F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- G. Outdoor enclosures: Type 3R.
 - 1. Finish: Factory-applied finish in manufacturer's standard color, undersurfaces treated with corrosive-resistant undercoating.
 - 2. Enclosure: Downward, rearward sloping roof, bolt-on rear covers for each section, with provisions for padlocking.
- H. Barriers: Between adjacent switchboard sections.
- I. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- K. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- L. Pull Box on Top of Switchboard:
 - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 2. Set back from front to clear circuit-breaker removal mechanism.
 - 3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 - 4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 - 5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- M. Buses and Connections: Three-phase, four-wire unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silverplated, with tin-plated aluminum or copper feeder circuit-breaker line connections.
 - 2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit- breaker position.
 - 3. Ground Bus: 1/4-by-2-inch hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 4. 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.
 - 5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

- 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- N. Adjustments for Oversized Conductors: Provide suitable means to terminate conductor sizes and quantities for supply and load feeders indicated on the drawings, including but not limited to larger lugs, buses, or overcurrent protective device frame sizes.
- O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 SURGE PROTECTION DEVICES

- A. Surge Protection Device Description: IEEE C62.41-compliant externally mounted, UL 1449 3rd edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
 - 1. Comply with Division Section 26 43 13 "Surge Protective for Low-Voltage Electrical Power Circuits".
 - 2. Provide a dedicated three pole circuit breaker for the surge protective device in the switchboard.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB) Up to 1600 A: Comply with UL 489, 100% rated to meet available fault currents. Use of series rated equipment is prohibited.
 - 1. Thermal-Magnetic Circuit Breakers Less Than 225 A: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element and front-mounted field-adjustable trip setting.
 - 3. Electronic trip circuit breakers, 225 A and larger shall have 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 I2t response.
 - 4. Current-Limiting Circuit Breakers: Frame size 400A and smaller; let through rating less than NEMA FU 1, RK-5.
 - 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 - 6. Molded-Case Circuit-Breaker (MCCB) Features and Options:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, dual rated CU/AL, suitable for number, size, and trip ratings.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete bases, 4-inch (100-mm) nominal thickness. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of switchboards unless otherwise indicated. Comply with requirements specified in Section 26 05 29 "Hangers and Supports for Electrical Systems" and Division 03 Concrete Sections.
 - 1. Install dowel rods to connect concrete base to concrete floor on 18 inch (450-mm) 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, install to elevations required for proper attachment to switchboards.
 - 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. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1.Set field adjustable switches and circuit breaker trip ranges.

- G. Verify tightness and torque all accessible bolted electrical connections to manufacturer's specified values using a calibrated torque wrench.
- H. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "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."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard 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.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and

rear panels so joints and connections are accessible to portable scanner.

- b. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection report, 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.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.6 **PROTECTION**

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until switchboard is ready to be energized and placed into service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers
 - 4. Electronic-grade panelboards.
- B. Related Requirements:
 - 1. Section 26 09 13 "Electrical Power Monitoring and Control" for interfacing communication and metering.
 - 2. Section 26 43 13 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" for transient voltage surge suppressors for low-voltage power, control, and communication equipment located in the switchgear.
 - 3. Section 26 05 73 "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
 - 4. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.
- C. SPD: Surge Protective Device.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, surge suppression device, accessory, and component indicated. Include dimensions and manufacturers'
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technical data on features, performance, electrical characteristics, ratings, and finishes.

- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. 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. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
- C. Qualification Data: For qualified testing agency.
- D. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective

covering for storage and identified with labels describing contents.

- 1. Keys: Two spares for each type of panelboard cabinet lock.
- 1.7 QUALITY ASSURANCE
 - A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
 - B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
 - C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
 - D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - E. Comply with NEMA PB 1.
 - F. Comply with International Building Code (IBC).
 - G. Comply with NFPA 70 (NEC).
 - H. Comply with Using Agency Design Standards.
- 1.8 DELIVERY, STORAGE, AND HANDLING
 - A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250W per panelboard) to prevent condensation.
 - B. Handle and prepare panelboards for installation according to NEMA PB 1 and NECA 407.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

- 1. Ambient temperatures within limits specified.
- 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Using Agency or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Using Agency no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Using Agency's written permission.
 - 3. Using Agency Lock-out/Tag-out procedures shall be used with Contractor controlled locks and tags.
 - 4. Comply with NFPA 70E.

1.10 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchorbolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One 1 year from date of Substantial Completion.

1.12 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spare for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Six 20A, single pole spares, of each type, for each panelboard shown on the drawings.
 - 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Corp., PLR2 Series.
 - 2. General Electric Company; GE Consumer & Industrial Electrical Distribution., AE Series.
 - 3. Siemens Energy & Automation, Inc., P1 Series.
 - 4. Square D; a brand of Schneider Electric., NF or NQ Series.
- C. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Enclosures: Flush and surface-mounted cabinets.
 - 1. 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. Kitchen, Food Service and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within door hinged trim cover.
 - 3. Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 4. Gutter Extension and Barrier: Same gauge and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 5. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pre-treating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel. Same finish as panels and trim.
 - 6. Directory Card: Inside attached to panelboard door, mounted in transparent protective cover with typed circuit descriptions and locations, dated with Electrical Installer's company name and contact information.
- D. Incoming Mains Location: Top and bottom.
- E. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 3. Isolated Ground Bus per plans or drawing panel schedules: Adequate for branch-circuit isolated ground conductors; insulated from box.

- 4. Fully rated Neutral bus.
- 5. Extra-Capacity Neutral Bus where directed on plans or panel schedules: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- F. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 - 4. Feed-Through Lugs per plans or panel schedules: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Sub-feed (Double) Lugs per plans or panel schedules: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- G. Adjustments for Oversized Conductors: Provide suitable means to terminate conductor sizes and quantities for supply and load feeders indicated on the drawings, including but not limited to larger lugs, buses, or overcurrent protective device frame sizes.
- H. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- I. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Short circuit current rating shall be as determined by the manufacturer's overcurrent protection device study. Refer to Section 260573 "Overcurrent Protective Device Coordination Study" for additional information.
- K. Nameplates:
 - 1. Provide engraved laminated phenolic nameplates for the panelboard and each device. Nameplate color shall be per the specifications.
 - 2. The panelboard nameplate shall indicate the name of the equipment as designated on the Drawings and Specifications. The nameplate shall also indicate the source feeding the equipment.
 - 3. The feeder device nameplates shall indicate the name of the equipment or load being served as designated on the Drawings and Specifications.
- L. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- M. Doors: Secured with Corbin Series 1001, master keyable and operate with a FAB-7 key.

2.2 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- C. Mains: Circuit breaker or Lugs as shown on the drawings.
- D. Branch Overcurrent Protective Devices for circuit breaker frame sizes 125A and smaller: Bolt-on circuit breakers.
- E. Branch Overcurrent Protective Devices for circuit breaker frame sizes 125A and larger: Bolt-on circuit breakers, plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices: Fused switches.
- G. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control Power Source: Control-power transformer with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 - 2. External Control-Power Source: 120-V branch circuit.
- H. Surge Protection Device: IEEE C62.41-compliant, complying with UL 1449, 3rd edition and Specification 264313.
- 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
 - B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
 - C. Mains: Circuit breaker or lugs, as indicated on the drawings.
 - D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
 - E. Contactor in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuits interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 - 2. External Control-Power Source: 120-V branch circuit.
 - F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
 - G. Column-Type Panelboards: Narrow gutter extension with cover to overhead junction box equipped with ground and neutral terminal buses.
 - H. Surge Protection Device: IEEE C62.41-compliant, [internally] [externally] mounted, complying with UL 1449, 3rd edition and Specification 264313.
- 2.4 LOAD CENTERS

- A. Load Centers: Comply with UL 67.
- B. Mains: Circuit breaker or lugs, as indicated on the drawings.
- C. Doors: Concealed hinges; secured with plastic flush latch.
- D. Branch Overcurrent Protection Devices: Plug-in circuit breaker, replaceable with disturbing adjacent units.
- E. Conductor Connectors: Mechanical type for main, neutral and ground lugs and buses.
- 2.5 ELECTRONIC-GRADE PANELBOARDS (Where indicated on plans or panel schedules)
 - A. Panelboards: NEMA PB 1; with factory-installed, integral TVSS; labeled by an NRTL for compliance with UL 67 after installing TVSS.
 - B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - C. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
 - D. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
 - E. Buses:
 - 1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
 - 2. Copper equipment and isolated ground buses.
 - F. Surge Protection Device: IEEE C62.41-compliant, complying with UL 1449, 3rd edition and Specification 264313.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. 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 for circuit-breaker frame sizes 250 A and larger; 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: Single- and two-pole configurations with Class B ground-fault protection (30-mA trip).
- 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breaker: Comply with UL 1699; 120/240-V, single-pole configurations.
- 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ranges and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Communication Capability: Communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - f. Shunt Trip: 120 -V trip coil energized from separate circuit.
 - g. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage with fieldadjustable 0.1- to 0.6-second time delay.
 - h. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit- breaker contacts.
 - i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - k. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - 1. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handles in on or off position.
 - m. Handle Clamp: Loose attachment, for holding circuit-breaker handles in on position.
 - n. Multi-pole circuit breakers shall have common trip, use of handle ties is not permitted.
- B. 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 Division 26 Section "Fuses".
 - 2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
 - 3. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.
- C. Nameplates:
 - 1. The equipment nameplates shall indicate the name of the equipment or load being served as designated on the Drawings and Specifications.

2.7 PANELBOARD SUPPRESSORS

A. Subject to compliance with requirements, Surge Protection Devices shall be IEEE C62.41compliant and complying with UL 1449, 3rd edition and Specification Section 26 43 13 " Surge Protection for Low-Voltage Electrical Power Circuits.

2.8 RETRO-FIT PANELBOARD KITS

- A. The panelboard kit shall be specifically designed for retrofit applications in existing panelboard boxes. Trims for retrofit panelboards shall be designed specifically for retrofit applications. Trim mounting shall not be dependent nor attached to the existing enclosure. The trim and door shall attach directly to the panelboard dead-front assembly so that no external trim-fastening hardware shall be required. Panelboards shall be fully rated.
- B. Interiors shall have field adjustable height and depth.
- C. Factory installed neutral and ground bars, field bondable for Service Entrance applications.
- D. Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit.
- E. Existing enclosures shall be identified for retrofit suitability in advance. The structural integrity of all existing enclosures shall be verified. Any enclosure that is damaged shall be replaced with a new enclosure and panelboard.

2.9 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. 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.

2.10 EXISTING DISTRIBUTION AND LIGHTING AND APPLIANCE PANELBOARDS

- A. Additions and modifications to existing panelboards shall be manufactured by the manufacturer of the original panelboard.
- B. Additions to existing panelboards shall maintain the Nationally Recognized Testing Laboratory listing of the panelboard.
- C. Circuit breakers added to an existing panelboard shall have an SCCR equal to the existing panelboard SCCR.
- D. In the event the manufacturer of the panelboard is no longer in business, additions to the existing panelboard shall be listed by a Nationally Recognized Testing Laboratory for installation into the discontinued panelboard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1 and NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1 and NECA 407. Where possible panelboards installed in finished areas shall be flush mounted and served through concealed conduit.
- B. Wall Mounted Panelboards: Install panelboards on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For panels not installed on walls, provide free-standing rack complying with Section 26 05 29 "Hangers and Supports for Electrical Systems".
- C. Floor-Mounted Panelboards: Install panelboards on concrete bases, 4-inch (100mm) nominal thickness. Comply with requirements for concrete base specified in division 03 Section "Cast-in-Place Concrete".
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 - 2. Support panelboard on concrete base.
 - 3. Attach panelboards to the vertical finished or structural surface behind the panelboards.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- E. Comply with mounting and anchoring requirements specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- F. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- G. 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.
- H. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit breaker trip ranges.
- I. Provide GFCI circuit breakers with 30 mA sensitivity trip for all freeze protection, temperature maintenance, and heat tracing circuits.
- J. Install filler plates in unused spaces.
- K. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.
- L. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four (4) 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- M. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- N. Comply with NECA 1.
- O. New circuit breakers installed in existing panelboards shall be of standard manufacturer, shall match existing, and shall have an interrupting rating of not less than the lowest rated circuit breaker in the panelboard.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Using Agency's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Directory shall contain complete and detailed information for loads on each circuit.
- 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."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform test 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.
 - 3. Comply with NETS.
- 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.

- 3. Perform the following infrared scan test and inspections and prepare reports.
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each panelboard. Remove front so joints and connections are accessible to portable scanner.
- 4. Instruments and Equipment:
 - a. Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 CLEANING

A. Vacuum dirt and debris from panelboard tubs; do not use compressed air to assist in cleaning.

3.6 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.7 **PROTECTION**

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 24 16

SECTION 26 27 13 – ELECTRICITY METERING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Equipment for electricity metering by Utility Company.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For electricity-metering equipment.
 - 1. Dimensioned plans and sections or elevation layouts.
 - 2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by UL and marked for intended location and application.
- B. Comply with Using Agency Design Standards.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Using Agency or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Using Agency no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Using Agency's written permission.

1.7 COORDINATION

- 1. Electrical Service Connections: Coordinate with Utility Companies and components they furnish as follows:
 - 1. Comply with requirements of Utilities providing electrical power services.
 - 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by Utility Company.
- B. Current-Transformer Cabinets: Comply with requirements of electrical-power Utility Company.
- C. Meter Sockets: Comply with requirements of electrical-power Utility Company.
- D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by Utility Company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by Utility Company.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.1. Comply with Utility Company requirements.
- B. Electricity metering will be considered defective if it does not pass Utility's tests and inspections.

PART 4 CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 27 13

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.2 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Receptacles with integral USB charger.
 - 3. Receptacles with integral Arc Fault Circuit Interrupter, AFCI.
 - 4. Plugload Control Receptacles.
 - 5. Twist-locking receptacles.
 - 6. Receptacles with integral surge-suppression units.
 - 7. Isolated-ground receptacles.
 - 8. Tamper-resistant receptacles.
 - 9. Weather-resistant receptacles.
 - 10. Snap switches.
 - 11. Wall-switches.
 - 12. Pendant cord-connector devices.
 - 13. Cord and plug sets.
 - 14. Floor service outlets, poke-through assemblies and multioutlet assemblies.

1.3 DEFINITIONS

- A. AFCI: Arc fault circuit interrupter.
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- E. Plugload Control Receptacle: Automatically occupancy switched receptacle.
- F. RFI: Radio-frequency interference.
- G. TVSS: Transient voltage surge suppressor.
- H. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
- 2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packinglabel warnings and instruction manuals that include labeling conditions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
 - 2. Poke-Through, Fire-Rated Closure Plugs: One for every 10 installed, but no fewer than one.
 - 3. TVSS Receptacles: One for every 10 installed, but no fewer than one.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; Wiring Device-Kellems (Hubbell) or a comparable product by one of the following:
 - 1. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - 2. Leviton Manufacturing Co., Inc.
 - 3. Pass & Seymour/Legrand (Pass & Seymour).
- C. 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.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors to comply with UL 2459 and be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.
- D. Devices color shall be coordinated with Architect prior to ordering.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, Heavy Duty 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL5361 (single), HBL5362 (duplex), or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 5361 (single), AH 5362 (duplex).
 - b. Leviton Manufacturing Co., Inc.; 5361 (single), 5362 (duplex).
 - c. Pass & Seymour/Legrand (Pass & Seymour); 5361 (single), 5362 (duplex).
- B. USB Charging Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596. Compatible with USB 1.1/2.0/3/0 devices, including Apple products.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; USB 20X2 duplex receptacle with 2 USB charging ports or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; TR7756.
 - b. Leviton Manufacturing Co., Inc.; T5362.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; TR5362USB.
- C. Arc Fault Convenience Receptacles, 125 V, 15A and 20A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; AFR25TRW, AFR20TRW, or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; TRAFC120.
 - b. Leviton Manufacturing Co., Inc.; AFTR2.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; AF20T.
- D. Permanently Marked Convenience Receptacles for Automatic Outlet Control Systems, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596, green device color.

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; BR20C1 with one controlled face split circuit hot tab or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.;
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
- E. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596, orange device color.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; IG5352 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; IG 5362.
 - b. Leviton Manufacturing Co., Inc.; 5362IG.
 - c. Pass & Seymour/Legrand (Pass & Seymour); IG5362.
 - 2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- F. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Wiring Device Kellems; BR20TR 8300 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; TRBR20.
 - b. Leviton Manufacturing Co., Inc.; TBR20.
 - c. Pass & Seymour/Legrand (Pass & Seymour); TR63.
 - Description: Labeled shall comply with NFPA 70, "Health Care Facilities" Article, Tamper-Resistant Convenience Receptacles, 125 V, 20 A. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
- G. Weather Resistant and Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Wiring Device Kellems; BR20 WRTR or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; TWR20.
 - b. Leviton Manufacturing Co., Inc.; TWR20.
 - c. Pass & Seymour/Legrand (Pass & Seymour); NO EQUAL.
- H. Single Receptacle, 125 V, 30 A, 2-pole, 3-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-30R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL9308 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 5716N
 - b. Leviton Manufacturing Co., Inc.; 5371
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 3802

- I. Single Receptacle, 250 V, 30 A, 2-pole, 3-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 6-30R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL9330 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 5700N
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 3801
- J. Single Receptacle, 125 V, 50 A, 2-pole, 3-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-50R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL9360 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 1253
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; D0553
- K. Single Receptacle, 250 V, 50 A, 2-pole, 3-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 6-50R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL9367 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 1254
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 3804
- L. Single Receptacle, 125/250 V, 20 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 14-20R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL8410 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 5759
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 3820
- M. Single Receptacle, 250 V, 3Ø, 20 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 15-20R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL8420 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 3821

- N. Single Receptacle, 125/250 V, 30 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 14-30R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL9430A or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 1257
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 3864
- O. Single Receptacle, 250 V, 3Ø, 30 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 15-30R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL8430A or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.;8430N
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 5740
- P. Single Receptacle, 125/250 V, 50 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 14-50R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL9450A or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 3894.
- Q. Single Receptacle, 250 V, 3Ø, 50 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 15-50R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL8450A or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 8450N.
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 5750.
- R. Single Receptacle, 125/250 V, 60 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 14-60R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL9460A or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 9460N.
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 1462

- S. Single Receptacle, 250 V, 3Ø, 60 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration 15-60R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL8460A or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 8460N
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).; 5760

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, 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. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; GF20LA or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; VGF20.
 - b. Leviton Manufacturing Co., Inc.; 7899.
 - c. Pass & Seymour/Legrand (Pass & Seymour); 2099.
- C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; GFTR20 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; TRVGF20.
 - b. Leviton Manufacturing Co., Inc.; T7899.
 - c. Pass & Seymour/Legrand (Pass & Seymour); 2095TR.

2.5 TVSS RECEPTACLES

- A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral TVSS in line to ground, line to neutral, and neutral to ground. Device color shall be blue.
 - 1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
 - 2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
- B. Duplex TVSS Convenience Receptacles:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL5362SA or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 5362 S.
 - b. Leviton Manufacturing Co., Inc.; 7380.
 - c. Pass & Seymour/Legrand (Pass & Seymour); 5362 SP.
- 2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.

2.6 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

- A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. EGS/Appleton Electric.
 - c. Killark.

2.7 TWIST-LOCKING RECEPTACLES

- A. Single Receptacles, 125 V, 20 A, 2-pole, 3-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL2310 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; AHL520R.
 - b. Leviton Manufacturing Co., Inc.; 2310.
 - c. Pass & Seymour/Legrand (Pass & Seymour); L520-R.
- B. Single Receptacles, 250 V, 3Ø, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L6-20R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL2320 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.;
 - c. Pass & Seymour/Legrand (Pass & Seymour);
- C. Single Receptacles, 125 V, 30 A, 2-pole, 3-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-30R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL2610 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.;
 - c. Pass & Seymour/Legrand (Pass & Seymour);

- D. Single Receptacles, 250 V, 3Ø, 30 A, 2-pole, 3-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration L6-30R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL2620 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.;
 - c. Pass & Seymour/Legrand (Pass & Seymour);
- E. Single Receptacles, 125/250 V, 20 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration L14-20R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL2410 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.;
 - c. Pass & Seymour/Legrand (Pass & Seymour);
- F. Single Receptacles, 250 V, 3Ø, 20 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration L15-20R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL2420 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.;
 - c. Pass & Seymour/Legrand (Pass & Seymour);
- G. Single Receptacles, 125/250 V, 30 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration L14-30R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL2710 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.;
 - c. Pass & Seymour/Legrand (Pass & Seymour);
- H. Single Receptacles, 250 V, 3Ø, 20 A, 3-pole, 4-wire grounding: Comply with NEMA WD 1, NEMA WD 6 Configuration L15-30R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL2720 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.;
 - c. Pass & Seymour/Legrand (Pass & Seymour);

2.8 PENDANT CORD-CONNECTOR DEVICES

- A. Description:
 - 1. Matching, locking-type plug and receptacle body connector.
 - 2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
 - 3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
 - 4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.9 CORD AND PLUG SETS

A. Description:

- 1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
- 2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with greeninsulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
- 3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.10 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
 - 1. Single Pole:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; 1221 or a comparable product by one of the following:
 - 1) Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; AH 1221.
 - 2) Leviton Manufacturing Co., Inc.; 1221-2.
 - 3) Pass & Seymour/Legrand (Pass & Seymour); PSAC1.
 - 2. Double Pole:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; 1222 or a comparable product by one of the following:
 - 1) Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; AH1222.
 - 2) Leviton Manufacturing Co., Inc.; 1222-2.
 - 3) Pass & Seymour/Legrand (Pass & Seymour); PS20AC2.
 - 3. Three Way:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; or a comparable product by one of the following:
 - 1) Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - 2) Leviton Manufacturing Co., Inc.
 - 3) Pass & Seymour/Legrand (Pass & Seymour).
- C. Key-Operated Switches, 120/277 V, 20 A:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; 1221L or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; AH1221L.
 - b. Leviton Manufacturing Co., Inc.; 1221-2L.
 - c. Pass & Seymour/Legrand (Pass & Seymour); PS20AC1-L.
- 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
- D. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL1557 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 1995.
 - b. Leviton Manufacturing Co., Inc.; 1257.
 - c. Pass & Seymour/Legrand (Pass & Seymour); 1251.
- E. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; HBL1557L or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 1995L.
 - b. Leviton Manufacturing Co., Inc.; 1257L.
 - c. Pass & Seymour/Legrand (Pass & Seymour); 1251L.
- 2.11 DECORATOR-STYLE DEVICES
 - A. Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; DR 20 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 6352.
 - b. Leviton Manufacturing Co., Inc.; 16352.
 - c. Pass & Seymour/Legrand (Pass & Seymour); 26352.
 - B. Tamper-Resistant Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; DR20TR or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; TR6352.
 - b. Leviton Manufacturing Co., Inc.; TDR20.
 - c. Pass & Seymour/Legrand (Pass & Seymour); TR26362.

- 2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.
- C. Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5 20R, and UL 498.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; DR20WRTR or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section, when installed in wet and damp locations.
- D. GFCI, Feed-Through Type, Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; GF20 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; VGF20.
 - b. Leviton Manufacturing Co., Inc.; 7899.
 - c. Pass & Seymour/Legrand (Pass & Seymour); 2095.
- E. GFCI, Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; GFTR20 or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; TWRVGF20.
 - b. Leviton Manufacturing Co., Inc.; W7899-TR.
 - c. Pass & Seymour/Legrand (Pass & Seymour); 2095TRWR.
 - 2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.
- F. Toggle Switches, Square Face, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; DS 120 (single pole), DS 220 (two pole), DS 320 (three-way DS 420 (4 way), or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 7621 (single pole), 7622 (two pole), 7623 (three way), 7624 (four way).
 - b. Leviton Manufacturing Co., Inc.; 5621-2 (single pole), 5622-2 (two pole), 5623-2 (three way), 5624-2 (four way).

- c. Pass & Seymour/Legrand (Pass & Seymour); 2621 (single pole), 2622 (two pole), 2623 (three way), 2624 (four way).
- G. Lighted Toggle Switches, Square Face, 120 V, 20 A: Comply with NEMA WD 1 and UL 20.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; DS120IL (single pole), DS 3201L (three way) or a comparable product by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.; 7631 (single pole), 7633 (three way).
 - b. Leviton Manufacturing Co., Inc.; 5631-2 (single pole), 5633-2 (three way).
 - c. Pass & Seymour/Legrand (Pass & Seymour); 2625 (single pole), 2626 (three way).
 - 2. Description: With neon-lighted handle, illuminated when switch is "off."

2.12 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.

2.13 FLOOR SERVICE FITTINGS

- A. Type: Modular, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling as described in division 27 communications specifications.
- C. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

2.14 POKE-THROUGH ASSEMBLIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; products named below or a comparable product by one of the following:
 - 1. FSR.
 - 2. Wiremold / Legrand.
- B. Description:
 - 1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
 - 2. Comply with UL 514 scrub water exclusion requirements.
 - 3. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables that comply with requirements in Section 271500 "Communications Horizontal Cabling."

2.15 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; or a comparable product by one of the following:

- 1. Wiremold / Legrand.
- B. Description:
 - 1. Two-piece surface painted steel, brushed aluminum or PVC raceway, with factory-wired multioutlet harness.
 - 2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Multi-Outlet Harness:
 - 1. Receptacles: 20 A, 125-V, NEMA WD 6 Configuration 5-20R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
 - 2. Receptacle Spacing: 12 inches.
 - 3. Wiring: No. 12 AWG solid, Type THHN copper, connecting alternating receptacles.

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.
- 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 devicemounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
 - 1. Install ground pin of vertically mounted receptacles up.
- 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. 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, multi-gang wall plates.
- H. Adjust locations of outlets to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Section 26 0553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 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 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Cartridge fuses rated 600-V ac and less for use in:
 - a. Control circuits
 - b. Enclosed switches
 - c. Panelboards
 - d. Switchboards
 - e. Enclosed controllers
 - f. Motor-control centers
 - 2. Plug fuses rated 125-V ac and less for use in plug-fuse type:
 - a. Enclosed switches
 - b. Fuseholders
 - c. Panelboards
 - 3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
 - 4. Spare-fuse cabinets.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.
- 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenanceCDB 040-010-115Page 1New Nursing Home and Domiciliary26 28 13Quincy Veterans' Home, Adams CountyBridging Documents

manuals. In addition to items specified in Division 01, include the following:

- 1. Ambient temperature adjustment information.
- 2. Current limitation curves for fuses with current-limiting characteristics.
- 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
- 4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three (3) of each size and type.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by UL and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.
- F. Comply with Using Agency Design Standards.

1.7 **PROJECT CONDITIONS**

A. Where ambient temperature to which fuses are directly exposed is less than [40 deg F (5 deg C)] or more than [100 deg F (38 deg C)], apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective, identified coverings for storage and a spare fuse rack identified with label describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Littlefuse, Inc. (IL)
 - 4. Mersen USA (Ferraz Shawmut)
- C. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 CARTRIDGE FUSES

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

2.3 PLUG FUSES

A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.4 PLUG-FUSE ADAPTERS

A. Characteristics: Adapter for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.5 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and keycoded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manuafcturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Provide fuses in accordance with Division 26 Section "Overcurrent Protective Device Coordination Study".
- B. Cartridge Fuses:
 - 1. Service Entrance:
 - a. Greater than 600A:
 - 1) Class L, time delay.
 - b. 600A or less:
 - 1) Class RK1, time delay.
 - 2. Feeders:
 - a. Greater than 600A:
 - 1) Class L, time delay.
 - b. 600A or less:
 - 1) Class RK1, time delay.
 - 3. Motor Branch Circuits:
 - a. Class RK1, time delay.
 - 4. Other Branch Circuits:
 - a. Class RK1, time delay.
 - 5. Control Circuits:
 - a. Class CC, fast acting or as indicated on the drawings.
- C. Plug Fuses:
 - 1. Motor Branch Circuits: Edison-base type, dual-element time delay.
 - 2. Other Branch Circuits: Edison-base type, dual-element time delay.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Provide fuses reducers where required to install fuses where indicated.

- C. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are removable once installed.
- D. Install spare-fuse cabinet(s) in electric rooms or where shown on the drawings, stock with spares and fuse pullers.
- 3.4 IDENTIFICATION
 - A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket and holder.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

- 4.1 GENERAL
 - A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 28 13

DIVISION 26 - ELECTRICAL Section 26 28 13 - Fuses

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SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Shunt trip switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Enclosures.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Unit shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means the unit will remain in place without separation of any parts from the device when subjected to forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

- 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.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Manufacturer's field service report.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner'] written permission.
 - 4. Comply with NFPA 70E.

1.10 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit. (IL)
 - 2. General Electric Company; GE Consumer & Industrial Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- C. HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- F. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

2.2 NON-FUSIBLE SWITCHES

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- F. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

2.3 SHUNT TRIP SWITCHES

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- 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. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight green ON pilot light.
 - 3. Isolated neutral lug; 100 percent rating.

- 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; 24-V dc coil voltage.
- 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- 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. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. 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 I²t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- J. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered 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.

- 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
- 6. Under voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
- 7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- 8. Accessory Control Power Voltage: Integrally mounted, self-powered 24-V dc.

2.7 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. Kitchen, Wash-Down Areas, Other Wet or Damp Indoor Locations: NEMA 250, Type 4X, stainless steel.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 5. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "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.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in the Examination and in the Quality Assurance sections of this 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.
- B. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

END OF SECTION 26 28 16

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SECTION 26 31 00 - PHOTOVOLTAIC COLLECTORS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: This Section specifies solar electric modules.
- B. Related Requirements:
 - 1. Section 26 10 00 "Medium-Voltage Electrical Distribution".
 - 2. Section 26 20 00 "Low-Voltage Electrical Transmission".
 - 3. Section 48 14 00 "Solar Energy Electrical Power Generation Equipment".
 - 4. Section 48 19 00 "Electrical Power Control Equipment".
 - 5. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.2 REFERENCES

- A. Definitions:
 - 1. NOCT: Normal operation cell temperature.
 - 2. STC: Values of standard test conditions.

B. Reference Standards:

- 1. National Electrical Code (NEC)
- 2. American National Standards Institute (ANSI):
- a. ANSI/UL 1703 Standard for Flat-Plate Photovoltaic Modules and Panels.
- 3. International Electrical Commission (IEC):
 - a. IEC 61215 International Standard (Extended Version) Crystalline silicon terrestrial photovoltaic (PV) modules Design qualification and type approval.
 - b. IEC 61730-1 International Standard Photovoltaic (PV) module safety qualification Part 1 Requirements for construction
 - c. IEC 61730-2 International Standard Photovoltaic (PV) module safety qualification Part 2 Requirements for testing.
- 4. International Organization for Standardization (ISO):
 - a. ISO 9001 Quality Management Systems.
 - b. ISO 14001 Environmental Management Systems.
- 5. Underwriters Laboratories, Inc. (UL):
 - a. UL 790 Standard Test Methods for Fire Tests of Roof Coverings.
 - b. UL 1703 Standard for Flat-Plate Photovoltaic Modules and Panels.
- 6. Underwriters Laboratories of Canada (ULC):
 - a. ULD/ORD-C1703 Requirements for Flat-Plate Photovoltaic Modules and Panels.

1.3 WORK INCLUDES

- A. Base Bid:
 - 1. Contractor Provide:
 - a. Roof Mounted Solar Panels
 - b. DC Disconnects
 - c. Inverters

1.4 DESCRIPTION OF SYSTEMS

CDB 040-010-115 New Nursing Home and Domiciliary Quincy Veterans' Home, Adams County
B. No exclusions from, or limitations in, the language used in the specifications shall be interpreted as meaning that the accessories necessary to complete any required system or item of equipment are to be omitted.

1.5 QUALITY ASSURANCE

- C. General
 - 1. The Electrical Contractor's work shall have total responsibility for the coordination and installation of the Work provided by the Photovoltaic System Supplier (PSS). The PSS shall be a company specializing in the installation of Photovoltaic systems for a minimum of three (3) years.
- D. Equipment/Materials:
 - 1. All equipment and materials required for installation under these specifications shall be new (less than 1 year from manufacturer) and unused without blemish or defect. All equipment shall bear labels attesting to Independent Testing Laboratories approval. Where no specific indication as to the type or quality of material or equipment is indicated, a first-class standard article shall be furnished. All manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of 5 years. If so directed by the Architect/Engineer, they must be able to furnish proof of their ability by submitting affidavits and descriptive data on their product of size and magnitude comparable to that specified herein.

1.6 REGULATORY REQUIREMENTS

- E. It shall be the Electrical Contractor's responsibility to submit all items required by the appropriate Regulatory Agencies and obtain all required permits.
- F. All work shall conform to all federal, state and local ordinances.
- G. References to the National Electrical Code (NEC) are a minimum installation requirement standard. Design drawings and specification sections shall govern in those instances where requirements are greater than those specified in the NEC.
- H. Include all items of labor and material required to comply with such standards and codes. Where quantity, sizes or other requirements indicated on the drawings or herein specified are in excess of the standard or code requirements, the specifications or drawings, respectively, shall govern.

1.7 ABBREVIATIONS

I. See drawings for complete abbreviations list.

1.8 SUBMITTALS

J. The Electrical work shall include preparation of a submittal schedule for all work within five (5) business days after the pre-construction meeting. All shop drawings shall be submitted

for review within 10 calendar days from notice to proceed. See the proposed project schedule in section 01010. AutoCAD backgrounds will be made available for use with the shop drawings.

- K. Submittals shall be prepared and presented for Engineer review and the following additional requirements. The operator's manual and service manuals shall be presented to the Architect/Engineer for their review prior to training:
 - 1. Shop Drawings:
 - a. <u>Submittal shall be a complete package for each section of the specifications.</u>
 - 1) Size and spacing of all anchors, joinery construction, etc., required for complete system installation.
 - 2) Sizes, shapes, thicknesses and finishes of all materials and equipment surfaces.
 - 3) Electrical riser diagrams identifying all signal, power and ground circuitry.
 - 4) Wiring diagrams for all equipment and devices (active and passive), which interface to the photovoltaic system.
 - 2. Product Data:
 - a. Submit product data in accordance with Section 013300 for all equipment showing:
 - 1) Product performance, mechanical and electrical specifications.
 - 2) Manufacturer's installation instructions.
 - 3. Operating and Maintenance (O & M) Data:
 - a. Operators Manual Provide four copies for the facility and one copy for the Architect/Engineer. Manuals shall be bound in "D-ring" binders with a detailed table of contents. Manuals shall be written in laymen's language and printed so as to become a permanent reference document for the operators.
 - b. Service Manual Provide four copies for the facility and one additional copy for the Architect/Engineer. The service manual shall be written in laymen's language and printed so as to become a permanent reference document for maintenance personnel, describing troubleshoot head-end and field devices with a complete scenario simulation of all possible system malfunctions and the appropriate corrective measures. The service manuals shall also contain product catalog cut sheets and specifications of all equipment.
 - 4. Record Documents:
 - a. Submit one (1) set of the "As-built" condition of all systems including:
 - 1) A set of updated shop drawings showing all Contract changes.
 - 2) A set of updated product data showing all Contract changes.
 - 3) Floor plan showing conduit raceway routing including all equipment racks, cabinet and pull box locations, and conduit sizes.
 - 4) Complete point-to-point wiring diagrams showing all equipment, devices, wire and cable (Signal, power and ground). This document shall also include all terminal block designations, abbreviations and color-coding.
 - 5) Two (2) copies of training session video tapes.
 - 5. Warranty:

- a. The photovoltaic systems shall be fully guaranteed for a period of five (5) years beginning on the date of Agency acceptance.
- b. The guarantee shall include the entire photovoltaic scope of work including all equipment, devices, materials, cable/wire, software and installation.
- c. The installation of the photovoltaic system on the existing roofing shall comply with the existing roofing warranty. Existing roofing is Firestone EPDM.

1.9 CERTIFICATION REQUIREMENTS

- L. Photovoltaic system installer shall be certified with the Illinois Commerce Commission per Title 83, Part 468 for the Illinois Admin Code.
- M. Installer must complete Certificate of Completion and Installer Certification documentation per Ameren Illinois Distributed Generation Requirements.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All products shall be new. (less than one year from manufacture, unused and without blemish or defect)

2.2 MANUFACTURED PRODUCTS:

- A. Materials and equipment furnished shall be of current standard production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available. <u>Custom or limited production equipment is not acceptable</u>.
- B. Equipment Assemblies and Components:
 - 1. All components of an assembled unit need not be products of the same manufacturer, however, all components must be acceptable to the Architect/Engineer.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. Components shall be compatible with each other and with the total assembly for the intended service.
- C. All factory and PSS wiring termination points shall be identified on equipment being furnished and on all wiring diagrams and included in the O & M manuals and Record Documents.
- D. All material and equipment shall be listed, labeled or certified by Independent Testing Laboratories, where such standards have been established. The PSS shall provide evidence of compliance in the shop drawing submittal.

2.3 EQUIPMENT IDENTIFICATION:

- A. In addition to the requirements of the National Electrical Code, install an identification nameplate that will clearly indicate information required for use and maintenance of items such as cabinets, enclosures and electronic equipment and as indicated on the drawings.
 - 1. At a minimum, the following labeling shall be provided at each photovoltaic module per NEC 695:

- a. Open-circuit voltage.
- b. Operating voltage.
- c. Maximum permissible system voltage.
- d. Operating current.
- e. Short-circuit current.
- f. Maximum power.
- B. Nameplates shall be laminated white phenolic resin with a black core and engraved lettering, a minimum of 1/4-inch high. Nameplates that are furnished by manufacturer, as a standard catalog item, or where other methods of identification are herein specified, are exceptions.
- C. Ameren Illinois Distributed Generation Labeling Requirements:
 - 1. Provide labeling at AC disconnect denoted by Keyed Note 3 on sheet E1.1.
 - a. Labeling shall be attached directly to the disconnect device.
 - b.
 - 1) Plaque must be mechanically fastened, glue or other adhesives not allowed.
 - c. Labeling shall be weatherproof and UV resistant.
 - d. Labeling means shall be a minimum of 5"x7".
 - e. Acceptable wording for disconnect:

1) "PARALLEL GENERATION PRESENT – LOCKABLE MAIN SERVICE DISCONNET AVAILABLE FOR ISOLATION."

- 2. Labeling required at Primary meters, as indicated on Keyed Note 10 on sheet E3.0.
 - a. Provide Campus Map Plaque attached to primary meter enclosure.
 - 1) Plaque must be mechanically fastened, glue or other adhesives not allowed.
 - 2) Plaque shall be weatherproof and UV resistant.
 - 3) Plaque shall be minimum of 11"x17"
 - 4) Location of primary meters shall be indicated.
 - 5) Location of parallel generation disconnects shall be indicated at buildings where parallel generation is present (Trimpe ATC and Hatheway Cultural Center).
- 3. Provide submittal for review on labeling.

2.4 PHOTOVOLTAIC PANEL

A. Acceptable Manufacturer:1. See drawings

2.5 Mounting:

- A. Mounting shall limit roof penetrations and be applied to tapered insulation structures with minimum slope of ¹/₂":12".
- B. Provide manufacturer's standard wireway for routing of all PV cable leads.

2.6 INVERTER

- A. Acceptable Manufacturer:
 - 1. See drawings
- 2. Provisions for Remote Computer Monitoring: Communication module in unit control panel shall provide capability for remote monitoring of status, parameters, and alarms as indicated below:
 - 1. Quantitative Indications:
 - 1) Input voltage, each phase, line to line.
 - 2) Input current, each phase, line to line.
 - 3) System output voltage, each phase, line to line.
 - 4) System output current, each phase.
 - 5) System output frequency.
 - 6) DC bus voltage.
 - 7) Basic Status Condition Indications:
 - a) Normal operation.
 - b) Inverter off.
 - c) Alarm condition exists.
 - d) Control power failure.
 - e) Fan failure.
 - f) Overload.
 - g) Input voltage.
 - h) Inverter fuse blown.
 - i) Inverter overtemperature.
 - j) Inverter power supply fault.
 - k) Inverter output overvoltage or undervoltage.
 - 1) System overload shutdown.
 - m) Inverter output contactor open.
 - n) Inverter current limit.
 - o) Controls:
 - i. Inverter on-off.
 - ii. Start.
 - iii. Alarm silence/reset.
 - iv. Output-voltage adjustment.
- 3. Electrical Power/ Data Monitoring.
 - a. Provide connectors and network interface units or modems for data transmission via serial link RS-485 up to 1200m. Provide standard communication protocol to allow for supervision with Data Monitoring System.
 - b. Software shall be designed to control and monitor inverter system functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of reports. Include capability for storage and analysis of power-line transient records.
 - c. Provide Annunciation of Alarms at inverter system control panel.
 - d. Keypad on device front panel shall provide access to monitored data using front panel display.
 - e. Provide network interface card to make measurements and recorded data accessible to

remote personal computer RS-485 connections utilizing industry standard communication protocals.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting solar panel performance.
- B. Examine roughing-in of conduit systems and electrical connections. Verify actual locations of connections before solar panel installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with solar panel manufacturers' written installation and alignment instructions.
- B. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted.
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. Identify system components according to the NEC and as indicated on the drawings.
- E. Install all equipment in strict accordance with the manufacturer's recommendations and reviewed shop drawings.
- F. Wiring shall be color coded, uniform and in accordance with the NEC and manufacturer's instructions.
- G. Equipment shall be firmly secured, plumb, and level.
- H. Coordinate the installation of all equipment with the installation of the new EPDM roofing. All materials, including but not limited to adhesives, flashing, fasteners and supports shall be compatible for use with the roofing materials and installation methods.
- I. All splices shall be in easily accessible junction boxes, on terminal boards with punch down blocks, or on screw terminals. Twisted and taped splices are unacceptable.
- J. Photocell Mounting
 - 1. Do not cut or modify Mounting System.
 - 2. Do not step or sit on the surface of a solar module. The module may break, resulting in shock or bodily injury. The module may also stop generating power.
 - 3. Use the supplied parts to attach the solar modules and mounts.
 - 4. Always use the specified tools. Verify proper torque of connections.
 - 5. Always use the specified materials. Use of other materials is dangerous.
 - 6. Do not modify or cut parts.
 - 7. Artificially concentrated sunlight shall not be directed on the module.

- 8. Install wires and cables with appropriate hardware in accordance with applicable electrical codes. Neatly train and support all wired and cables. Support output cables so that there is no slack.
- 9. Wiring methods should be in accordance with the NEC.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 1. Tests and Inspections:
 - a. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for Solar Panels and for Inverter Systems.
 - b. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of solar panel system before and during system operation.
 - c. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency and verify that performance is as specified in manufacturer literature. Measure the voltage at the output of the solar panels and also at the output from the inverters.
 - d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - e. Remove and replace malfunctioning components as specified above.
 - f. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
 - g. 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.
- B. Demonstration:
 - 1. Upon notification the Architect/Engineer will visit the project for a demonstration of all system components and an inspection of the completed work in conformance with the Project Documents.
 - 2. After all final tests and adjustments have been completed by the Contractor, the Agency shall be notified and will schedule the staff training sessions.
- C. Training:
 - 1. Training shall be provided by the PSS in the base contract. "On-site" training shall be conducted by qualified instructors that are employees of the PSS.
 - 2. A single training session shall be video taped by the PSS
 - 3. Within a period of 1-year after substantial completion the PSS shall provide 8 hours of additional training, this training shall cover topics dictated by the owner.
 - 4. Time to be allocated for operation and maintenance training shall be as follows:
 - 1) Operator Training Two (2) 4 hour sessions to demonstrate the proper operation of the system and the system components. (one of these training sessions will be conducted after hours)
 - 2) Maintenance Training Two (2) 6 hour sessions, (one of these training sessions will be conducted after hours)

D. Warranty:

- 1. All Work shall be guaranteed to be free from defects. Any defective materials or workmanship shall be replaced or repaired as directed by the owner for a period of five (5) years from the date of Owner acceptance.
- 2. Acceptance by a manufacturer of an order for equipment for this contract signifies acceptance of this guarantee.
- 3. During the warranty period, there shall be <u>no</u> charges to the Owner for service calls (mileage, labor, travel, expenses, etc.) for warranty work.

END OF SECTION 26 31 00

DIVISION 26 - ELECTRICAL Section 26 31 00 - Photovoltaic Collectors

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SECTION 26 32 13 - PACKAGED ENGINE DRIVEN GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Providing a complete integrated generator system to provide an alternate source of power to portions of the facility in the event of a utility power outage. The system consists of a packaged engine-driven generator set with related component accessories, all installed in a sound attenuated outdoor enclosure. The generator set shall have the following features and accessories:
 - a. Battery charger.
 - b. Integral base-mounted fuel tank.
 - c. Engine-generator set.
 - d. Muffler/silencer.
 - e. Exhaust piping external to set.
 - f. Outdoor sound attenuated enclosure.
 - g. Remote annunciator.
 - h. Unit mounted cooling system.
 - i. Remote-mounting control and monitoring.
 - j. Remote stop switch.
 - k. Performance requirements for sensitive loads.
 - 1. Network Communications.
- B. Related Requirements:
 - 1. Division 23 Section "Facility Fuel Oil Piping" for fuel storage, pumping systems and piping.
 - 2. Section 26 36 00"Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
 - 3. Section 26 09 13 "Electrical Power Monitoring and Control" for communication features of power distribution system devices.
 - 4. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.
- C. Provide fully automatic operation so that the generator accepts rated load within 10 seconds after loss of normal electric power. Upon restoration of normal electric power, the system shall automatically transfer the emergency load back to normal power portion of the electric system and shutdown the generator, returning the emergency system to standby, ready to accept load.

1.3 DEFINITIONS

A. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage.

B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Data on features, components, accessories ratings and performance.
 - 2. Thermal damage curve for generator.
 - 3. Time-current characteristic curves for generator protective device.
- B. Shop Drawings: "Typical" drawings are not acceptable. Provide project specific drawings for engine-generator and all specified components. Drawings shall detail equipment assemblies and indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified including enclosure.
 - 2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 - 4. Wiring Diagrams: Power, signal, and control wiring.
- C. Welding certificates.
- D. Qualification Data: For manufacturer.
- E. Source quality-control test reports.
 - 1. Certified summary of prototype-unit test report.
 - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 - 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 - 4. Report of factory test on units to be shipped for this Project, showing evidence of

compliance with specified requirements.

- 5. Report of sound generation.
- 6. Report of exhaust emissions showing compliance with applicable regulations.
- 7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- H. Warranty: Special warranty specified in this Section.
- I. Emergency generator load calculations shall be submitted to verify that the loads associated with the equipment, devices and systems listed in this Section will be provided upon transfer.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
 - 2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 150 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Testing Agency Qualifications: An independent agency, with experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- E. Product Options: Drawings indicate size, profiles and dimensional requirements of packaged generator sets and are based on the specific system indicated. Refer to division 01 Section "Product requirements".
- F. Welding: Qualify procedures and personal according to ASME Boiler and Pressure Vessel Code:

Section IX for welding exhaust-and cooling-system piping.

- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL and marked for intended use.
- H. Comply with ASME B15.1.
- I. Comply with NFPA 30.
- J. Comply with NFPA 37.
- K. Comply with NFPA 70.
- L. Comply with NFPA 110 requirements for Level 1, Type 10, Class "X" emergency power supply system.
- M. Comply with latest EPA Tier requirements.
- N. Comply with Using Agency Design Standards.
- O. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- P. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.7 **PROJECT CONDITIONS**

- A. Products Selection for Restricted Space: Drawings indicate maximum dimensions for generators including clearances between generators and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: Minus 15 to plus 50 deg C.
 - 2. Relative Humidity: 0 to 95 percent.
 - 3. Altitude: Sea level to 1000 feet (300 m).

1.8 EMISSIONS

A. To maintain environmental quality, engine shall be equipped with a pre-combustion chamber fuel system; or have suitable emission control equipment to ensure that gaseous exhaust emissions meet Federal, State and local EPA emissions standards.

1.9 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division

03.

1.10 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: Five years from date of Substantial Completion. Warranty shall be Comprehensive with no deductible.

1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.12 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every 10 of each type and rating, but no less than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.13 PERMITS

- A. Provide and EPA permit for the generator assembly when required.
- B. The Office of the State Fire Marshal inspection is required before filling the generator tank with fuel.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. CK Power, Kohler Co., Generator Division.
 - 2. Altorfer CAT; Engine Generator Division. (IL)
 - 3. Onan Corp./Cummins Power Generation, Industrial Business Group.

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.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- C. Capacities and Characteristics:
 - 1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
 - 2. Each engine-generator specified for parallel operation shall be configured for automatic parallel operation. Each engine-generator shall be capable of parallel operation with one or more engine-generators on an isolated bus.
 - 3. Each engine-generator specified for parallel operation shall be configured to automatically load-share with other engine-generators by proportional loading.
 - 4. Output Connections: Three-phase, four-wire.
 - 5. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- D. Generator-Set Performance:
 - 1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
 - 2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
 - 3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 3 second.
 - 4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
 - 5. 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.
 - 6. 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 four seconds.
 - 7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 - 8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

- 9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet excitation for power source to voltage regulator.
- 10. Start Time: Comply with NFPA 110, Type 10, system requirements.
- 11. Accept rated load in one step.

2.3 ENGINE

- A. Fuel: Fuel oil, Grade DF-2.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
- 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.
- 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. Engine 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. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 - 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 - 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 - 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82

deg C), and non-collapsible under vacuum.

- b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- 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. Minimum sound attenuation of 25 dB at 500 Hz.
 - 2. Factory installed and piped.
 - 3. Weather-cap on outlet.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: 12-24V electric, with negative ground.
 - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 - 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 Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging. Battery shall be maintenance free, sealed lead acid type.
 - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
 - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 - 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates. LED Display is acceptable in lieu of meters.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts

that provide a battery-charger malfunction indication at system control and monitoring panel.

- f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.
- g. Provide one charger for each battery bank.

2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30, NFPA 37, and Illinois Code.
- B. Fuel Supply Tank: Comply with UL 142, skid base, factory- fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
 - 1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of tank.
 - a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
 - 2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of minimum 96 hours' operation at 100 percent of rated power output of engine-generator system without being refilled. The skid base tank shall not be less than 12 inches in height
 - 3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
 - 4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
 - 5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
 - 6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve. The fuel tank shall be equipped with a manual fuel level gauge capable of being seen by the operator to determine the fuel level in the tank.

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 modeselector 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. Operation of a remote emergency-stop switch also shuts down generator set.
- 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. Operation of a remote emergency-stop switch also shuts down generator set.
- C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring pane, microprocessor based, mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

- D. The control panel shall be designed and built by the engine manufacturer.
- E. The control panel shall provide real time digital communications to all engine and regulator controls.
- F. Control panel:
 - 1. The control shall include a backlight graphical display with text-based alarm/event descriptions.
 - 2. Audible horn for alarm and shutdown with horn silence switch
 - 3. Remote start/stop control
 - 4. Local run/off/auto control integral to system microprocessor
 - 5. Cool-down timer
 - 6. Speed adjust, programmable
 - 7. Lamp test
 - 8. Voltage adjust, programmable
 - 9. Voltage regulator V/Hz slope adjustable
 - 10. Password protected system programming
- G. Indicating Digital Readouts: As required by NFPA 110 for Level 1 system and the following:
 - 1. AC volts.
 - 2. AC amps.
 - 3. AC frequency.
 - 4. KW
 - 5. kVA.
 - 6. kVAR.
 - 7. Power Factor.
 - 8. KWH.
 - 9. Exciter voltage and current.
 - 10. DC voltmeter (alternator battery charging).
 - 11. Engine-coolant temperature.
 - 12. Engine lubricating-oil pressure.
 - 13. Running-time meter.
 - 14. Fuel tank high-level shutdown of fuel supply alarm.
 - 15. Generator overload.
 - 16. Engine RPM.
- H. 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.
- I. Network Communications: Communication Gateway, discrete 10 relay I/O module, for each alarm and status indication for data-link transmission of indications to remote data terminals and control network. Generator shall be capable of communicating with Using Agency's existing data collection and control network.
 - 1. The network shall be MOD-bus isolated data link through a standard RS-485 connection.

- J. 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. Coolant low-temperature alarm.
 - 3. Coolant high-temperature alarm.
 - 4. Coolant high-temperature shutdown.
 - 5. Low coolant level.
 - 6. Loss of coolant shutdown.
 - 7. Control switch not in auto position.
 - 8. Battery-charger malfunction alarm.
 - 9. Battery low-voltage alarm.
 - 10. Battery high-voltage alarm.
 - 11. Low oil pressure warning.
 - 12. Low oil pressure shutdown.
 - 13. Overspeed shutdown.
- K. Generator Alarm/Shutdown.
 - 1. Generator over voltage.
 - 2. Generator under voltage
 - 3. Generator over frequency
 - 4. Generator under frequency
 - 5. Generator reverse power
 - 6. Generator overcurrent
- L. Voltage Regulator Alarm/Shutdown
 - 1. Loss of excitation alarm/shutdown
 - 2. Instantaneous over excitation alarm/shutdown
 - 3. Time over excitation alarm/shutdown
 - 4. Loss of sensing
- M. 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. The annunciator shall have the ability to be located up to 800 ft. from the generator set.
- N. Generator exerciser: Mounted in the Automatic Transfer Switch
 - 1. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 14 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:
 - a. Day of week
 - b. Time of day to start
 - c. Duration of Cycle

O. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded Case, electronic-trip type; 100 percent rated; complying with UL 489. See drawings for circuit breaker Amperage ratings.
 - 1. Tripping Characteristics: Adjustable long-time, short-time delay and instantaneous.
 - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 - 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.
- 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. Field adjustable via technician's lap-top computer.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: 2/3 pitch stator winding and fully linked amortisseur winding.
- K. Sub-transient Reactance: 12 percent, maximum.
- 2.8 MOTORS

- A. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven loads will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.9 VIBRATION ISOLATION DEVICES

1. Factory standard integral vibration isolation.

2.10 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Housing: Description: Vandal-resistant, weatherproof, non-walk-in type, aluminum housing; wind resistant up to 150 mph. Instruments and control shall be mounted within enclosure. Acoustically rated, 75dBa @ 23 feet. Enclosure with the following features:
 - 1. Hinged Doors: With padlocking provisions.
 - 2. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
- B. Muffler Location: Within enclosure.
- C. Walk in enclosure type Interior Lights with Switch: Factory-wired, vapor-proof-type fluorescent or LED fixtures within housing; arranged to illuminate controls and accessible interior. Provide switch at all access doors. Electrical connection to load center.
- D. Walk in enclosure type Convenience Outlets: Factory wired, GFCI, four required, electrical connection to load center.
- E. 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.
- F. Louvers: motor operated cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow, exterior dust, birds, and rodents.

2.11 FINISHES

- A. Indoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.
- B. Outdoor Enclosures and Components: As selected by Architect from Manufacturer's standard finishes.

2.12 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.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Full load run.
 - 3. Maximum power.
 - 4. Voltage regulation.
 - 5. Transient and steady-state governing.
 - 6. Single-step load pickup.
 - 7. Safety shutdown.
 - 8. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with Structural Engineer.
- B. Concrete bases specified in Division 26 Section "Hangers for Electrical Systems", and concrete materials and installation requirements are specified in Division 03.

3.3 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 outdoor engine generators on a concrete pad designed by the Structural Engineer.
- D. Install service platforms for outdoor walk- in enclosures.

- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- F. Coordinate installation of fuel oil piping from main storage tank to generators and all associated work with Division 23 Contractor. This Contractor shall be responsible to provide a complete working system.
- G. Install remote Annunciator in building security command center or as indicated. Provide all interconnecting wiring.

3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values using a calibrated torque wrench. Provide a list of all torqued connections and values.
- D. Furnish and install wiring from communications devices to Using Agency's data collection and control network.
- E. Furnish and install control and power wiring for remote fuel oil pumping systems.

3.5 IDENTIFICATION

A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

3.6 ADJUSTING

A. Set engine-generator circuit breaker and relay protective functions per Division 26 Section "OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY."

3.7 FIELD QUALITY CONTROL

- A. 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.
- B. 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.
- C. This Contractor is responsible for the following tests and inspections:

- 1. 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.
- 2. The diesel generator set shall operate under full load conditions for a minimum of four (4) hours. The generator set shall maintain rated voltage and rated frequency per Specifications for the duration of the full load test. Voltage, amperage and frequency measurements, as well as engine gauge and monitor points, shall be recorded at 15 minute intervals.
- 3. 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 fullcharging 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.
- 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and floatcharging conditions.
- 5. 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.
- 6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). 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.
- 7. Exhaust Emissions Test: Comply with applicable government test criteria. Factory supplied systems are exempt from this test.
- 8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
- 9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- 10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified

requirements are met.

- J. This Contractor shall top off all fuel tanks at completion of testing. Fill all engine fluids to levels as recommended by manufacturer.
- K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations.
- L. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

3.8 DEMONSTRATION

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

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 32 13

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SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Transfer switches rated 600 V and less, including the following:
 - a. Automatic Transfer Switches (ATS).
 - b. Remote annunciation systems.
- B. Related Requirements:
 - 1. Section 26 09 13 "Electrical Power Monitoring and Control" for interfacing communication and metering.
 - 2. Section 26 32 13 "Package Engine Driven Generators" for interfacing with Emergency Power Systems.
 - 3. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, accessories and catalog data sheets.
- B. Shop Drawings: "Typical" drawings are not acceptable. Provide project specific drawings for each transfer switch. 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. Wiring Diagrams: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Qualification Data: For manufacturer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

- 1. Features and operating sequences, both automatic and manual.
- 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 DEFINITIONS

- A. Closed Transition (Make-Before-Break): In a switch device, a configuration in which the new connection path is established before the previous contacts are opened. This prevents the momentary connection of path from ever seeing an open circuit.
- B. Open Transition (Break-Before-Make): A switch that is configured to break (open) the first set of contacts before engaging (closing) the new contacts. This prevents the momentary connection of the old and new circuit paths together.
- C. Withstand duration: The withstand rating value is the level of fault current that must be withstood for a specified length of time, i.e., 42000 amps at 3 cycles.
- D. Level 1 Equipment Level 1 is more stringent NFPA emergency life safety requirement and is imposed when failure of the emergency system, including the transfer equipment could result in loss of human life or serious injury.
- E. Level 2 Equipment Level 2 is less stringent NFPA emergency life safety requirement and is imposed when failure of the emergency system, including the transfer equipment is less critical to human life.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. 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.
- E. Comply with NEMA ICS 1.
- F. Comply with NFPA 70.
- G. Comply with NFPA 110.
- H. Comply with UL 1008 unless requirements of these Specifications are stricter.

I. Comply with Using Agency Design Standards.

1.6 WARRANTY

A. The automatic transfer switch shall be provided with a five-year warranty, covering all parts, labor, travel and expenses during the first two years, followed by three years of replacement parts coverage. Warranty shall commence on startup or six months from date of shipment, whichever occurs first. Warranty shall not be dependent upon customer purchase of additional equipment or preventive maintenance contracts.

1.7 COORDINATION

- A. Coordinate sensor-communication module package with data network and with monitoring equipment specified in Division 26 Section "Electrical Power Monitoring and Control" for successful transmission and remote readout of remote monitoring data specified in this Section.
- B. Floor mounted switches: Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).
- B. Manufacturers: Subject to compliance with requirements, provide products by:
 - 1. Contactor Transfer Switches:
 - a. CK Power, Kohler Power Systems Division
 - b. Altorfer CAT, Engine Division. (IL)
 - c. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - d. Emerson; ASCO Power Technologies, LP.
 - e. Onan/Cummins Power Generation; Industrial Business Group.
 - f. Russelectric, Inc.

2.2 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver-tungsten alloy. Main contacts on all size switches shall be segmented, and shall have separate arcing contacts with magnetic blowouts for positive arc-quenching and maximum contact life.
- C. Switching Arrangement: Equipment Branch The automatic transfer switch shall be double throw, actuated by one or two electrical operators, momentarily energized and connected to the

transfer mechanism by a simple over-center type linkage, providing inherent "quick-break", "quick-make" (Open Transition) operation when operated electrically or manually.

- D. Switching Arrangement: Life Safety Branch The automatic transfer switch shall be double throw, actuated by one or two electrical operators, momentarily energized and connected to the transfer mechanism by a simple over-center type linkage, providing inherent "quick-make", "quick-break" (Closed Transition) operation when operated electrically or manually.
- E. Manual Switch Operation –Bypass Isolation: All open transition transfer switches shall be equipped with a safe manual operator designed to prevent injury to operating personnel. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flash-over from switching the main contacts slowly. Manual operation shall not require prior disconnection of electrical operators or control wiring, and shall be safe even if the electrical operator becomes energized during manual operation. The manual operator shall be external type, operable through the door of the enclosure. Safe manual transfer shall be possible under all load conditions, either energized or non-energized. The external manual operator is not required on transfer switches equipped with a bypass switch.
- F. Automatic Transfer-Switch Features:
 - Programmable Undervoltage and Frequency Sensing for Each Phase of Normal and Emergency Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 70 to 98 percent of nominal, and dropout voltage is adjustable from 72 to 100 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent. Over voltage to pick up at 102 to 110% and drop out at 100 to 108%. Over frequency sensing to pick up at 50.1 to 69.8 Hz and drop out at 50.0 to 69.7 Hz. Under – frequency sensing to pick up at 45.0 to 59.9 Hz and drop out at 45.1 to 60 .0 Hz (VFS1,2)
 - 2. Contact to close on normal source failure to initiate engine start (CES).
 - 3. Normal status relay (CS1A).
 - 4. Emergency status relay (CS2A).
 - 5. Bypass and transfer switch auxiliary contact in parallel with engine start to maintain start signal whenever load is connected to emergency source (CMES).
 - 6. The controller shall monitor phase rotation of both sources and inhibit transfer if both sources are not the same phase rotation. Source rotation shall be field selectable as either ABC or CBA (PRR).
 - 7. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for 3 seconds (TDES).
 - 8. Adjustable Time Delay: transfer to emergency, adjustable 0 9999 seconds. Factory set at 3 seconds (TDNPS).
 - 9. 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 105 percent of nominal. Factory set for pickup at 95 percent (VFS2).
 - 10. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 5 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored (TDPS).
 - 11. Time delays to control transition time delay on transfer and re-transfer (TDNNP, TDNP). For dual operator and closed transition types only.
 - 12. Test Switch: Simulate normal-source failure (XT1G).

- 13. Switch-Position LED Pilot Lights: (LT1, LT2) Indicate source to which load is connected (green for normal, red for emergency).
- 14. Bypass switch position: Green LED (LT16) to indicate bypass switch is in bypass to normal position, flashing when ATS is isolated. Red LED (LT17) to indicate bypass switch is in bypass to emergency position.
- 15. Provisions to accept customer supplied remote contact closure or 24 VDC signal to initiate load test (LTR).
- 16. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: (T3) Amber light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: (LT4) Amber light with nameplate engraved "Emergency Source Available."
- 17. Unassigned Auxiliary Contacts: Two normally closed, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac (CS1P, CS2P).
- 18. Unassigned Auxiliary Contacts: Two normally closed, single-pole, double-throw contacts for emergency switch position, rated 10 A at 240-V ac (CS2P).
- 19. Unassigned Auxiliary Contacts: Two closed, single-pole, double-throw contacts when switch is bypassed to normal and emergency switch positions, rated 10 A at 240-VAC (CB1, CB2).
- 20. Pushbutton: to bypass re-transfer time delay (XP8).
- 21. Two position key operated switch to disconnect engine start, with manual mode LED light and nameplate to read "Engine Lock-out Switch" (XK16).
- 22. Provide additional elevator signals on switches connected to emergency equipment branch:
 - a. Additional Form "C" contacts (two) to indicate ATS in Emergency position.
 - b. Form "C" time delay contacts (two) that change state simultaneously 0-3600 seconds before transfer in either direction and revert 0-3600 seconds after transfer is completed.
- 23. Engine Shutdown Timer: Time delay adjustable from zero to five minutes, and factory set for five minutes. Timer shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
- 24. Engine overrun to provide unloaded operation after retransfer to normal (2e), adjustable from0 3600 seconds, factory set at 300 seconds. The transfer switch cool-down timer shall be coordinated with any engine control cool-down timers to avoid excessive unloaded operation.
 - a. Engine-Generator Exerciser: The controller shall include a user configurable exerciser. Exerciser shall be configurable for daily, 7 day exercise periods. Each event shall be configurable for Test with Load and Test without Load. Each event shall include user adjustable start time, date and test duration. All time and date settings shall be stored in non- volatile EEPROMM memory. The controller shall include full programmability for daylight savings time.
- 25. All pilot lights shall be LED, push-to-test type.

2.3 BYPASS/ISOLATION SWITCHES

A. Comply with requirements for Level 1 equipment according to NFPA 110. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. The bypass isolation switch shall provide a safe and convenient means of manually bypassing and isolating the automatic transfer switch, regardless of the condition of position of the automatic transfer switch. The bypass isolation switch shall have the ability to be used as an emergency backup system in the event of a transfer switch failure. Include the following features for each combined automatic transfer switch and

bypass/isolation switch:

- 1. The bypass switch shall be load break design. Bypassing shall be by means of a single, externally operated handle. This handle shall allow direct, one step bypass to either Source 1 or Source 2, regardless of the position of the automatic transfer switch. The bypass isolation switch shall be purely mechanical, and bypass operation shall not be dependent upon any electrical device or interlocks for safety purposes or proper sequencing.
- 2. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
- 3. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.
- 4. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
- 5. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
- 6. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
- 7. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
- 8. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
- 9. Installation: Enclosure requires front and side access.
- B. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches:
 - 1. Factory- installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.4. REMOTE ANNUNCIATOR SYSTEM

- A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall be located in the maintenance shop and shall include the following:
 - 1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 - 2. Switch position.
 - 3. Switch in test mode.
 - 4. Failure of communication link.
- B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
- 2.5. 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.
 - Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems." Paint front edge yellow.
- B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- C. Identify components according to Division 26 Section "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

3.2 STANDALONE ATS INSTALLATION

- A. Wall-Mounting ATS: Install ATS on walls with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, and bottom of enclosure not less than 12 inches (305 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Floor-Mounting ATS: Install ATS on 4-inch (100-mm) nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."]
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) 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 supported equipment.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Using Agency if necessary to accommodate required wiring.
- B. Ground equipment according to Section 26526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FACTORY TESTS

- A. The Automatic Transfer Switch and Bypass Isolation Switch shall be factory tested to verify compliance with these specifications and ensure proper operation.
- 3.5 FIELD QUALITY CONTROL
 - A. 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.
 - B. 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 installation, including connections, and to assist in testing.
 - 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 insulationresistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - 2. Check for electrical continuity of circuits and for short circuits.
 - 3. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - 4. Verify that manual transfer warnings are properly placed.
 - 5. 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. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
- f. Perform contact-resistance test across main contacts and correct values exceeding 500 micro-ohms and values for 1 pole deviating by more than 50 percent from other poles.
- g. 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.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. 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.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Infrared Scanning: After Substantial Completion, but prior to beneficial occupancy, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 - 2. Instrument: Use and infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report identifying switch checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below.
- B. Coordinate this training with that for generator equipment.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 36 00
DIVISION 26 - ELECTRICAL Section 26 36 00 - Transfer Switches

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SECTION 26 41 13 – LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section and all following Division 26 and 28 sections.
- B. Refer to specification section 019113 GENERAL COMMISSIONING REQUIREMENTS for commissioning requirements.

1.2 SUMMARY

A. Section includes lightning protection for structures.

1.3 SUBMITTALS

- B. Product Data: For each type of product indicated.
- C. 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.
- D. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- E. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
 - 1. Ground rods.
 - 2. Ground loop conductor.

1.4 QUALITY ASSURANCE

- H. Installer Qualifications: Certified by UL as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- I. System Certificate:
 - 1. UL Master Label.
- J. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.2 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

- 2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS
 - A. Comply with UL 96 and NFPA 780.
 - B. Roof-Mounted Air Terminals: NFPA 780, Class I 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. Robbins Lightning, Inc.
 - h. Thompson Lightning Protection, Inc.
 - i. Pre-approved equivalent.
 - 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 Division 07 roofing Sections.
 - C. Main and Bonding Conductors: Copper or Aluminum.
 - D. Ground Loop Conductor: The same size and type as the main conductor except tinned.
 - E. Ground Rods: Copper-clad steel[, 3/4 inch in diameter by 10 feet long.
 - F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Solid copper or Lead sheathed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:

- 1. Down conductors.
- 2. Interior conductors.
- 3. Conductors within normal view of exterior locations at grade within 200 feet of building.
- D. 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.
- E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions. Verify material will not void the roof warranty. Coordinate with roof manufacturer and installer.
- F. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.
- G. Ground Loop: 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 building steel column to the ground loop by exothermically welded leads at each perimeter structural column.
 - 3. Bond ground terminals to the ground loop.
 - 4. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.
- H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
- 3.3 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.
- 3.4 FIELD QUALITY CONTROL
 - A. Notify A/E at least 48 hours in advance of inspection before concealing lightning protection components.
 - B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

END OF SECTION 26 41 13

<u>DIVISION 26 - ELECTRICAL</u> Section 26 41 13 – Lightning Protection for Structures

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SECTION 26 43 13 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

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

B. Related Requirements:

- 1. Section 26 11 16 "Secondary Unit Substations" for factory-installed SPDs or as indicated otherwise.
- 2. Section 26 24 13 "Switchboards" for factory-installed SPDs or as indicated otherwise.
- 3. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

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

Section 26 43 13 - Surge Protection for Low-Voltage Electrical Power Circuits

- 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.
- 1.5 INFORMATIONAL SUBMITTALS
 - A. Field quality-control reports.
 - B. Sample Warranty: For manufacturer's special warranty.
- 1.6 CLOSEOUT SUBMITTALS
 - A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Ten (10) years from date of Substantial Completion.

PART 2 - PRODUCTS

- 2.1 GENERAL SPD REQUIREMENTS
 - A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Subject to compliance with requirements, provide products by the following:
 - 1. ABB France.
 - 2. Advanced Protection Technologies Inc. (APT).
 - 3. Eaton Corporation.
 - 4. Emerson Electric Co.
 - 5. GE Zenith Controls.
 - 6. LEA International; Protection Technology Group.
 - 7. Leviton Manufacturing Co., Inc.
 - 8. Power Logics, Inc.
 - 9. Schneider Electric Industries SAS.
 - 10. Siemens Industry, Inc.
 - B. Comply with NFPA 70.
 - C. Comply with UL 1449.
 - D. MCOV of the SPD shall be the nominal system voltage.
- 2.2 SERVICE ENTRANCE SUPPRESSOR
 - A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).

- B. SPDs: Comply with UL 1449, Type 2.
- C. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 2.
 - 1. SPDs with the following features and accessories:
 - a. Integral disconnect switch.
 - b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - c. Indicator light display for protection status.
 - d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device.
 - e. Surge counter.
- D. Comply with UL 1283.
- E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
 - 1. Line to Neutral: 1200 V for 480Y/277 V.
 - 2. Line to Ground: 1200 V for 480Y/277 V.
 - 3. Line to Line: 2000 V for 480Y/277 V.
- G. SCCR: Equal or exceed 200 kA.
- H. Nominal Rating: 20 kA.

2.3 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.
- 2.4 CONDUCTORS AND CABLES
 - A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Wiring:
 - 1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- 3.2 FIELD QUALITY CONTROL
 - A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
 - B. An SPD will be considered defective if it does not pass tests and inspections.
 - C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.
- 3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 43 13

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SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior solid-state luminaires that use LED technology.
 - 2. Lighting fixture supports.
- B. Related Requirements:
 - 1. Section 26 09 43 "Network Lighting Controls"
 - 2. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project, IES LM-79 and IES LM-80.

- a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For luminaires and light engines. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Lighting luminaires.
 - 2. Suspended ceiling components.
 - 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
 - 4. Structural members to which equipment and /or luminaires will be attached.
 - 5. Initial access modules for acoustical tile, including size and locations.
 - 6. Items penetrating finished ceiling, including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Ceiling-mounted projectors.
 - 7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of luminaire.
- E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - Lighting fixtures: At least ten percent of each type and rating installed. However, if less than
 (5) fixtures are provided of a fixture type, no spare fixtures are required for that fixture type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- 1.9 DELIVERY, STORAGE, AND HANDLING
 - A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Three year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

- 2.1 LUMINAIRE REQUIREMENTS
 - 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. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. Bulb shape complying with ANSI C79.1.
- F. CRI of minimum 80. CCT of 3500 K.
- G. Rated lamp life of 50,000 hours.
- H. Lighting fixtures to be compatible with dimming per lighting controls.
- I. Internal driver.
- J. Nominal Operating Voltage: 277 V ac.
 - 1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- K. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517). Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include lighting fixtures as described in the lighting fixture schedule, or approved equals, by one of the following:
 - a. Philips Lighting Company.
 - b. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - c. Cooper Lighting, an Eaton business.
 - d. Hubbell Industrial Lighting; Hubbell Incorporated.

2.2 METAL FINISHES

A. White powder-coat or painted finish unless noted otherwise.

2.3 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "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 luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- D. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- E. Ceiling-Mounted Luminaire Support:
 - 1. Ceiling mount with hook mount.
- F. Ceiling-Grid-Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

- G. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- 3.4 IDENTIFICATION
 - A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- 3.5 FIELD QUALITY CONTROL
 - A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
 - B. Luminaire will be considered defective if it does not pass operation tests and inspections.
 - C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260943 "Network Lighting Controls."

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace light sources or luminaires that are defective. Parts and supplies shall be manufacturer's authorized replacement parts and supplies
 - 2. Field program any lighting fixture controls and/or dimming occupancy or vacancy sensors for proper mode operation as directed by Owner or Architect.
 - 3. Adjust the aim of luminaires in the presence of the Architect if requested.

END OF SECTION 26 51 19

SECTION 26 52 13 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.2 SUMMARY

- A. Section Includes:
 - 1. Exit signs.
 - 2. Luminaire supports.

1.3 **DEFINITIONS**

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IBS LM-45, for each luminaire type.
 - 1. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data tor remaining luminaires and signs shall be certified by manufacturer.
 - 2. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule:
 - 1. For emergency lighting units. Use same designations indicated in Lighting Fixture Schedule on Drawings.
 - 2. For exit signs. Use same designations indicated in Lighting Fixture Schedule on Drawings.
- D. Qualification Data: For testing laboratory providing photometric data for luminaires.
- E. Product Certificates: For each type of luminaire.
- F. Product Test Reports: For each luminaire for tests performed by a qualified testing agency.
- G. Sample Warranty: For manufacturer's special warranty.
- H. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.
- I. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
 - 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IBS testing standards.
- 1.6 DELIVERY, STORAGE, AND HANDLING
 - A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.7 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).

2.2 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Provide exit signs as described in the Lighting Fixture Schedule in the drawing set. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Philips Lighting Company.
 - b. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - c. Cooper Lighting, an Eaton business.
 - d. Hubbell Industrial Lighting; Hubbell Incorporated.
 - 2. Operating at nominal voltage of 277 V ac.
 - 3. Lamps for AC Operation: Fluorescent, two for each luminaire; 20,000 hours of rated lamp life.
 - 4. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
 - 5. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
 - 6. Master/Remote Sign Configurations:
 - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply, ballast for power connection to remote unit.
 - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging,

- B. Doors, Frames, and Other Internal Access:
 - 1. Smooth operating, free of light leakage under operating conditions.
 - 2. Designed to permit relamping without use of tools.
 - 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
 - 1. Clear, UV-stabilized acrylic.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - **3**. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

- 1. Thermoplastic, white finish.
- E. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

2.4 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- 2.5 LUMINAIRE SUPPORT COMPONENTS
 - A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
 - B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight,
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires; Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 1. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
 - 2. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

- 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 26 52 13

SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. General requirements for a complete and fully operational Exterior Lighting System including:
 - 1. Exterior Luminaires
 - 2. Lamps
 - 3. Drivers
 - 4. Accessories
 - 5. Luminaire supports
 - 6. Poles
 - 7. LED Arrays
- B. Related Requirements:
 - 1. Section 26 00 10 "General Electrical Requirements" for general requirements and related documents that apply to this Section.
 - 2. Section 26 05 10 "Common Work Results for Electrical" for raceways, conductors, cables and cords.
 - 3. Section 26 05 26"Grounding and Bonding for Electrical Systems".
 - 4. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems".
 - 5. Section 26 05 53 "Identification for Electrical Systems".
 - 6. Section 26 28 16 "Enclosed Switches and Circuit Breakers".
 - 7. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements.

1.3 SYSTEM DESCRIPTION

- A. Catalog numbers indicated in the Light Fixture Schedule are a design series reference and do not necessarily represent the exact catalog number, size, voltage, wattage, type of light engine, driver, finish trim, ceiling type, mounting hardware or special requirements as Specified or as required by the particular installations. Provide complete luminaire to correspond with the features, accessories, number of lamps, wattage and/or size Specified in the text description of each luminaire type. Additional features, accessories and options Specified shall be included.
- B. Luminaire voltage shall match the voltage of the circuit serving same.

1.4 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.

- C. LER: Luminaire efficacy rating.
- D. Luminaire: Complete lighting fixture, including driver housing if provided.
- E. Pole: Luminaire support structure, including tower used for large area illumination.
- F. Standard: Same definition as "Pole" above.
- 1.5 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION
 - A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
 - B. Live Load: Single load of 500 lb, distributed as stated in AASHTO LTS-4-M.
 - C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.
 - D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
 - 1. Basic wind speed of calculating wind load for poles 50 feet (15 M) high or less is 126 mph.
 - a. Wind Importance Factor: 1.0.
 - b. Minimum Design Life: 25 years.
 - c. Wind induced vibration.

1.6 SUBMITTALS

- A. The authorized manufacturer's representative for the Project area shall prepare Submittals for each luminaire type. In addition to the luminaire Submittals, a list shall be provided identifying the manufacturer representative for each luminaire type. Provide manufacturers' names, addresses, and telephone numbers. Requests for prior approval shall also include this information. Submittals or requests for prior approval without this information will be rejected.
- B. Product Data shall indicate that luminaire, light engines, drivers fully comply with Contract Documents. Data shall be submitted for each type of luminaire indicated, arranged in order of luminaire designation. For standard catalog luminaires provide original product catalog sheets indicating data on features, accessories, finishes, and the following:
 - 1. Materials and dimensions of luminaires.
 - 2. Photometric data, in IESNA format, based on certified results of laboratory tests of each luminaire type, outfitted with lamps, LED arrays, drivers and accessories identical to those indicated for the luminaire as applied in the Project.
 - a. Photometric data shall be certified by a qualified independent testing agency.
 - 3. Low voltage transformers.
 - 4. LED power supplies and drivers.
 - 5. Types of lamps and LED's, including manufacturer, wattage, and Color Rendering Index (CRI) and color temperature in degrees Kelvin (K).
- C. Shop Drawings shall:

- 1. Show details of nonstandard or custom luminaires.
- 2. Indicate dimensions, weights, method of field assembly, components, features, and accessories.
- 3. This Contractor shall provide the manufacturer with accurate field dimensions where required.
- 4. Include wiring diagrams, power and control wiring.
- D. Wiring Diagrams shall detail wiring for luminaires and differentiate between manufacturerinstalled and field-installed wiring.
- E. Product Certificates shall be signed by manufacturers of luminaires certifying that products comply with requirements.
- F. Maintenance Data shall be provided for luminaires and equipment to include in emergency, operation, and maintenance manuals Specified in Specifications Section describing Operations and Maintenance Data.
- G. Field quality control test reports.
- H. Special Warranties Specified in this Section.
- I. Review of luminaire submittals which indicate voltage, mounting condition, or quantities shall not be considered to be approval of said voltage, mounting condition, or quantities. This Contractor shall field verify voltage and actual mounting condition and method.
- J. Product samples complete with housing, trim, specified lamp, and 8' cord with plug shall be submitted if requested.
- K. Pole and Support Component Certificates: Signed by Manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a Professional Engineer.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and luminaires to include in emergency, operation, and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and applicable codes.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 5% of each type and rating installed. Furnish at least one of each type.
 - 2. Glass, Plastic Diffusers and Lenses: 10% or one dozen (whichever is less) of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: 5% of each type and rating installed. Furnish at least one of each type.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Package poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle with web fabric straps.
- 1.10 QUALITY ASSURANCE
 - A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
 - B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.
 - C. Comply with NFPA 70.
 - D. All luminaires shall bear a UL label.
 - E. Comply with IEEE C2, "National Electrical Safety Code."
 - F. Designated manufacturers are listed to define the requirements for quality and function of the specified product.
 - G. Comply with Using Agency Design Standards.

1.11 COORDINATION

- A. Coordinate layout and installation of luminaires with plantings, paving, site walls and other site work elements.
- B. Coordination Meetings: This Contractor shall meet at least twice with the sitework installer(s). Hold first meeting before submittal of shop drawings to coordinate each luminaire mounting condition and location. During second meeting, coordinate layout with other site components. Coordinate depth and location of all luminaire pole bases in all areas.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

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- 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
- 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
- 4. Warranty Period for LED arrays/drivers: Five years from date of Substantial Completion.
- 5. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
- 6. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 All products supplied for this project must comply with the Illinois Procurement of Domestic Products Act (30 ILCS 517).

2.2 MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include lighting fixtures as described in the lighting fixture schedule, or approved equals, by one of the following:
 - a. Philips Lighting Company.
 - b. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - c. Cooper Lighting, an Eaton business.
 - d. Hubbell Industrial Lighting; Hubbell Incorporated.

2.3 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. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Comply with IESNA TM-15-07 Luminaire Classification System for Outdoor Luminaires.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect driver when door opens.
- G. Exposed Hardware Material: Stainless steel.

- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Optical assemblies: Full cutoff with zero uplight, "dark sky" compliant. LED assemblies shall comply with BUG rating system.
- K. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 90 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- L. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- M. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Finish: premium 5 stage TGIC polyester powder coat paint.
 - 3. Color: See Luminaire Schedule.
- O. Outdoor Wall Mounted Area Luminaires
 - 1. Shall have minimum 52 lumens per watt.
 - 2. No more than 48% of the total luminaire output shall be within the forward 60-80° zone.
 - 3. No more than 3% of the total luminaire output shall be in the forward 80-90° zone.
 - 4. No light at or above horizontal 90-180° zone.
- P. Parking Structure Luminaires
 - 1. Shall have minimum 70 lumens per watt.
 - 2. At least 30% of total luminaire output shall be within the 60-80° zone.
 - 3. No more than 20% of total luminaire output shall be above the 80° zone.
- Q. Canopy Luminaires
 - 1. Shall have minimum 70 lumens per watt.
 - 2. At least 30% of total luminaire output shall be within the 40-60° zone.
 - 3. No more than 20% of total luminaire output shall be above the 80° zone.

2.4 LED DRIVERS AND ARRAYS

- A. UL 1598 listing.
- B. LED arrays shall have LED's that produce minimum 55 lumens/watt when operated at 350mA.
 - 1. Lumen Depreciation Data: At 40 deg C ambient, the L70 hours shall be 50,000 at 520 mA driver.
 - 2. LED color: neutral white, 4100 deg K, CRI of 75.
- C. Drivers shall accept 120 through 480 volts, 50/60 Hz.
- D. The housing shall have an integral thermal management system with extruded aluminum radiation fins and lateral airways.
- E. Comply with IES LM-79-08 and LM-90-08 Approved Methods.
- F. Comply with In-Situ testing for more reliable results.
- G. LED's shall be Restriction of Hazardous Substances Directive (RoHS) compliant.

2.5 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
 - 1. Adjustable window slide for adjusting on-off set points.

2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
 - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.

- 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
- 3. Anchor-Bolt Template: Plywood or steel.
- D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches with cover secured by stainless-steel captive screws.
- E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."

2.7 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: Refer to Luminaire Schedule or shall match existing site poles.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation.
- B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- C. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- D. 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.
 - 1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 - 2. Finish: Match pole and luminaire material and finish.
- E. Aluminum Finish: 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. Finish: Premium five (5) stage TGIC polyester powder coat paint.
 - a. Color: As selected by Architect from manufacturer's full range or to match existing adjacent poles.

2.8 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
- B. Fusing: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by driver manufacturer.
- C. Banner Arms: Coordinate with manufacturer for maximum banner size limitations to avoid banner arm or pole failure. Banner arms shall be break-away type designed to fail before over

stressing the pole.

D. Wind Mitigation Devices: provide in areas of consistent, high, uneven winds.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.2 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
 - 3. Trees: 15 feet from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 2. Install base covers unless otherwise indicated.
 - 3. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Raise and set poles using web fabric slings (not chain or cable).
- 3.3 BOLLARD AND INDIVIDUAL GROUND MOUNTED LUMINAIRES
 - A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

- A. Ground metal poles and support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.6 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Replace all burned out or inoperative lamps or LED arrays at the end of Construction prior to Using Agency occupancy.
- C. Advance Notice: Give dates and times for field tests.
- D. Provide instruments to make and record test results.
- E. Test as follows:
 - 1. Verify proper operation, switching and phasing of each luminaire after installation.
 - 2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation. Verify normal transfer to generator and retransfer to normal.
 - 3. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to the lighting system, retest to demonstrate compliance with standards.
- F. Malfunctioning Luminaires and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
- G. Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.

H. Illumination Tests:

- 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - b. IESNA LM-72, "Directional Positioning of Photometric Data."
- I. 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.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

- 4.1 GENERAL
 - A. Comply with applicable provisions of division 01 Section "Quality Requirements" for requirements for Contractor's Quality Control Program.

END OF SECTION 26 56 00

DIVISION 26 - ELECTRICAL Section 26 56 00 - Exterior Lighting

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27 00 00 - COMMUNICATION GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section, used in conjunction with each separate specification section, outline the general communications design requirements, administration topics, and installation requirements for Information Technology System (ITS).

B. Related Requirements

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 2. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them, including but not limited to the following:
- 3. This specification covers all ,general requirements for work under this contract and the following specification sections:
- 4. Section 27 05 26 Communication Bonding and Grounding
- 5. Section 27 05 28 Communication Pathways
- 6. Section 27 05 29 Communication Hangers and Supports
- 7. Section 27 05 33 Communication Conduits and Boxes
- 8. Section 27 05 53 Communication Identification
- 9. Section 27 08 00 Communication Commissioning
- 10. Section 27 11 16 Communication Cabinets Racks and Enclosures
- 11. Section 27 11 19 Communication Termination Blocks and Patch Panels
- 12. Section 27 11 23 Communication Cable Management and Runway
- 13. Section 27 13 13 Communication Copper Backbone Cabling
- 14. Section 27 13 23 Communication Optical Fiber Backbone Cabling
- 15. Section 27 13 24 Communication Optical Fiber Splicing
- 16. Section 27 13 33 Communication Coaxial Backbone Cabling
- 17. Section 27 13 34 Communication Coaxial Splicing and Termination
- 18. Section 27 15 13 Communication Copper Horizontal Cabling
- 19. Section 27 15 23 Communication Optical Fiber Horizontal Cabling
- 20. Section 27 15 33 Communication Coaxial Horizontal Cabling
- 21. Section 27 15 43 Communication Faceplates and Connectors
- 22. Section 27 16 19 Communication Patch Cords

1.2 **REFERENCES**:

- A. Abbreviations:
 - 1. A/E: Architect / Engineer (designer)
 - 2. BET: Building Entrance Terminal
 - 3. CBC: Coupled Bonding Conductor
- 4. E.E. Electrical Engineer
- 5. EMI: Electromagnetic Interference
- 6. FTP Foiled Twisted Pair
- 7. GE: Ground Equalizer
- 8. IDC: Insulation Displacement Contact
- 9. IDF: Intermediate Distribution Facility
- 10. I/O: Information Outlet or Work Area Information Outlet
- 11. ITS: Information Technology System
- 12. LAN: Local Area Network
- 13. LC: A type of small form factor optical fiber connector
- 14. LOMMF: Laser Optimized Multimode Fiber
- 15. MC: Main Cross-Connect
- 16. MDF: Main Distribution Facility
- 17. OFE: Owner Furnished Equipment
- 18. OTDR: Optical Time Domain Reflectometer
- 19. RCDD: Registered Communications Distribution Designer
- 20. RoHS: Restriction of Hazardous Substances
- 21. SMF: Single-mode Fiber
- 22. TBB: Telecommunications Bonding Backbone
- 23. TBC: Telecommunications Bonding Conductor
- 24. TGB: Telecommunications Ground Bus Bar
- 25. TMBC: Telecommunications Main Bonding Conductor
- 26. TMGB: Telecommunications Main Grounding Bus Bar
- 27. UTP: Unshielded Twisted Pair
- 28. WA: Work Area

1.3 REFERENCE STANDARDS & CODES:

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. The publications listed in this section form a part of this specification. The publications are referred to in the text of applicable specifications by basic designation only.
- D. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest edition of each as adopted by the projects local AHJ.
- E. Conflicts:
 - 1. Drawings and specifications are to be used in conjunction with one another and to supplement one another. In general, the specifications determine the nature and quality of the materials and tests, and the drawings establish the quantities, details, and give characteristics of performance that should be adhered to in the installation of the communications system components.

- 2. If there is an apparent conflict between the drawings and specifications, or between specification sections, the items with the greater quantity or quality shall be estimated and installed.
- 3. Clarification with the Owner and/or Owner's Representative about these items shall be made prior to ordering and installation of components.
- F. All materials, installation and workmanship shall comply with the most recently approved applicable reference standards and codes addressed within each specification document.
 - 1. The latest edition of the codes as approved and adopted by the agency/authority having jurisdiction (AHJ) as of the date that the work is advertised for bids, shall apply to the work under the Contract Documents.
 - 2. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.)
 - a. National Electric Code (NEC) (NFPA 70)
 - b. National Electric Safety Code (NESC)
 - c. National Fire Protection Association (NFPA)
 - d. Washington Electrical Code
 - e. Local Municipal Codes
 - 3. ANSI/IEEE 802.12: 100Base-TX Ethernet
 - 4. ANSI/IEEE 802.3ab: 1000Base-T Ethernet Specification
 - 5. ANSI/IEEE 802.3ae: 10Gb/s Ethernet Specifications
 - 6. ANSI/IEEE 802.11: Wireless Ethernet Specifications, including 802.11a, 802.11b ,802.11g and 802.11n
 - 7. ANSI/TIA-455-57-B: FOTP-57, Preparation and Examination of Optical Fiber End Face for Testing Purposes
 - 8. ANSI/TIA-455-78-B: FOTP-78, Measurement Methods and Test Procedures Attenuation
 - 9. ANSI/TIA-455-95-A: FOTP-95, Absolute Optical Power Testing for Optical Fiber and Cables
 - 10. ANSI/TIA-455-133-A: FOTP-133, Measurement Methods and Test Procedures Length Measurement
 - 11. TIA-492AAAD: Detail specification for 850-nm laser-optimized, 50-um core diameter/125-um cladding diameter class Ia graded-index multimode optical fibers
 - 12. TIA-492CAAB: Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak
 - 13. ANSI/TIA-526-7: OFSTP-7, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - 14. ANSI/TIA-526-14-A: OFSTP-14, Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant
 - 15. ANSI/TIA-568-C, Series of Standards for Commercial Building Telecommunications
 - 16. ANSI/TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
 - 17. TIA-598-C: Optical Fiber Color Coding
 - 18. ANSI/TIA-606-B Administration Standard for Telecommunications Infrastructure
 - 19. TIA-607-C Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
 - 20. ANSI/NECA/BICSI 607-2011 Standard for Telecommunications Bonding and Grounding

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- 21. TIA-758-B: Customer-owned Outside Plant Telecommunications Infrastructure Standard
- 22. ANSI/TIA-942: Telecommunications Infrastructure for Data Centers
- 23. BICSI Telecommunications Distribution Methods Manual
- 24. BICSI Information Technology Systems Installation Manual
- 25. BICSI Outside Plant Design Reference Manual
- 26. BICSI Electronic Safety and Security Design Reference Manual
- 27. Infocomm/BICSI AV Design Reference Manual
- 28. Underwriters Laboratories (UL) Cable Certification and Follow-Up Program.
- 29. National Electrical Manufacturers Association (NEMA)
- 30. American Society for Testing Materials (ASTM)
- 31. Institute of Electrical and Electronic Engineers (IEEE)
- 32. UL Testing Bulletin
- 33. Local, county, state and federal regulations and codes in effect as of date of installation.
- 34. Equipment of foreign manufacture must meet U.S. codes and standards. It shall be indicated in the proposal the components that may be of foreign manufacture, if any, and the country of origin.

1.4 SCOPE OF WORK:

- A. Work of this section covers a complete installation of both permanent and channel links for a structured Information Technology System (ITS) utilizing copper and fiber transmission media that includes, but is not limited to the following. The Design Builder shall:
 - 1. Outside Cable Plant connecting each building with copper and fiber.
 - 2. Develop a planned and phased approach to decommission existing cable plants upon completion of the new outside cable plant.
 - a. Long-Term Care :
 - b. Domiciliary Building
 - c. Neilson Building
 - d. Copper and fiber cable associated pathways that are affected by new construction
 - e. Redundancy:
 - 1) Primary and secondary pathways to each building
 - 3. Inside Cable Plant
 - a. Work Stations
 - 1) All units
 - 2) Common Areas
 - 3) Specialty Rooms, and spaces
 - 4) Refer to drawings for reference
 - b. Internet of Things (IoT) to support building controls, and automation
 - c. Wireless Access Points
 - d. Racks, Patch Panels, and Wire Management
 - e. Ladder Rack
 - f. Grounding & Bonding
 - g. Fire stopping

- h. UPS's (uninterruptable power supplies) sized appropriately for owner furnished equipment
- i. PDU's (Power distribution units)
- 4. Backbone Cable
 - a. Copper and Fiber
 - b. Redundancy
 - 1) Fiber and copper between each MPOE (main point of entry) room.
- 5.
- 6. Comply with all Master Specifications documents and the following requirements for a complete project installation.
- 7. Coordinate with other trades to ensure pathways and all infrastructure are installed to comply with all specifications and contract documents.
 - a. Coordinate with Division 26 Design Builder to verify conduit routing does not cause cabling to exceed specified electrical length, pulling tension, bend radius, or bend quantity.
 - b. Bonding and grounding from MDF and IDF rooms to Grounding Electrode System provided by Division 26 Design Builder.
- 8. Provide a structured cabling system as described hereafter that includes, but is not limited to, supplying, installing, labeling and testing of: fiber and copper riser and backbone cable; fiber and copper horizontal cabling, cable connectors, communications outlets and terminations, and equipment racks/cabinets for networking hardware, patch panels, and patch cords as required to provide a complete and functioning system.
- 9. Furnish all labor, materials, tools, equipment and services for the installation described herein. Provide add/deduct unit pricing for all components as part of the bid response. All requirements and specifications shall be enforced. Cable pathways and runs to individual outlets are not shown in their entirety, but shall be provided as if shown in their entirety.
- 10. Follow industry standard installation procedures for communications cable to assure that the mechanical and electrical transmission characteristics of this cable plant and equipment are maintained.
- 11. Provide and install UL-listed firestopping systems in all communication pass-throughs, conduits and cable trays, used in ceiling, wall and floor penetrations in coordination with Design Builder.
- 12. Provide Submittals prior to commencement of work as outlined later in this specification.
- 13. Conduct a final document handover meeting with client, consultant, and PM to review, discuss and educate the Owner on the test results and As-Built Drawings.
- 14. Provide a Manufacturer's Extended Product Warranty and System Assurance Warranty for this structured cabling system.

1.5 PRODUCTS AND OWNER-FURNISHED EQUIPMENT (OFE):

A. The Owner may separately purchase and/or provide certain equipment and miscellaneous items that will be installed during the course of the installation process, by the Owner. Such items may not be indicated in the project documents. Design Builder shall coordinate with the Owner to ensure required provisioning of infrstructure in support of OFE:

- 1. Provision and installation of phone systems, computer hardware, and related networking software and equipment.
- 2. Provision and installation of UPS in communications rooms.
- 3. Provision and installation of a building generator to provide emergency power to communications rooms.
- 4. Communications grounding busbars and bonding conductors connecting to the main building electrode system.
- 5. Dedicated power panels, ground busbars, circuits and utility outlets.
- 6. Installation and finishing of plywood backboards.
- 7. Building mechanical ductwork, cooling/heating system, and environmental control sensors.
- 8. Communication pathway devices such as, but not limited to, cable tray and flex-tray in corridors, office spaces and open areas, conduits, conduit sleeves, and penetrations in walls and floors.

1.6 MEASUREMENT PROCEDURES:

- A. The Design Builder shall
 - 1. Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements and scale on shop drawings.
 - 2. Coordinate fabrication schedule with construction progress to avoid delaying the work.
 - 3. Where field measurements cannot be made without delaying the work, establish dimensions and coordinate with the Design Builder, and when approved, proceed with fabricating units without field measurements.
 - 4. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.
 - 5. Immediately notify the Project Team of any discrepancies before and during construction.

1.7 ALTERNATES:

- A. If an alternate material is proposed that is equal to or exceeds specified requirements, Design Builder shall provide manufacturers' specifications in writing for Owner approval prior to purchase and installation.
- B. Substitutions of material by the Design Builder shall be in writing complete with written manufacturers' specifications. The material substituted shall not void, alter or change manufacturers' structured cabling system warranty.
- C. Design Builder shall:
 - 1. Provide a complete cabling ITS infrastructure according to these written specifications and drawings.
 - 2. Respond to these changes with a complete material list, including pricing, labor, and taxes in writing presented to the Owner's Representative for approval.
 - 3. Not proceed with additional scope of work without a signed approval by the Owner.

D. Any additional work performed by the Design Builder without signed approval of these changes shall be at the Design Builder's own risk. Design Builder will submit a copy of signed change order upon billing.

1.8 SUBSTITUTION PROCEDURES

- A. Substitution may be considered when a product becomes unavailable through no fault of the Design Builder.
- B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Include in each request for substitution:
 - 1. Product identification, manufacturer's name and address.
 - 2. Product Data: Description, performance and test data, reference standards, finishes and colors.
 - 3. Samples: Finishes
 - 4. Complete and accurate drawings indicating construction revisions required (if any) to accommodate substitutions.
 - 5. Data relating to changes required in construction schedule.
 - 6. Cost comparison between specified and proposed substitution.
 - 7. Product specification cut sheets.
- C. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- D. The Owner will be the final judge of acceptability, with review by Owner's Representative and the distribution of the acceptance by the Architect. No substitute shall be ordered, installed or utilized without the Architect's prior written verification of acceptance from the Owner.

1.9 SYSTEM DESCRIPTION:

A. The objective of this project is to provide a complete ITS infrastructure installation including, but not limited to: fiber backbone, riser system, horizontal data and voice cabling with associated terminations, mounting equipment, cable pathway and management systems, testing and other items/materials, as specified in drawings, these specifications, and contract documents.

1.10 SUBMITTALS:

- A. The Design Builder:
 - 1. Shall submit a minimum of six (6) weeks prior to the commencement of any work all shop drawings, product data, or samples for approval by the Owner's Representative. Such work shall be in accordance with the requirements of all specification sections related to the work.
 - a. Shop drawings as required by the owner or as a minimum to include an electronic set of plan view and elevations of all work to be installed. The Design Builder shall

make any corrections required by the owner or the owner's representative or consultant team file corrected copies and furnish such other copies as may be needed. The consultant's approval of such drawings or schedules shall not relieve the Design Builder from responsibility for deviations from drawings or specifications, unless the Design Builder has in writing called the Architect's attention to such deviations at the time of submission, nor shall it relieve the Design Builder from responsibility for errors of any sort in shop drawings or schedules.

- 2. Shall not perform any portion of the work that would disqualify any part or all of the ITS installation from the Manufacturer's warranty qualification.
- B. The Design Builder shall provide a copy of the Certified Test Data Sheet, available from the delivering distribution warehouse for either a full run or cut piece from the Master Reel of the fiber cable to be installed
 - 1. The Certified Test Data Sheet shall include the Master Reel number, cable description, a passing test result with details, test equipment description, date certified, and a certificate of compliance stamp, and shall be included in the O&M Manual as a component of the final deliverables submittal package.
 - 2. Design Builder shall also include a copy of their acceptance test performed prior to installing the delivered optical fiber.
- C. The Design Builder shall provide the appropriate documentation from the certifying manufacturer showing the project is registered and qualified for the System Assurance Warranty. All subsequent work shall be in accordance with approved submittals.
- D. The Design Builder's BICSI Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all documents prior to submitting. The Design Builder's RCDD shall warrant in writing that 100% of the installation meets the requirements specified herein upon completion of all work.
- E. Product Certificates shall be signed by manufacturers of cables, connectors, and terminal equipment certifying that products furnished comply with requirements.
- F. Design Builder shall submit the required Field Test Reports in the format and media specified, upon completion of testing the installed system.
- G. Design Builder shall submit sustainable design related submittals. Requirements are provided within individual technical specification sections.

- H. Design Builder shall deliver manufacturer's signed long-term Warranty of installed cabling system to include all components that comprise the complete cabling system. Delivery to be effected within two weeks of the time of final punch list review. Failure of any component to pass system component tests shall be promptly corrected, repaired or replaced to meet standards compliance. Design Builder shall coordinate with manufacturer for warranty paperwork and procedures prior to the start of the project.
- I. Cable Commissioning Plan:
 - 1. The Design Builder shall:
 - a. Provide a complete and detailed commissioning plan for approval of the cabling system specified herein, including a complete list of test equipment for copper and fiber optic components and accessories prior to beginning cable testing. The following minimal items shall be submitted for review:
 - b. Comply with all testing procedures and methods as listed in Specification 27 08 00 Communication Commissioning.
 - c. Provide product data for test equipment
 - d. Provide certifications and qualifications of all persons conducting the testing.
 - 2. Calibration certificates indicating that equipment calibration meets National Institute of Standards and Technology (NIST) standards and has been calibrated at least once within the previous year of the testing date.
 - a. Include validation, and testing. Owner will require that the telecommunications cabling system installed by the Design Builder be fully certified to meet all necessary requirements to be compliant with referenced IEEE and TIA standards, specifications, and vendor's warranty.
 - b. Will determine the source/cause of test failure readings and correct malfunctioning component and/or workmanship within each channel or permanent link and retest to demonstrate compliance until corrected failure produces a passing result.
- J. Cable Testing Reports: The Design Builder shall submit cable test reports as follows:
 - 1. Submit certified test reports of Design Builder-performed tests.
 - a. The tests shall clearly demonstrate that the media and its components fully comply with the requirements specified herein.
 - b. One (1) set of electronic version of test reports shall be submitted together and clearly identified with cable identification.
 - c. Include software required to read test reports.
 - 2. Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination equipment. Submit data electronically on CD-ROM, listing products furnished, including:
 - a. Manufacturer's name.
 - b. Manufacturer's part numbers.
 - c. Cable numbers.
 - d. Location and riser assignments.

- e. Product Data:
- 3. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer's latest standard design in satisfactory use for at least one year prior to bid opening.
- K. Shop Drawings:
 - 1. The Design Builder shall:
 - a. Submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be marked with an arrow, highlighted, or underlined to indicate exact selection.
 - b. Identify applicable specification section reference for each product performance for each component specified for approval prior to purchase and installation.
 - c. Submit for approval diagrams showing room layouts, rack layouts (including elevations), riser layouts, etc.
 - d. Submit sample floor plan demonstrating outlet administration, clearly identifying each outlet with correct nomenclature, and legibly located on drawing.
- L. Qualifications:
 - 1. The Design Builder shall provide the appropriate documentation to comply with the requirements described in SECTION 1.11- QUALITY ASSURANCE, included with, and at the time of bid submittal.
- M. Closeout Submittals (As-built Drawings):
 - 1. As-Built drawings are to be supplied to the Architect to prepare the Record Drawings.
 - 2. As-Built drawings shall be in AutoCAD format, same version as used by Architect and consultant. PDFs of these drawings will also be made available if requested. Dimensions and scale of the drawing sheets submitted shall match the size of the drawing used for the contract documents, and shall include the cable numbers labeled in accordance with this document.
 - 3. Utilize industry recognized drafting procedures that match Architect and consultant guidelines, methodology, and symbols.
 - 4. The As-Built drawings shall incorporate all changes made to the building identified in, but not limited to, addendum, change notices, site instructions or deviations resulting from site conditions.
 - 5. Design Builder shall:
 - a. Clearly identify any resubmitted drawing sheets, documents or cut sheets either by using a color to highlight or cloud around resubmitted information.
 - b. Maintain drawing numbering, and graphic symbol consistency as per drawings issued by Architect
 - 6. Provide dimensioned plan and elevation views of networking components, showing:
 - a. All communications data/voice outlet locations complete with outlet/cable labeling.
 - b. Cable routing paths of communications cables to identified infrastructure pathways.

- c. All rack and cabinet locations and labeling thereof.
- d. Standard or typical installation details of installations unique to Owner's requirements.

1.11 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Design Builder shall supply all city, county, and state telecommunication cabling permits required by appropriate governing agency.
 - 2. Design Builder shall be state-licensed and/or bonded as required for telecommunications/low voltage cabling systems.
- B. Certifications:
 - 1. Design Builder shall submit an up-to-date and valid certification verifying qualifications of the Design Builder and installers to perform the work specified herein at time of bid submission.
 - 2. Design Builder shall have a complete working knowledge of low voltage cabling applications such as, but not limited to data, voice and video network systems.
 - 3. Contracting firm shall have installed similar-sized systems in at least ten (10) other projects in the last five years prior to this bid and be regularly engaged in the business of installation of the types of systems specified in this document. Certification shall include, but not be limited to, items such as name and location of project contacts and numbers, total square footage, total number of cables/drops, types of media, etc.
 - 4. Design Builder shall provide certificates for the appropriate insurance coverage as defined in contract documents.
 - 5. All installer personnel that will be assigned to this project shall be listed in the qualification questionnaire document. 25% shall have a minimum of 3 years' experience in the installation of the types of systems, equipment, and cables specified in this document prior to this bid. Any personnel substitutions shall be noted in writing to Owner prior to commencement of work.
 - 6. Design Builder shall provide a registered BICSI Technician who shall act as the on-site Foreman throughout the duration of the project.
 - 7. Design Builder shall submit evidence of compliance with these requirements prior to beginning work on the project.
 - 8. Cabling installers shall be trained and certified by the connectivity/cable manufacturer for telecommunication cabling installations and maintenance of said materials. Refer also to General Conditions.

1.12 ADMINISTRATIVE REQUIREMENTS AND COORDINATION:

- A. The Design Builder shall:
 - 1. Provide a specified contact person (name and contact number) for coordination to attend project meetings with the telecommunication consultant, the Owner and others.
 - 2. Provide a specified contact person (name and contact number) for BIM coordination of models with GC, consultant, owner and others for overall system coordination.

- 3. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the A/E. Any repairs or changes made necessary in the contract work, caused by the Design Builder's neglect, shall be made by the Design Builder at their own expense
- 4. Coordinate work of this section with Owner's telephone system specifications, workstations, equipment suppliers, and installers.
- 5. Coordinate installation work with other crafts (examples include ceiling grid Design Builders, HVAC and sheet metal Design Builders, etc.) to resolve procedures and installation placement for cable trays and cable bundle pathways. The goal of this coordination will be to establish priority pathways for critical structured cabling infrastructure, materials, associated hardware, as well as mitigate delays to the project and to allow service access for communications and HVAC components. Damage by Design Builder to the craftwork of others will be remedied at the Design Builder's expense in a timely manner.
- 6. Exchange information and agree on details of equipment arrangements and installation interfaces. Record agreements reached in meetings and distribute record to other participants, Owner and telecommunication consultant.
- 7. Adjust arrangement and locations of distribution frames, patch panels, and cross-connect blocks in equipment rooms and racks to accommodate and optimize arrangement and space requirements of any service provider equipment, telephone system, and LAN equipment. Tasks shall be coordinated with Owner or his representative, and other trades' installation representatives.
- 8. Where installed, confirm exact locations and method of mounting outlets in modular furniture. Follow furniture manufacturers' written instructions for installing cable and devices in modular partitions. Obtain modular furniture and power pole locations from the Design Builder. Cabling locations noted in plans along walls or in floors for modular furniture are approximate and will have to be determined by Design Builder at time of installation. Field condition adjustments for installation shall be made and coordination efforts with the electrical Design Builder for pathway must take place early on in the project to comply with maximum 40% conduit fill ratio requirements.
- 9. When requested by Owner or Owner's representative, furnish extra materials that match specified products and that are factory packaged with protective covering for storage and identified with labels describing contents.
- 10. Related Documents:
- 11. Drawings and General provisions of the contract, including Uniform General Conditions, Supplementary General Conditions, architectural plans and specifications, requirements of Division 01, electrical, mechanical, plumbing, audio visual, security and telecommunications specifications and plans apply to the telecommunications section, and shall be considered a part of this section. The Design Builder shall read all sections in their entirety and apply them as appropriate for work in this section.
- 12. In order to accomplish the conditions of this agreement, the Design Builder shall perform the specific duties listed herein.
- 13. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the Design Builder.
- 14. The Design Builder will respect and protect the privacy and confidentiality of Owner, its employees, processes, products, and intellectual property to extent necessary, consistent with the legal responsibilities of the Owner's policies.

- 15. When required the Design Builder shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this project.
- 16. Use of Sub-Design Builders: Successful bidder shall inform the Owner's contact and Design Builder in writing about the intention to use Sub-Design Builder and the scope of work for which they are being hired. The Owner or Owner's designated contact must approve the use of Sub-Design Builder in writing prior to the Sub-Design Builder's hiring and start of any work.
- 17. The Design Builder's designated project manager will be recognized as a single point of contact. The Project manager shall oversee all work performed to ensure compliance with specifications as outlined in bid documents (which includes all specifications and drawings) to ensure a quality installation.

1.13 CONTRACT ADMINISTRATION:

- A. Change orders shall be submitted to the Owner/Project Manager complete with price breakdown and description for approval before any work is done.
- B. Owner's Representative will provide job field reports upon inspection of Design Builder's installation, materials, supporting hardware, coordination with other trades and progress to schedule to the client.
- C. Job Field Report outline:
 - 1. General installation progress in relation to scheduled work made by the Design Builder up to that date.
 - 2. All deficiencies noted in the cable installation to be corrected by the Design Builder.
- D. Pre-Installation Meetings Design Builder shall:
 - 1. Attend and/or arrange a scheduled pre-installation conference prior to beginning any work of this section.
 - a. Agenda: This venue is to ask and clarify questions in writing related to work to be performed, scheduling, coordination, etc. with consultant and/or project manager/Owner representative.
 - b. Attendance: Communications project manager/supervisor shall attend meetings arranged by Design Builder, Owner's representatives, and other parties affected by work of this document.
 - c. All individuals who will supervise installers of communication cables and equipment on-site, including project managers and lead installers, shall be required to attend the pre-installation conference. Individuals who do not attend the conference will not be permitted to supervise the installation of communications cables on the project.

1.14 POST-INSTALLATION MEETINGS:

- A. At the time of substantial completion, or shortly thereafter, the Design Builder shall call and arrange for a post-installation meeting to present and review all submittal documents to include, but not limited to as-built drawings, test reports, warranty documentation, etc. Attendees shall be Owner staff, Owner's Representative, Design Builder, and others that the Design Builder deems appropriate.
- B. At this meeting the Design Builder shall present and explain all documentation, and asking for feedback on its completeness. Any discrepancies or deviations noted by and agreed to by participants shall be remedied by Design Builder and resubmitted within one week of meeting.

1.15 DELIVERY, STORAGE, AND HANDLING:

- A. Coordination with delivery companies, drivers, site address, and contact person(s) will be the responsibility of the Design Builder.
- B. Design Builder Shall:
 - 1. Be responsible for prompt material deliveries to meet contracted completion date.
 - 2. Coordinate deliveries and submittals with the Design Builder to ensure a timely installation.
 - 3. No equipment materials shall be delivered to the job site more than three weeks prior to the commencement of its installation.
 - 4. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
 - 5. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
 - 6. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.
 - 7. Design Builder shall be responsible for all handling and control of equipment. Design Builder is liable for any material loss due to delivery and storage problems.
- C. Owner shall supply a list of security requirements for Design Builder to follow.

1.16 PROJECT/SITE CONDITIONS

- A. For all security recommendations, refer to related Division 01.
- B. After completing system installation, including outlet fittings and devices, inspect exposed finish. Design Builder will remove burrs, dirt, and construction debris. If applicable, the Design Builder will repair damaged finishes, including chips, scratches, and abrasions.
- C. Design Builder shall provide daily a clean work environment, free from dust, trash/rubbish accumulated during and after cabling installation.
- D. Telecommunication spaces shall be maintained in a dust/debris free manner at all times.

E. Design Builder shall keep all liquids (drinks, sodas, etc.) off finished floors, carpets, and tiles. If any liquid or other detriment (cuts, soils, stains, etc.) damages the above finishes, Design Builder shall provide professional services to clean or repair scratched/soiled finishes, at Design Builder's expense.

1.17 WARRANTY

- A. Design Builder shall provide a minimum one (1) year warranty on installation and workmanship PLUS an Extended Product Warranty and System Assurance Warranty for this cabling system and shall commit to make available local support for the product and system during the Warranty period.
 - 1. The Extended Product Warranty shall apply to all passive structured cabling system components and shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products for a minimum of one (1) year.
 - 2. The System Assurance Warranty provides a complete system and product warranty that will be extended to the end-user, ensuring the structured cabling system will be free of defects in materials and workmanship, will meet or exceed applicable performance requirements defined in the most current version of the Commercial Building Telecommunications Cabling Standards, and support all current network applications for a minimum of twenty (20) years.
- B. System Certification: Upon successful completion of the installation and subsequent inspection, the Owner shall be provided with a numbered certificate, from the manufacturer, registering the installation.

1.18 MAINTENANCE

A. Support Availability: The Design Builder shall commit to make available local support for the product and system maintenance during the Warranty or Extended Warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Comply with specifications for each specific Division 27 section for acceptable products.
- B. All materials shall be UL and/or ETL listed and labeled in accordance with NFPA 70 for all products where labeling service normally applies.
- C. Materials and equipment requiring UL 94, 149 or 1863 listing shall be so labeled. Modification of products that nullifies UL labels is not permitted.
- D. The installed systems shall not generate nor be susceptible to any harmful electromagnetic emission, radiation, or induction that degrades, or obstructs any equipment.

- E. All material and equipment as provided should be the standard Commercial-Off-The-Shelf (COTS) products of a manufacturer engaged in the manufacturing of such products. All shall be typical commercial designs that comply with the requirements specified. All material and equipment shall be readily available through manufacturers and/or distributors.
- F. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.
- G. Expansion Capability: Unless otherwise indicated, provide spare positions in patch panels, cross connects, and terminal strips, and space in cable pathways and backboard layouts to accommodate 20% future increase in campus distribution and active workstations.
- H. Backward Compatibility: The provided solution shall be backward compatible with lower category ratings such that if higher category components are used with lower category components, the basic link and channel measures shall meet or exceed the lower channel's specified parameters.
- I. Component Compliance: The provided solution's components shall each meet the minimum transmission specifications listed herein such that no individual component will be less than specifications for permanent link and channel, regardless of the fact that tests for link and channel ultimately meet required specifications.
- J. In the event of a breach of the representations and warranties contained herein, the Design Builder, at their own expense, shall take all measures necessary to make the cabling system work and comply with the applicable manufacturer written technical recommendations and standards.

PART 3 - EXECUTION

3.1 INSTALLATION DESIGN BUILDER

- A. Provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services to provide and install a complete inside and outside plant fiber and copper infrastructure system. Pay all required sales, gross receipts, and other taxes.
- B. A BICSI RCDD shall be employed as the Project Manager and approve all on-site work as a recognized member of the Design Builder's installation team. All installation team members must demonstrate knowledge and compliance with all BICSI, TIA, UL, and NEC methods, standards and codes.

3.2 EXAMINATION:

- A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.
- B. Established Dimensions: Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating units without field measurements. Coordinate

supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

3.3 PREPARATION:

- A. Design Builder's RCDD Project Manager shall review, approve and stamp all shop drawings, coordination drawings As-Built Drawings and submittal documents.
- B. Pre-installation inspection
 - 1. The Design Builder shall visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport. Visibly damaged goods are not acceptable and shall be replaced by the Design Builder at no additional cost to the Owner.

3.4 INSTALLATION:

- A. General
 - 1. Design Builder shall install work following specifications, drawings, manufacturer's instructions and approved submittal data.
 - 2. Allowable Cable Bend Radius and Pull Tension:
 - a. In general, communications cable cannot tolerate sharp bends or excessive pull tension during installation. Refer to cable manufacturer's bend radius recommendations for the maximum allowable limits.
 - b. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue. Use only lubricants specifically designed for high performance cable installation.
- B. Pull Strings:
 - 1. Horizontal Cable
 - a. Provide pull strings in all new conduits, including all conduits with cable installed as part of this contract.
 - b. Pull string shall have a rated average breaking strength of 200 pounds.
 - c. Data and video cables can be pulled in tandem with pull strings. During pulling sessions, pull strings must move freely to prevent cable jacket/cable damage.
- C. Conduit Fill:
 - 1. Reference manufacturer's Design Installation Guidelines manual.
 - 2. Comply with all applicable Listed Firestop Assembly requirements.
- D. Firestop Procedures:

- 1. Install and seal penetrations (conduit, sleeves, slots, chases) into or through fire-rated barriers created by or made for or on the behalf of the Design Builder to prevent the passage of smoke, fire, toxic gas, or water through the penetrations.
- 2. All through penetrations in a fire rated surface require a sleeve, regardless of penetration diameter or penetrating cable count.
- 3. Provide listed fire-resistant materials to restore originally-designed fire-ratings to all wall, floor, and ceiling penetrations used in the distribution and installation for communications cabling system. Coordinate firestopping procedures and materials with Design Builder. Following the pathway of others through compliant and non-compliant penetrations does not remove the requirement to maintain code-compliant firestopping.
- 4. Provide and install intumescent systems in floor chases in an approved fashion in all openings.
- 5. Shall supply Owner with training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.
- 6. Provide manufacturer's UL Listed Assembly Sheet for rated protection for all fire barrier penetrations.
- 7. Shall laminate and permanently affix adjacent to chases the following information:
 - a. Manufacturer of firestop system.
 - b. Date of installation/repair.
 - c. Listed Assembly number of system.
- 8. Solutions and shop drawings/submittals for firestop materials and systems shall be presented to the Design Builder for written approval of materials/systems prior to purchase and installation.
- 9. Materials shall be installed per manufacturer instructions, be UL-listed for intended use, meet NEC and local codes for fire stopping measures and maintain the STE requirements of the wall or floor assembly.
- 10. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and maintain the characteristics for which it is designed to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.
- 11. Closeout documentation shall include digital photographs of all firestops related to communication cables.

E. Labeling

- 1. Cable Labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.
- 2. Flat-surface labels: Self-adhesive vinyl or vinyl-cloth labels, machine printed with alphanumeric cable designations.
- 3. Design Builder shall:
 - a. Coordinate with Owner correct nomenclature for all labeling.
 - b. Provide and install transparent plastic label holders, and 4-pair marked colored labels, according to the type of field as per ANSI/TIA-606-B color code designations.
 - c. Use the ANSI/TIA-606-B designation strip color-code guidelines for voice, data, cross-connect, riser, and backbone fields.

F. Site Tests:

- 1. Upon completion of the communications infrastructure systems, including all pathways and bonding, the Design Builder shall test the system.
 - a. Cables and termination modules/connectors shall be affixed, mounted or installed to the designed/specified permanent location prior to testing. Any removal and reinstallation of any component in the circuit shall require retesting of that circuit.
 - b. If the Design Builder is found to have manipulated any failing test result for any reason (without written notice and approval of the Owner), the Design Builder shall be required to employ a Third-Party Testing Agent selected by the Owner to retest the complete cable plant and shall be required to pay all costs associated with this retesting.
- 2. These specifications will be strictly enforced. The Design Builder shall verify that the requirements of the specifications are fully met through testing with an approved tester (rated for testing the cable type in use), and documentation as specified below. This includes confirmation of requirements by demonstration, testing and inspection. Demonstration shall be provided at final walk-through in soft copy test data.
- 3. Notification of the likelihood of a cable exceeding standardized lengths must be made prior to installation of the cable. Without Design Builder's prior written notice and written approval by the Owner, testing that shows some or all pairs of cable not meeting specifications, shall be replaced at Design Builder's expense (including respective connectors).
- 4. With the Owner's written approval, the over-length cable(s) may be excluded from requirements to pass standardized tests and shall be explicitly identified.
- 5. Testing is still required for non-compliant cabling. The tests shall be for wire-mapping, opens, cable-pair shorts, and shorts-to-ground. The test results must be within acceptable tolerances and shall be submitted with the Owner's acceptance document.
- 6. Third-Party testing of the completed cable infrastructure is an Owner option that can be implemented and completed after (1) all Design Builder testing is complete and submitted, and (2) Design Builder certifies that cable plant meets or exceeds test result requirements as specified in these and ANSI/TIA test standards. Third-Party testing can be implemented at the Owner's discretion by:
 - a. The Owner's preference to independently confirm the submitted Design Builder's standards-compliant testing results
 - b. Payment of all Third-Party testing shall be by the Owner if the Third-Party testing is requested for confirming Design Builder's complete and standards-compliant test results.
 - c. Third-Party shall pick a randomized sample of 15% of total installed cable plant. Prior to testing, this party shall develop and submit a test schedule for approval by Owner.
 - d. Third-Party testing processes will adhere to the testing protocols delineated in this document under Section 1.10 and Specification Section 27 08 00
 - e. All Third-Party tested cables that test as failed shall be retested by the Third Party to confirm failure.
 - f. If Third-Party tests show a failure rate of 2% or greater of tests of all completed cabling, this shall force the retesting of the complete cable plant by the Third-Party at the Design Builder's expense.

- g. All confirmed failures shall be promptly corrected and retested by Design Builder and Third-Party under the same testing protocols and guidelines.
- h. Payment of all Third-Party testing shall be by Design Builder from Design Builder's original accepted bid if Third-Party testing is required.
- i. Third-Party shall retest 100% of the total installed cable plant. Prior to testing, this party shall develop and submit a test schedule for approval by Owner.
- j. All Third-Party tested cables that test as failed shall be retested by the Third Party to confirm failure.
- k. All confirmed failures shall be promptly corrected the installing Design Builder and retested by Third-Party under the same testing protocols and guidelines.
- 1. Design Builder will complete all work and documentation according to manufacturer guidelines to ensure manufacturer's warranty remains in effect. Design Builder shall obtain certificates from manufacturer attesting to warranty being in effect and include certificates with other deliverables due at the completion of the project.
- m. Owner reserves the right to be present during any or all testing.

3.5 CLEANING

- A. Work areas will be kept in a broom clean condition throughout the duration of the installation process.
- B. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.
- C. The Design Builder will damp clean all surfaces prior to final acceptance by Owner.

3.6 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted, and Owner is satisfied that all work is in accordance with contract documents, the Owner shall notify Design Builder in writing of formal acceptance of the system.
- B. Design Builder must warrant in writing that 100% of the installation meets the requirements specified herein (Standards Compliance & Test Requirements).
- C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation soft and hard copies as described herein.

3.7 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.8 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

END OF SECTION

SECTION 270526 - COMMUNICATION BONDING AND GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Telecommunications Busbars
- B. Bonding Conductors and Components

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

- A. Bonding of all metallic components within ITS spaces, such as, but not limited to, building steel, ladder rack, cable runway, cable tray, racks, cabinets, and conduits.
- B. Testing of all bonding connections shall be conducted under the requirements of this specification.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINSTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 1 - PRODUCTS

1.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 – 1.8

1.2 BUSBAR ASSEMBLY:

- A. Manufacturer
 - 1. Harger Lightning & Grounding
 - 2. ERICO International Corporation
 - 3. Cooper Industries
 - 4. NO Substitutions Allowed
- B. TMGB: 1/4-inch-thick by 4 inches high of variable length pre-drilled with TIA standard hole patterns and spacing. Number of required connections determines length of busbar.
- C. TGB: 1/4-inch-thick by 2 inches high of variable length pre-drilled with TIA standard hole patterns and spacing. Number of required connections determines length of busbar.
- D. When Isolated Ground is required:
 - 1. Rack mounted busbar: solid copper busbar 1/8-inch-thick by 2 inches wide and threaded 10-32. Varying height
- E. Insulators: The busbar shall be insulated from its support.
- F. Wall mounting brackets shall provide a minimum 2" separation from the wall to the back of the busbar
- G. Busbars shall be UL Listed as bonding and grounding equipment.

1.3 BONDING CONDUCTORS AND COMPONENTS

- A. Manufacturer
 - 1. USA Wire and Cable
 - 2. CERRO
 - 3. Southwire
 - 4. Harger
 - 5. Burndy
 - 6. Cooper Industries
- B. Copper Bonding Conductors
 - 1. Bare or Insulated and green in color
 - 2. Sized in accordance with TIA-607-B (2 kcmil per linear foot of conductor length)
 - 3. Minimum size bonding conductor shall be 6 AWG
 - 4. Maximum size bonding conductor shall be 3/0 AWG
 - a. For example: A conductor 25 feet in length shall be 2 AWG (66,360 cmil)
 - b. A bonding conductor 100 feet in length shall be 3/0 AWG
 - 5. Insulation shall be rated for the environment in which installed.
- C. Bolt-On Connector Lugs
 - 1. Lugs for connecting to the TMGB and TGB shall be UL Listed two-hole, long barrel, electro tin-plated compression lugs with inspection port.
 - 2. Compression lugs shall have two holes spaced on 5/8 inch (15.8 mm) or 1 inch (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbars.
 - 3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 3/0, as stated below.
 - 4. Antioxidant joint compound, shall be applied to the contact areas.
 - 5. Lugs shall be secured to the ground bars with ¹/₄" minimum stainless steel hex head cap screws with stainless steel washers, lock washers and nuts.
- D. Exothermic Welded Connections
 - 1. Exothermic Welded connections shall be Ultraweld by Harger.
 - 2. Weld types BE shall be made to the ground bars using appropriate size weld metal.
 - 3. Weld types VA, VD, or VU shall be made to structural steel framework
- E. Shield Bond Connector
 - 1. Shield bonding assembly, with base and top members made of tin-plated tempered brass, slightly curved to exert a continuous spring force on sheath and shield after clamping, and two securing lock nuts. Designed to make a stable, low resistance electrical connection between the shield of a communications cable and a bonding conductor.

PART 2 - EXECUTION

2.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

2.2 INSTALLATION

- A. Wall-Mount Busbars
 - 1. The telecommunications main grounding bar (TMGB) is a dedicated extension of the building grounding electrode system for the telecommunications system. The TMGB should be located near the telecommunications service entrance and the electric service entrance in the MPOE. All other spaces shall have a TGB.
 - 2. Only One (1) busbar shall be installed in any space.
 - 3. All Telecommunications Busbars shall be mounted above the cable runway in the space they serve.
 - 4. Busbars shall be located to minimize the length of bonding conductors within the telecommunications space.
 - 5. Attach busbars to the wall with appropriate hardware according to the manufacturer's installation instructions.
 - 6. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
 - 7. Each wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.
- B. Racks and Cabinets
 - 1. Every rack and cabinet shall be bonded to the closest T(M)GB.
 - 2. Minimum bonding connection to racks and cabinets shall be made with an irreversible 2hole lug sized to fit the conductor and rack and installed according to ANSI/NECA/BICSI 607-2011, BICSI Best Practices, and manufacturer recommendations.
 - 3. Remove paint between rack/cabinet and bonding lug, clean surface and use antioxidant between the rack and the bonding lug to help prevent corrosion at the bond.
- C. Bonding to Structural Steel of a Building
 - 1. All bonding conductors and connectors for bonding the metal frame of a building shall be listed for the purpose intended by a NRTL.
 - 2. In buildings where metal frames (structural steel) are effectively grounded, each T(M)GB shall be bonded to the structural steel within the room using a properly sized bonding conductor and connection method.
 - 3. Connections to the structural steel frame shall be made by exothermic welding or by Harger No. 217 or Harger No. 223T electro tin-plated bronze bonding plates. The area of

contact on the steel frame shall be cleaned to bare metal removing all paint and mill scale. The contact area shall be protected from corrosion using Harger series HAAJC antioxidant joint compound.

- 4. Where the structural steel is external to the room and readily accessible the structural steel shall be bonded to the T(M)GB with a properly sized bonding conductor.
- 5. Steel bars of a reinforced concrete building are not required to be bonded to the T(M)GB.
- D. Conduits and Cable Trays
 - 1. All metal conduits and raceways for telecommunications cabling located within the telecommunications space as the busbar shall be bonded to the busbar.
 - 2. Metal cable trays shall be bonded to the busbar.
- E. Telecommunications Backbone (TBB)
 - 1. The telecommunications backbone (TBB) is a conductor that originates at the TMGB and extends throughout the building interconnecting all telecommunications grounding busbars (TGBs) with the TMGB.
 - 2. The TBB shall be a copper conductor. The minimum size of the conductor shall be 6 AWG. The size of the conductor shall be increased 2 kcmil per linear foot as the length of the TBB increases to a maximum of 3/0 AWG. For example: A TBB 25 feet in length shall be 2 AWG (66,360 cmil). A TBB 100 feet in length shall be 3/0 AWG.
 - 3. The TBB conductors should be installed without splices. Where splices are necessary, the number of splices should be minimized and located in accessible telecommunications spaces. Splices shall be made using exothermic welding, listed irreversible compression connectors or equivalent.
 - 4. The building water piping system shall not be used as a TBB.
 - 5. Metallic cable shields or metallic conduits shall not be used as a TBB.
 - 6. The TBB shall not rely on connections to any TGB for continuity to another TGB.
- F. Grounding Equalizer (GE)
 - 1. Where there are multiple telecommunications rooms or spaces with multiple TBBs, the TBBs shall be interconnected with a Grounding Equalizer (GE) conductor at the TGBs.
 - 2. The GE shall be sized as specified for the TBB.
 - 3. Connections of the GE to the TGBs shall be made by exothermic welding or by listed two-hole compression lugs.
- G. Shield Bond Connector Installation
 - 1. The Design Builder shall provide a shield bond connector to the shield of each fiber optic and copper riser cable in order to make a stable, low-resistance connections between the shield and a bonding conductor.
 - 2. The bonding jumper at the shield bond connector end shall have a single hole standard barrel lug with a 6 AWG conductor. The other end of the bonding jumper shall be a 2-hole long barrel compression for bonding at the T(M)GB.
- H. Testing

- 1. The Telecommunications Bonding and Grounding System shall be tested with an Earth Ground Resistance Tester using the Two Point Test Method.
- 2. The following shall be required to test the bonding and grounding.
 - a. An Earth Ground Resistance Tester with the attachments.
 - b. All testing should be done with the entire building in operation. Nothing needs to be shut down to test the bonding and grounding with this tester.
 - c. If the resistance value is less than 0.1 Ohm between the two test points the bonding is adequate.
- 3. Tests to be conducted:
 - a. The installer / technician conducting these tests must be certified
 - b. Test between the TMGB and the service equipment (power) ground.
 - c. Test between the TMGB and each TGB in the system.
 - d. Test between the TGB and:
 - 1) Data racks
 - 2) Cable tray
 - 3) Telecommunication conduit
 - 4) Caging
 - 5) Electronic equipment
- 4. Tests shall be conducted with the systems in operation.
- I. Tests shall be recorded and submitted to the Owner's Representative.

2.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

2.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

END OF SECTION

SECTION 270528 - COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Cable Pathway Systems
- B. Sleeves for Pathways and Cables
- C. Backbone Cable Routing
- D. Horizontal Cable Routing

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

- A. This section includes the minimum requirements for communications cable pathway installations.
 - 1. Backbone Cable Routing
 - 2. Horizontal Cable Routing
 - 3. Products

DIVISION 27 - GENERAL REQUIREMENTS Section 27 00 00 – Communications Infrastructure

- 4. Common Requirements for Communications Installations
- 5. Separation from EMI Sources
- 6. Wire Mesh Cable Tray
- 7. Sleeve Installation for Communications Penetrations
- 8. Penetration of Building Surfaces
- 9. Cutting and Patching
- 10. Retrofit-Cutover

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 CABLE PATHWAY SYSTEMS

- A. Cable Support: NRTL labeled and designed to prevent degradation of cable performance and pinch points that could damage cable. Also, to be installed independently of "Other Trades" support system.
 - 1. Wire mesh cable tray
 - 2. Support brackets with cable tie slots for fastening cable ties to brackets.
 - 3. Basket style cable trays are the preferred method of installation. Telecommunications cable shall be installed in "saddle bags" type of pathways from the point of departing from main cable trays.
 - 4. Straps and other devices.
- B. Approved manufacturers:
 - 1. Snake Tray
 - 2. Cooper Industries

- 3. Middle Atlantic Products
- 4. Chatsworth Products, Inc. (CPI)
- 5. Wiremold

2.3 SLEEVES FOR PATHWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends, with plastic bushings.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter, less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter, equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.4 FIRESTOPPING

- A. Subject to compliance with requirements, provide products of one of the following manufacturers:
 - 1. Hilti Firestop Systems
 - 2. 3M, Electrical Products Division
 - 3. Specified Technologies Inc.
- B. Provide materials classified by UL to provide fire barrier equal to time rating of construction being penetrated.
- C. Provide asbestos free materials that comply with applicable Codes and have been tested in accordance with UL 1479 or ASTM E 814.
- D. Fire Rated Cable Pathways: Device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill
- E. Or equivalent product from different manufacturer, after approval by owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 BACKBONE CABLE ROUTING

- A. Adequate riser sleeve/slot space shall be available with the ability to ingress the area at a later date in all telecommunications rooms, such that no drilling of additional sleeves/slots are necessary.
- B. The backbone cables shall be installed in a star topology, emanating from the main cross-connect to each telecommunications room. An intermediate cross-connect may be present between the main cross-connect and the horizontal cross-connect.
- C. Backbone pathways shall be installed or selected such that the minimum bend radius and pulling tension of backbone cables is kept within cable manufacturer specifications both during and after installation.

3.3 HORIZONTAL CABLE ROUTING

- A. All horizontal cables shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.
- B. Consolidation points shall not be used.
- C. Horizontal pathways shall be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation.
- D. In open ceiling cabling, cable supports shall be provided by means that is structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 1.5 m (5 ft) apart.
- E. For voice or data applications, 4-pair copper balanced twisted-pair cables shall be run using a star topology from the telecommunications room serving that floor to every individual information outlet. The Owner prior to installation of the cabling shall approve all cable routes.
- F. The Design Builder shall observe the bend radius and pulling strength requirements of the 4 pair copper balanced twisted-pair optic cable during handling and installation.
- G. Each run of 4-pair copper twisted-pair cable between horizontal portions of the cross-connect in the telecommunication closet and the information outlet shall not contain splices.
- H. In a false ceiling environment, a minimum of 75 mm (3 in) shall be observed between the cable supports and the false ceiling.
- I. Continuous conduit runs installed by the Design Builder should not exceed 30.5 m (100 ft) or contain more than two (2) 90-degree bends without utilizing appropriately sized pull boxes.
- J. All horizontal pathways shall be designed, installed and grounded to meet applicable local and national building and electrical codes.
- K. The number of horizontal cables placed in a cable support or pathway shall be limited to a number of cables that will not cause a geometric shape of the cables to be altered. Under no circumstances should cables in the horizontal pathway be bundled. This is to minimize "alien" cross talk.

- L. Maximum conduit pathway capacity shall not exceed a 40 percent fill. However, perimeter and furniture fill ratio is limited to 60% fill for moves, adds, and changes.
 - 1. Horizontal distribution cables shall not be exposed in the work area or other locations with public access.

3.4 SEPARATION FROM EMI SOURCES:

- A. Comply with TIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
- B. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - 1. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - 2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - 3. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
- C. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 1. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - 2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - 3. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
- D. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - 1. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - 3. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- E. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or higher: A minimum of 48 inches.
- F. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 WIRE MESH CABLE TRAY

- A. Provide all components of the tray system (tray, supports, splices, fasteners, and accessories) from a single manufacturer.
- B. Supports will be sized at minimum to match the width of the wire mesh cable tray that is supported. The support may be wider than wire mesh cable tray.
- C. Wire mesh cable tray shall be secured independently to the structural ceiling, building truss system, wall or floor using manufacturer's recommended supports and appropriate hardware as defined by local code or the authority having jurisdiction (AHJ).

- D. When the pathway is overhead, wire mesh cable tray shall be installed with a minimum clearance of 12 inches above the tray. Leave 12 inches in between the tray and ceiling/building truss structure. Multiple tiers of wire mesh cable tray shall be installed with a minimum clearance of 12 inches in between the trays. When located above an acoustical drop ceiling, wire mesh cable tray shall be installed a minimum of 3 inches above the drop ceiling tiles.
- E. When installed under a raised floor, wire mesh cable tray shall be installed with a minimum ³/₄ inch clearance between the top of the tray and the bottom of the floor tiles or floor system stringers, whichever are lower in elevation. Maintain a 3-inch clearance between trays wherever trays cross over.
- F. Wire mesh cable tray shall be supported by manufacturer's specifications. Support wire mesh cable tray on both sides of every change in elevation.
- G. Wire mesh cable tray shall be labeled with a sign along its side (6 inches by 12 inches) that states the Telecommunications Room that it serves and shall point to the direction of the nearest telecommunications room that it serves, spaced at intervals of every 25 feet with footage markers showing the total footage in reference to the Telecommunications Room that it serves.
- H. Secure wire mesh cable tray to each support with a minimum of one fastener. Follow the manufacturers' recommended assembly, splice and intersection-forming practices.
- I. Use installation tools recommended by the manufacturer to field fabricate wire mesh cable tray intersections and changes in elevation. Use shear cutters to cut wire mesh cable tray. Use a bending tool to form the ends of cut sections downward at 90° to allow easy drop-in installation with approved supports.
- J. Wire mesh cable tray shall be bonded to the Telecommunications Grounding Busbar (TGB) using an approved ground lug on the wire basket tray and a minimum #6 grounding wire or as recommended by the AHJ. Verify bonds at splices and intersections between individual cable tray sections and supports. Cable pathway should be electrically continuous through bonding and attached to the TGB.
- K. The quantity of cables within the tray will not exceed a whole number value equal to 50 percent of the interior area of the tray divided by the cross-sectional area of the cable. Cable fill will not exceed the depth of the cable tray's side rail (2, 4 or 6 inches).
- L. The combined weight of cables within the tray will not exceed stated load capacity in manufacturer's specifications.
- M. Separate different media type within the tray. Treat each type of media separately when determining cable fill limits.
- N. When pathways for other utilities or building services are within 2 feet of the wire mesh cable tray, cover the tray after cables are installed.

3.6 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

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

- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Each pipe sleeve, horizontal or vertical, shall have a plastic type "end-bushing" on both ends to protect cables from abrasion when pulled through sleeves. The "end-bushing" shall be installed prior to install cables through sleeve.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls with respect to plastic "endbushings". The plastic "end-bushing" shall be plenum rated if applied in plenum space.
- G. Extend sleeves installed in floors 2 inches above finished floor level with respect to plastic "endbushings". The plastic "end-bushing" shall be plenum rated if applied in plenum space.
- H. Size pipe sleeves to provide ¹/₄-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Weather seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

3.7 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- C. Provide sleeves for new conduit and cable penetrations of building construction.
 - 1. Openings to accept sleeves in new building construction will be formed in building construction by the Design Builder for General Construction work. Openings to accept

sleeves in existing building construction shall be provided under this division of the Specifications. Refer to, CUTTING AND PATCHING in this Section.

- 2. Use galvanized rigid conduit sleeves for penetrations through exterior masonry/concrete walls and foundations, concrete floor slabs on grade and above grade, and concrete-filled decks.
- 3. Use only fire-rated listed assemblies for the type of sleeve being installed through CMU walls or gypsum walls for communications penetrations. Sleeve type shall be galvanized rigid conduit.
- D. Where conduits are installed before building construction being penetrated, install sleeves loose around conduits. Split, fit, and weld steel sleeves over existing conduits, with respect to anything flammable in the surrounding environment.
- E. Secure sleeves firmly in place using filling and patching materials (grout) that match with surrounding construction.
- F. In floor penetrations, extend sleeve 4 inches above finished floor unless noted otherwise. In wall penetrations, cut sleeves flush with wall surface and use metal escutcheon plates in finished interior areas.
- G. Seal voids between sleeves and building construction with joint sealants. Make allowances for and coordinate the Work with installation of firestopping, conduit insulation, and waterproofing as applicable.
- H. The Design Builder shall be fully responsible for final and correct location of sleeves. Sleeves which are omitted or incorrectly located in existing building construction, shall be corrected and provided by the Communications Design Builder, at no additional costs to the Owner.

3.8 PENETRATION OF BUILDING SURFACES

- A. Above Grade Level or Non-Waterproof Areas
 - 1. Seal each annular space between conduits or cable and building surfaces. Pack space with oakum, other rope packing, or backer rod materials and cover with fire-resistant sealant or other protection materials.
 - 2. Provide sleeves as specified in article, sleeve-seal installation in this section for conduit and cable penetrations. Seal each space between conduit or cable and sleeve. Sealing shall be as specified in above paragraph.
- B. Waterproof areas (above and below grade)
 - 1. In new and existing construction for penetrations through concrete below grade, ground water level, or in other waterproof areas, provide through-wall and floor seals having galvanized fittings, sealing assemblies, and sleeves as specified.
 - 2. In existing construction when core bore drilled openings are used for conduit penetrations below grade, ground water level, or in other waterproof areas, provide sealing.
- C. Fire-resistant areas

- 1. Provide through-penetration firestop systems for penetrations through fire-rated walls, floors, and other partitions of building construction. Comply with requirements in division 07 section "penetration firestopping".
- 2. In walls or partitions with 2-hour or less fire ratings, provide only metallic outlet or device boxes installed per ul fire resistance director, nec, and other national building code requirements.

3.9 CUTTING AND PATCHING

- A. Provide openings, cutting, coring, and patching of openings in existing building construction as required. Patching includes openings and voids left in existing construction as a result of demolition.
- B. The Work shall include necessary assemblies and materials to maintain required fire ratings.
- C. Perform cutting as to not impair structural stability of building construction and systems. Do not drill holes or weld attachments to beams and other structural members without prior written approval from the Owner's Representative. Contact the Engineer-of-Record for guidance.
- D. The Work shall be done by a craftsperson skilled in the particular trades affected.
- E. Patching materials shall match existing materials in type and quality. Patching shall be done in a manner to match appearance of adjacent surfaces.

3.10 RETROFIT-CUTOVER

- A. Furnish equipment, materials, labor and services, and perform operations required to retrofit/cutover existing cabling systems. Removals shown are general indications and may not indicate full extent of removals which may be required to complete Work.
- B. Furnish equipment, materials, labor and services, and performing operations required to enable continued functioning of existing system until cutover to new system.
- C. Remove wiring, punch blocks, cabinets, outlets, raceways, and equipment not required for new system.
 - 1. Abandon flush mounted device and junction boxes and cover with blank plate to match the current room decor.
 - 2. Remove surface telecommunications outlets and pathways unless said removal will damage the existing finish on surfaces, or physically damage the structure.
 - 3. Remove wiring from abandoned conduits and raceways from the work area outlet back to the corresponding termination point in the telecommunication room. Place a trailer string in vacated conduits and raceways.
 - 4. Remove labeling at both ends for abandoned cables/wiring.
 - 5. The collected abandoned cables/wiring shall be collected and removed from site by Design Builder.
- D. Perform the work in neat and workmanlike manner in accordance with the applicable codes, standards and AHJ.

- E. Removal and replacement of existing ceilings:
 - 1. Carefully remove existing ceilings as required to perform the work. Store removed tiles in an area designated by the owner. Modify and augment existing suspension systems as necessary. Restore ceiling systems to their original finish.
 - 2. Repair any damage to ceilings due to modifications, removal, and replacement of same. Replace damaged ceiling tiles, including tiles with holes or openings left as a result of demolition, with materials of like kind.
- F. Existing equipment or material shall not be reused without specific approval of the Owner's Representative except as noted below:
 - 1. Existing cable terminal housings may be reused if in good condition.
- G. Equipment and materials to be removed and not desired by the Owner shall be removed from site promptly.
- H. Equipment and material to be removed and that is desired by the Owner shall be moved to an onsite storage location as directed by the Owner.

3.11 FIRESTOPPING

- A. Performance Requirements
 - 1. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur.
 - 2. Where non- mechanical products are utilized, provide products that upon curing do no reemulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.
 - 3. Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with reenterable products that do not cure or dry.
 - 4. Openings for cable trays shall be sealed using re-enterable firestopping pillows.
- B. Quality assurance
 - 1. Products/systems: provide firestopping systems that comply with the following requirements:
 - 2. Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is ul, or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.
 - 3. Firestopping products bear the classification marking of qualified testing and inspection agency.
 - 4. Installer qualifications: experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.
- C. Project conditions
- 1. Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
- 2. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
- 3. Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
- 4. Do not use materials that contain flammable solvents.
- 5. Coordinate construction of openings and penetrating items to ensure that throughpenetration firestop systems are installed according to specified requirements.
- 6. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- 7. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

3.12 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.13 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 270529 - COMMUNICATION HANGERS AND SUPPORT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Non-continuous cable supports.

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications information for appropriate support in areas where cable tray or conduits are not practical.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 – 1.8

2.2 NON-CONTINUOUS CABLE SUPPORTS

- A. Manufacturer List:
 - 1. ERICO International Corporation
 - 2. Cooper Industries
 - 3. Panduit –J-Mod System
 - 4. Arlington Industries
- B. Select support system components capable of supporting the telecommunications cable quantities required for each location. Options are as follows:
 - 1. Support slings
 - 2. Four-inch (4"), two-inch (2") J-hook supports
- C. Description:
 - 1. Non-continuous cable supports shall be available in multiple sizes, styles and materials. Rigid supports shall be equipped with flared edges and pre-configured bend radius controls.
 - 2. Provide drop wire supports and threaded rod assemblies in areas where structural mounting surfaces are non-functional or inaccessible.
 - 3. Sling assemblies shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance FTP/UTP and optical fiber cables. Support slings shall have a static load limit of 100 lbs.
 - 4. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable.
 - 5. Select approved non-continuous cable supports suitable for specific installation environments and/or air handling (plenum) spaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 NON-CONTINUOUS CABLE SUPPORT INSTALLATION

A. Process:

- 1. Follow manufacturer's instructions and recommended industry standards and guidelines.
- 2. The installed non-continuous support system must be an independent support structure for the voice/data communication system.
- 3. The non-continuous support system shall consist of a scalable pathway system of Jhooks. The "J" hook style horizontal station cable support system shall be sized to accommodate a 50% increase in future cable counts.
- 4. Supporting cables with other structures in the ceiling is unacceptable. Water pipes, ceiling grid, sprinkler system, electrical conduits, cables, or supports, air ducts or any other in-ceiling structure shall not be used for cable support.
- 5. Design Builder installed supports shall be used to supplement the main cable support system when any cabling leaves the main support system or is unsupported for more than four feet (4'-0").
- 6. The maximum cable "sag" shall be no greater than six (6) inches below the noncontinuous support system.
- 7. Cable must be routed to follow existing corridors and parallel or 90 degree angles from all walls and the cable tray whenever possible.
- 8. All directional changes shall be supported with a "J" hook or support sling in addition to those required by normal support spacing.
- 9. The non-continuous support system should have the following minimum clearances maintained throughout the entire cable length:
 - a. Six inches (0'-6"), including cable "sag", from the ceiling support channels (T-bars) and ceiling panels.
 - b. Three inches (0'-3") of clear vertical space from obstructions above & below.
 - c. Three inches (0'-3") of clear horizontal space from obstructions on each side.
 - d. When parallel to electrical pathways a minimum six inches (0'6") of clearance shall be maintained.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 270533 - COMMUNICATION CONDUITS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Telecom conduits and boxes.

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for conduit pathways, back boxes and pull box enclosures utilized for the distribution and housing of telecommunications cabling and components:

1.6 SUBMITTALS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.10
- B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating post-consumer and pre-consumer recycled content and cost.

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 TELECOM CONDUITS AND FITTINGS

- A. Conduit
 - 1. Republic Conduit
 - 2. Wheatland Tube
 - 3. Or equal
- B. All EMT connectors and couplings shall be zinc-plated steel set screw type. Die cast zinc fittings shall not be used.
- C. Provide bushing on ends of all conduits not terminated with a connector or coupling.
- D. Provide pull string in all conduits.

2.3 TELECOM PULL BOXES

- A. Conduit
 - 1. B-Line,
 - 2. Hoffman Engineering Co,
 - 3. Or equal
- B. Pull boxes: Galvanized steel, screw cover pull box. Grey powder coat finish inside and exterior to be coordinated with the Owner's Representative.

C. Pull boxes to be sized per Section 3.2 A 6 of this Specification, to accommodate the number of conduits as shown on Telecom drawings with adequate clearances, access and cable management space.

2.4 TELECOM BACK BOXES

- A. Recycled content: Post-consumer recycled content plus one-half pre-consumer recycled content shall not be less than 25 percent.
- B. Back Boxes
 - 1. Randl
 - 2. Siemon
- C. Integral cable management system
- D. (1) 1" and (1) 1-1/4" knockout each side

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 TELECOM CONDUITS AND BOXES

- A. Pull Boxes:
 - 1. Install Pull boxes in easily accessible locations.
 - 2. Install Horizontal cabling boxes minimum 6" above suspended ceilings.
 - 3. A pull box should not be used in lieu of a bend.
 - 4. Conduits that enter the pull box from opposite ends with each other should be aligned.
 - 5. For direct access to a box located above inaccessible ceilings provide a suitable, marked, hinged access panel (or equivalent) in the ceiling. This access panel can also serve as the cover for the box.
 - 6. Pull box sizing table:

Conduit Trade Size (in.)	Pull box Width (in.)	Pull box Length (in.)	Pull box Depth (in.)	Pull box Width Increase for Additional Conduit (in.)
1	4	16	3	2
1 1/4	6	20	3	3
1 1/2	8	27	4	4
2	8	36	4	5
2 1/2	10	42	5	6
3	12	48	5	6
3 1/2	12	54	6	6
4	15	60	8	8

B. Back Boxes:

- 1. Provide 5" H X 5" W X 2-7/8" D outlet back boxes with integrated cable management at all telecom outlet locations shown on drawings.
- 2. Provide (1) 1-1/4" conduit from back box to telecom cable tray, except as otherwise noted.
- 3. Provide single gang plaster/mud ring on all communications outlet back boxes, unless indicated otherwise in the contract drawings.
- 4. Provide bonding to cable pathways.
- C. Conduit Support and Bracing:
 - 1. Coordinate layout and installation of conduits and pull boxes with other trade conditions to ensure adequate clearances, access and cable management.
 - 2. Provide seismic support and bracing for all conduits and pull boxes installed under work of this project per the project's structural requirements. Any proposed reinforcement is the responsibility of the Design Builder.
 - 3. Coordinate seismic design with architectural, structural, mechanical, electrical, plumbing, fire protection, and other trades.
 - 4. Structural braces and/or reinforcements are to be attached directly to structural framework and secondary structural members; do not attach braces and/or reinforcements to elements other than structural framework and secondary structural members.
 - 5. Install and provide support for conduits and pull boxes in accordance with the latest edition of the NEC, as well as all state and local codes and requirements. Coordinate installation and location with existing conditions.
 - 6. Install conduits above ceilings at height to provide access to pull boxes and cable access to where conduits terminate to meet up with cable trays. Install conduits and pull boxes level and square and at proper elevations. Ensure adequate clearances, access and cable management.

- 7. Supporting devices: U channel trapeze assemblies, 3/8" threaded rods, clamps, conduit straps, C-clamps and retainers.
- 8. Fasteners: Carbon steel expansion anchors with minimum 3" embed into concrete slab for pull box U-channel support attachment. The anchors must be tested and approved under dual load conditions.
- 9. U-channel systems: 16-gauge steel channels. Provide fittings and accessories that match with the U-channel of the same manufacturer.
- 10. Use fittings and support devices compatible with conduits and pull boxes and suitable for use and location.
- 11. Install individual and multiple trapeze hangers and riser clamps as necessary to support the conduits. Provide U-bolts, clamp attachments and other necessary hardware for hanger assemblies and for securing hanger rods and conduits. Space supports for conduits on maximum 10-foot centers.
- 12. Provide and install expansion or deflection fittings for conduits runs at all instances of seismic or expansion joints to allow for movement in any direction.
- D. Conduit Routing, Bends and Radius Guidelines:
 - 1. If the conduit has an internal diameter of 2 inches or less the bend radius must be at least 6 times the internal conduit diameter.
 - 2. If the conduit has an internal diameter of more than 2 inches the bend radius must be at least 10 times the internal conduit diameter.
 - 3. Conduit bends should be smooth, even, and free of kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation.
 - 4. If a conduit run requires more than two 90-degree bends, then provide a pull box between sections with two bends or less.
 - 5. If a conduit run requires a reverse bend (between 100 degrees and 180 degrees) then insert a pull point or pull box at each bend having an angle from 100 degrees to 180 degrees.
 - 6. Consider an offset as equivalent to a 90-degree bend.
 - 7. Achieve the best direct route with no bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
 - 8. Contain no continuous sections longer than 100 ft.
 - 9. For runs that total more than 100 ft. in length, pull points or pull boxes should be inserted so that no segment between points/boxes exceeds the 100 ft. limit.
 - 10. Withstand the environment to which they will be exposed.
 - 11. Conduits shall not be routed through areas in which flammable material may be stored or over or adjacent to boilers, incinerators, hot-water lines and steam lines.
 - 12. Maintain 6" separation from parallel runs of steam, hot water pipes or mechanical ductwork so as not to affect cable performance.
- E. Conduit Terminations:
 - 1. Join conduits with fittings designed and approved for the purpose. Make the joints tight without protrusions that may damage cable inside the conduits.
 - 2. Where conduits are terminated with locknuts and bushings align the conduit to enter squarely and install the locknuts with dished part against the box. Use two locknuts, one inside and one outside the box.
 - 3. Ream all conduit ends and fit them with an insulated bushing, connector, or coupling to eliminate sharp edges that can damage cables during installation or service.

- 4. Conduits that enter a telecom room should terminate near the corners to allow for proper cable racking.
- 5. Terminate conduits that protrude through the structural floor 3 inches above the surface.
- 6. Maintain the integrity of all fire stop barriers for all floor and wall penetrations.
- 7. Provide bonding for conduits and pull boxes as indicated by the NEC, ANSI/NECA/BICSI 607-2011, and as instructed by manufacturer.
- 8. Conduits shall be clearly labeled at both ends designating the opposite locations(s) served. The numbering scheme shall be room number plus a suffix to guarantee uniqueness, e.g., 143-1. Labeling must be machine generated.
- F. Conduit Protection:
 - 1. Remove burrs, dirt and construction debris from conduits and pull boxes.
 - 2. Conduits should be left capped for protection.
 - 3. Provide final protection and maintain conditions in a manner acceptable to the Owner's Representative to ensure that coatings, finishes and pull boxes are without damage or deterioration at completion. Repair damage to galvanized finishes with zinc-rich paint recommended by the manufacturer.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 270536 - COMMUNICATION CABLE TRAY

PART 1 - GENERAL

1.1 SUMMARY

- A. Provides specifications for cable tray support components utilized to provide main horizontal pathway support for low voltage telecommunications, audio visual and security cables.
- B. Section Includes:
 - 1. Ladder style aluminum cable tray.
 - 2. Channel style aluminum cable tray.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ANSI: American National Standards Institute
 - 2. BICSI: Building Industry Consulting Service International
 - 3. RCDD: Registered Communications Distribution Designer
 - 4. TDMM: Telecommunications Distribution Methods Manual
 - 5. UL: Underwriters Laboratory
- B. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.)
 - 1. National Electric Safety Code (NESC)
 - 2. National Fire Protection Association
 - 3. Washington Electrical Code
 - 4. Washington Building Code
 - 5. Local Municipal Codes
- C. Reference Material: Refer to the most recent version, update or addenda.
 - 1. Telecommunications Industry Association standards and specifications:
 - a. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard Part-1: General Requirements
 - b. ANSI/TIA-569-A-1: Commercial Building Standard for Telecommunications Pathways and Spaces
 - c. ANSI/J-STD-607-C: Commercial Building Grounding and Bonding Requirements for Telecommunication
 - 2. Building Industry Consulting Services International (BICSI) Manuals:
 - a. Telecommunications Distribution Methods Manual (TDMM)
 - b. Information Transport Systems Installation Manual (ITSIM)

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Refer to Section 27 00 00 Communications General Requirements, Part 1.12 Administrative Requirements and Coordination.
- 2. Install and coordinate the telecommunications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the architect. Any repairs or changes made necessary in the contract work, caused by the Design Builder's neglect, shall be made by the Design Builder at their own expense
- B. Scheduling:
 - 1. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the Design Builder.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Submit all product data in accordance with general requirements of the construction documents.
 - 2. Submit product cut sheets and a detailed list of components a minimum of six (6) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Alternate and "Or Equal" designated products must be submitted for review and judgment to the A/E prior to installation. The Design Builder-proposed alternate products or components must be verified by two (2) independent sources within the past 6 months. This request shall include the two (2) independent sources, the original product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product.
 - 4. Any request of an alternate or substitution must be submitted to the A/E for action no later than fourteen (14) calendar days after release of the original telecommunications bid documents.
- B. Shop Drawings:
 - 1. Submit all shop drawings in accordance with the general requirements of the construction documents.
 - 2. Submit shop drawings a minimum of six (6) weeks prior to commencement of Division-27 work for A/E review and action.
 - 3. Shop drawings shall include evidence of cable tray system components are coordinated with field conditions and the work of other trades.
 - 4. This submittal may have a written component and a visual component for review and action by the A/E prior to installation.

1.5 INFORMATIONAL SUBMITTALS

A. Certificates:

- 1. Submit management and installation team reference documentation verifying that:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.
 - b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents.
- B. Qualification Statements:
 - 1. The Design Builder shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.

1.6 CLOSEOUT SUBMITTALS

- A. As-Built Drawings
 - 1. Submit all as-built drawings in accordance with the general requirements of the construction documents.
 - 2. Submit as-built drawings a minimum of two (2) weeks after completion of all Division-27 work for A/E and Owners Representative reference.

1.7 QUALITY ASSURANCE

- A. Qualifications Manufacturer:
 - 1. Component manufactures shall be ISO 9001:2000-compliant and shall offer products that are RoHS compliant.
- B. Qualifications Installer:
 - 1. At a minimum, seventy-five percent (75%) of the onsite Design Builder provided field technicians shall be factory certified within 12 months by the manufacturer of the selected telecommunications system components being installed. Proof of certification shall be available on site for review at all times for each field technician.

PART 2 - PRODUCTS

2.1 LADDER STYLE ALUMINUM CABLE TRAY

- A. Manufacturer List:
 - 1. B-Line
 - 2. Cablofil PW series
 - 3. Or equal

B. Product Options:

- 1. The indicated manufacturers shall be the basis of the design and each assembly selected shall address the particular infrastructure requirements.
- 2. Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units.
- 3. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards.
- 4. Coordinate cable tray finishes with architectural requirements in exposed ceiling spaces.
- C. Additional construction features:
 - 1. Cable tray shall be available as follows:
 - a. Ladder style cable tray system.
 - b. Materials and Finish: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063.
 - c. Ladder Cable Trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 9-inches on center. Rung spacing in radiused fittings shall be industry standard 9" and measured at the center of the tray's width. Each rung must be capable of supporting a 200 lb. concentrated load at the center of the cable tray over and above the cable load with a safety factor of 1.5.
 - d. Cable tray loading depth shall be 6-inches.
 - e. Straight sections shall have side rails fabricated as I-beams. Straight sections shall be supplied in standard 20 foot lengths.
 - f. Cable tray widths shall be as shown on drawings.
 - g. A full complement of fittings for the cable tray shall be available including, but not limited to, 45 and 90 degree flat elbows, vertical inside and outside elbows, tee fittings, splice couplings for joining sections of the tray, hangers, end blanks, and all other components necessary to make the system workable. The fittings and accessories shall be of compatible material and color.
 - h. The cable tray system shall include all continuous grounding hardware components.
 - i. Cable tray shall have dividers to segregate the various disciplines cabling infrastructure.
 - 2. Select cable tray width and depth parameters to maintain a final fill capacity of no greater than 50% per NEC.
 - 3. Consider exposure rating of cable tray components for all installation environments including air handling (plenum) spaces, extreme, harsh, indoor or outdoor areas.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 LADDER STYLE ALUMINUM CABLE TRAY

A. Process:

- 1. Installation of cable tray must at all times provide a clear cable pathway to accommodate the installation of telecommunications cable types and conform to the telecommunications industry standard bend radii for these cables.
- 2. Follow manufacturers' instructions and recommended industry guidelines. Adhere to maximum load recommendations on all threaded rod and support mechanisms.
- 3. Mount cable tray using factory manufactured and approved trapeze style support accessories.
- 4. Cable tray shall be capable of carrying a uniformly distributed load of 100 lbs./ft. on a 20 ft. support span with a safety factor of 1.5 when supported as a simple span. In addition to the uniformly distributed load the cable tray shall support 200 lbs. concentrated load at mid-point of span. Load and safety factors specified are applicable to both the side rails and rung capacities.
- 5. Seismically brace the basket-type cable tray adhering to construction regulations relative to the building's seismic zone.
- 6. Maintain straight cable tray lengths where possible. Install cable tray parallel to the slab unless field conditions require necessary direction or elevation changes.
- 7. Cable tray must be routed to follow existing corridors and parallel or 90 degree angles from all walls and the cable tray whenever possible.
- 8. Cut factory lengths using manufacturer-approved tools. Remove sharp or burred edges on all non-factory cuts and end pieces.
- 9. Splice and bond adjoining cable tray lengths using manufacturer accessories maintaining a continuous ground throughout the cable tray system.

3.3 RE-INSTALLATION

A. No additional burden to Owners Representative regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for reinstallation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and any test documentation required prior to acceptance by Owners Representative.

SECTION 270553 - COMMUNICATION IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Labeling and identification.

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications information for identification of the various components of the telecommunications infrastructure and pathway system.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 – 1.8

2.2 LABELING AND IDENTIFICATION

- A. Manufacturer List:
 - 1. Panduit thermal transfer printer.
 - 2. Brady labeling system.
- B. Description:
 - 1. All labels shall be machine-manufactured. Handwritten labels shall not be accepted for final labeling.
 - 2. The intention of the labeling scheme is to be ANSI/TIA-606-B compliant.
 - 3. It is the responsibility of the Design Builder to acquire, understand, and utilize Owners Representative's labeling scheme for all components of the voice data communications system.
 - 4. It is the responsibility of the Design Builder to provide labels sized to show Owner's labeling scheme in readable font size while still matching the specified hardware identification dimensions.
- C. Indoor Copper and Fiber Optic Cables and Bonding Conductors:
 - 1. The cable sheaths shall be labeled with machine-printed polyester self-laminating wraparound labels sized to fit Owner's labeling scheme in readable font size.
- D. Outside Plant Copper and Fiber Optic Cables:
 - 1. The cable sheaths shall be labeled with non-adhesive thermal transfer marker plates attached to the cables with nylon cable ties. The marker plates shall withstand harsh solvents, oils, and chemicals without over-lamination. Marker plates shall offer crisp, clear legends with superior legibility when printed on a thermal transfer desktop printer utilizing the resin ribbon designated for use and shall meet requirements for MIL-STD-202G, Notice 12 Method 215J sized to fit Owner's labeling scheme in readable font size.
- E. Horizontal Cable Outlet Housings and Faceplates:
 - 1. Cable termination connectors at each position on the outlet housing shall be labeled with laser-printed labels inserted into the outlet housing labeling window.

- F. Copper Patch Panels:
 - 1. The patch panels shall be labeled on the front and rear top left corner with a laser-printed polyester self-laminating label sequentially identifying the patch panel.
- G. Copper Patch Termination Blocks:
 - 1. The termination blocks shall be labeled on the front rows with the termination block designation strip colored per ANSI/TIA-606-B requirements identifying the copper cable pairs.
- H. Fiber Optic Termination Panels and Housings:
 - 1. The panels and housings shall be labeled on the outside front and rear top left corner with a laser-printed polyester self-laminating label sequentially identifying the panel.
 - 2. Cable termination identifier and fiber positions inside the termination panels shall be made using the manufacturer's provided label card behind the plastic panel.
- I. Equipment Racks
 - 1. Metal Card Holder bracket attached to rack to runway support bracket. NorCal Metal Fabricators Part no. NC-D1185-11. Or equal.
 - 2. Metal Card Holder (2" W x 12.75" L): NorCal Metal Fabricators Part no. NC-D1180-1.
 - 3. Label card: NorCal Metal Fabricators Part no. NC-D1180-2.
 - 4. Clear plastic cover: NorCal Metal Fabricators Part no. NC-D1180-3.
 - 5. Or equal
- J. Equipment Cabinets:
 - 1. Reflective Lettering System Labels shall be adhesive backed individual letters and numbers. Dimension per individual label is 1 ¹/₂" X 1". 3M Scotchlite 5005 Reflective Lettering System. Or equal.
 - 2. Individual letters and numbers shall be compiled to match identification for each rack or cabinet location and shall be placed on a Decal Strip Holder attached to front and rear of each equipment rack or cabinet. 3M 5012L Decal Strip Holder. Or equal.
- K. Indoor Pull Boxes:
 - 1. Each pullbox shall be labeled on the outside door panel facing and unobstructed view with a reflective lettering system. Labels shall be adhesive backed individual letters and numbers.
 - 2. Dimension per individual label is 1 ¹/₂" X 1". 3M Scotchlite 5005 Reflective Lettering System. Or equal.
- L. Outdoor Enclosures:
 - 1. Each wall mounted enclosure shall be identified with its individual identifier at the top right of the enclosure door. The Lettering is 1-inch-tall solid two colored injection molded letters held in an aluminum tag/letter holder. The aluminum tag/letter holder shall be attached to the enclosure with appropriate fasteners.

- 2. AH106 Aluminum tag/letter holder and ELHWK 1-inch-tall white on black injection molded letters: Everlast, Makers and Tags, Tech Products, Inc.
- 3. Or equal, no known equal.
- M. Conduit Labeling
 - 1. All conduits smaller than 3" shall be labeled within 12" of termination with a laserprinted polyester self-laminating label sequentially identifying the conduit and its origin and termination end (to and from).
 - 2. All 3" and larger conduits shall be labeled with a stainless steel marker tag.
 - 3. Stainless steel marker tag shall be machine embossed with a labeling scheme approved by Owners Representative.
 - 4. Stainless steel marker tag shall be secured with stainless steel tie wraps.
 - 5. Marker tags shall be located at each penetration through a wall or floor, and at 50 ft.' intervals on continuous runs.
 - 6. Stainless steel marker tags shall be Panduit MMP350-C316, or equal.
 - 7. Stainless steel tie wraps shall be Panduit MLT-S, or equal.
- N. Outside Plant Conduits & Pull Boxes/Manholes/Vaults:
 - 1. Each OSP conduit shall be labeled on the inside of the pull box, manhole or vault with a non-adhesive thermal transfer marker plates attached to the pull box, manhole or vault with mechanical fasteners. The marker plates shall withstand harsh solvents, oils, and chemicals without over-lamination. Marker plates shall offer crisp, clear legends with superior legibility when printed on a thermal transfer desktop printer utilizing the resin ribbon designated for use and shall meet requirements for MIL-STD-202G, Notice 12 Method 215J sized to fit Owners Representative's labeling scheme in readable font size, sequentially identifying the conduit and its origin and termination end (to and from).
 - 2. Each pull box/manhole/vault shall be identified on the cover plate/lid sequentially identifying the pull box/manhole/vault.

PART 3 - EXECUTION

3.1 LABELING

- A. The labeling scheme is intended to comply with ANSI/TIA-606-B standard for labeling and administration of a cable plant. It is the responsibility of the Design Builder to acquire, understand, and utilize the Owner labeling scheme for all component of the voice data communications systems including, but not limited to:
 - 1. Indoor Horizontal copper and fiber optic cables (Identify at both ends within 6-inches of termination)
 - 2. Indoor copper and fiber optic backbone cables shall be identified at both ends within 12inches of the point that the cable enters or exits termination panels/blocks, pull boxes, wall and floor sleeves.
 - 3. Outside plant copper and fiber optic backbone cables shall be identified at both ends within 12-inches of the point that the cable enters or exits termination panels/blocks, pull boxes, manholes, vaults and pedestals.

- 4. Workstation outlets, faceplates and individual outlet connectors.
- 5. Termination panels and blocks.
- 6. Racks, cabinets, and equipment enclosures. (front and rear)
- 7. Indoor and OSP conduit pathways, pull boxes, manholes, and vaults.
- 8. Bonding conductors and busbars.
- 9. Label each component with a specified label at an unobstructed view location and where it is accessible for administration.

3.2 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 270800 - COMMUNICATION COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Copper cable test device
- B. Optical fiber test device
- C. Coaxial cable test device

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for a certification tester used for end to end testing, certification, and documentation of all test results to confirm the installed connectivity system complies with industry standards and specific category and performance ratings.

1.6 SUBMITTALS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.10
 - 1. Electronic Reports: Submit in CD format. Include necessary software required to view test results. Accompany electronic reports by Certificate signed by authorized representative of Design Builder warranting truth and accuracy of electronic report. Certificate: Reference traceable circuit numbers that match electronic record. Contain following information on each row of report: Circuit ID, test specification used, length, date of test, and pass/fail results.

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 COPPER CABLE TESTER

- A. Manufacturer List:
 - 1. Fluke
 - 2. Agilent
- B. Description:
 - 1. Must meet or exceed TIA Level IV compliant network cable-testing device certification by an independent laboratory, such as Intertek, for verification of high performance cables.
 - 2. Copper test equipment must be capable of certifying Category-3, Category-5e, Category-6 and Category-6A UTP and F/UTP links or channels independent of termination hardware configuration (8P8C port or 110-style) for each level of performance.
 - 3. Provide full 2-way Autotest of Category-3, 5E, 6 and 6A twisted pair links.
 - 4. All test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

- C. Accessory Products:
 - 1. Interface Adapters
 - 2. Category/Class E permanent link adapters for TIA unshielded and shielded cables.
 - 3. DTX ten (10) Gigabit Kit

2.3 OPTICAL FIBER TESTER

- A. Manufacturer List:
 - 1. Fluke
 - 2. Agilent

B. Product Options:

- 1. Select analyzer to comprehensively certify each optical fiber connection and record results verifying compliance with TIA performance standards and manufacturer specifications.
- 2. Tier 2 OptiFiber or Equal Certifying OTDR
- C. Description:
 - 1. The optical fiber source shall permit full end to end testing of Multimode, Single-mode and LOMMF optical fiber cabling fully compliant with industry standards and manufacturer recommendations.
 - 2. Available source types and wavelengths shall be as follows:
 - a. Multimode 850nm LED and 1300nm LED.
 - b. Single-mode 1310nm FP Laser and 1550nm FP Laser.
 - c. LOMMF 850nm VCSEL and 1310nm FP Laser.
 - 3. The built in power meter shall be calibrated to read 850, 1310 and 1550nm wavelengths.
 - 4. All test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
- D. Accessory Products:
 - 1. Interface Adapters
 - a. Fiber Modules including Multimode, Single-mode and LOMMF adapters.
 - b. Optical Fiber Mandrels.

2.4 COAXIAL CABLE TESTER

- A. Manufacturer List:
 - 1. Fluke
 - 2. Agilent

- B. Product Options
 - 1. Select analyzer to comprehensively Autotest each connection and record results verifying compliance with industry standards and manufacturer specifications.
 - a. DTX or Equal Digital Cable Analyzer
- C. Description
 - 1. The tester's Autotest function shall test and record cable resistance, length, impedance, insertion loss and propagation delay. Additionally, the tester shall provide a TDR function that provides extended troubleshooting capabilities.
 - 2. All test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
- D. Accessory Products:
 - 1. Interface Adapters
 - a. DTX-Coax Interface Adapters

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
- B. Verify telecommunications cabling is installed and supported, terminated, mounted in an appropriate housing or terminated on the applicable component and labeled prior to certification testing and documentation.
- C. Verify certification tester universal interface adapters and manufacturer patch cords that enable permanent link verification are in new condition not indicating any twisting or kinking resulting from incorrect storage of the tester interface adapters.
- D. Optical fiber patch cords shall be inspected to ensure connector surfaces are clean and free of defects that may affect testing results.
- E. Refer to Section 01 91 00 General Commissioning Requirements.
- F. Refer to Section 27 00 00 Communication General Requirements 3.4 F for additional requirements.

3.2 TEST INSTRUMENT SUBMITTALS

- A. All copper & fiber optic test instruments used on the site shall be capable of storing test data files and downloading these test results as data files. The unique cable/strand number previously approved as per Specification 27 05 53 shall be used as the record identifier for each test.
- B. Submit a certificate verifying the model number, serial number, manufacturer, last date of calibration/certification for each test instrument used on the site prior to any testing.

3.3 TEST AND EVALUATION REPORTS:

- A. Prior to commencement of full system testing a test sample shall be submitted to Owner's Representative in order to verify correct testing procedures.
 - 1. Sample test reports shall include:
 - a. Copper tests for one (1) complete 48 port patch panel
 - b. Optical Fiber tests for 24 consecutive MMF strands
 - c. Optical Fiber tests for 24 consecutive SMF strands
 - 2. These reports shall be reviewed and accepted by Owner's Representative prior to any additional testing.
- B. A complete set of test results verifying the installed link performance parameter results for all cable types shall be presented to the Owner's Representative at least two (2) weeks before the placement of any active electronics in technology rooms and/or spaces.
- C. Verification and test results in electronic format saved directly from the testing device software application. Results must be neatly presented and organized according to floor and cable type; OSP, ISP, Category-6A, Category-3, and optical fiber cables (backbone and workstation fiber) must be divided into separate sections for each floor. Electronic results shall be presented in the testing device's native file type with a copy of the electronic software used to generate the test results when requested.

3.4 OPTICAL FIBER CABLE TESTING

- A. Fiber Testing: Perform on fibers in completed end to end system. Splices not allowed unless clearly defined and pre-approved by Owner's Representative.
 - 1. Testing: Bi-directional end to end power meter test, TIA 455-53A.
 - 2. Test horizontal multimode fiber at both 850nm and 1300nm, TIA-526-14-A OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant - Method B, (1 Jumper Reference)
 - a. The following loss limits shall apply to Horizontal segments regardless of actual link configuration:
 - 1) Permanent Link 2.0 dB
 - 2) Permanent Link w/ CP 2.8 dB
 - 3) Permanent Link w/MUTOA 2.0 dB

- 4) Centralized Fiber 3.3 dB
- 5) Centralized Fiber w/ CP 3.3 dB
- 3. Test backbone multimode fiber at both 850nm and 1300nm, TIA-526-14-A OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant - Method A, (2 Jumper Reference)
- 4. Test all single-mode fiber at both 1310 nm and 1550 nm, TIA 526-7 OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant -Method A.2 (2 Jumper Reference)
- B. Pre-installation Cable Testing: Test fiber optic cable prior to installation of cable.
 - 1. Design Builder shall be solely responsible for replacement of cable if found defective at later date.
- C. Loss Budget Fiber Links: Maximum loss of:
 - 1. (Allowable cable loss per km) *(km's of fiber in link) + (.75dB) *(number of connector pairs) + (.3dB) *(number of splices) = maximum allowable loss
 - 2. Splice Losses from Fusion Splice Pigtail Connectors and Fusion Splice-On Connectors shall not be counted in the Loss Budget. Only the Connector Loss shall be counted for Loss Budget.
 - 3. All test reports exhibiting a Headroom Margin of 0.25 dB or less shall be considered as not meeting requirements of this specification.
 - 4. Bring links not meeting requirements of this specification into compliance, at no charge to Owner.
- D. Documentation: Provide native electronic test reports to point of contact, include required software to view electronic results.

3.5 COPPER AND COAXIAL CABLE TESTING

- Certification test 100% of the installed cabling plant including all backbone and horizontal four (4) pair copper, multi-pair UTP and coaxial connections.
- B. Follow manufacturers' instructions and recommended industry standards and guidelines to complete all TIA testing procedures to verify performance levels.
- C. Follow manufacturer requirements for self-calibration procedures.
- D. Update tester software to show specific project information including but not limited to:
 - 1. Date and time of testing
 - 2. Project name
 - 3. Field technicians name
 - 4. Cable identification number
 - 5. Cable manufacturer, type and part number

- E. Repair
 - 1. Any connections failing to meet referenced standards or more stringent performance requirements stated above, must be removed and replaced with connections that prove, in additional testing, to meet or exceed the performance standards set forth.
 - 2. Refer to Section 01 91 00 General Commissioning Requirements.

3.6 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.7 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 271116 - COMMUNICATION CABINETS RACKS & ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Equipment Cabinets
- B. 2-Post Telecom Racks
- C. Wall Mount Racks Swing Out Frame
- D. Wall Mount IDF Enclosure
- E. Type 4X Single Door Wall Mounted Enclosure

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for network cabinets, racks, and telecommunications enclosure components utilized to house various telecommunications infrastructure components within technology distribution spaces.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 – 1.8

2.2 19" EQUIPMENT CABINETS

- A. Manufacturer List:
 - 1. B-Line
 - 2. Chatsworth
 - 3. Ortronics
 - 4. Middle Atlantic Products

B. Description:

- 1. Cabinet dimensions:
 - a. Minimum of forty-five (45) rack units (RU) marked in a contrasting color.
 - b. Standard 19" compliant rack width
 - c. Depth 42"
- 2. Equipment cabinet components shall be black in color. Finish shall be powder coat.
- 3. Rated load for equipment cabinets shall be no less than 2000 pounds.
- 4. Each cabinet enclosure shall have a rectangular frame with removable top panel, side panels and doors. Installed cabinets shall include thermal, power, and cable management accessories that control airflow through the cabinet and keep network and power cables separate and organized.
- 5. Provide minimum 20 RU of various configurable size blanking panels for each equipment cabinet.
- 6. The cabinet frame shall be rectangular with four corner posts, manufactured from steel and aluminum with welded and bolted frame construction. The horizontal frame members shall be aluminum extrusion with grooves that accept captive hardware to allow

attachment of equipment mounting rails and thermal, cable and power management accessories. The captive hardware will slide within the groove allowing rails and accessories to be adjusted in depth without removal from the cabinet. The slide extrusions will be marked with a scale that allows easy top-to-bottom alignment of mounting rails and other accessories when adjusted in depth.

- 7. Each cabinet shall include two pairs of equipment mounting rails. Mounting rails shall bolt to the side of the cabinet frame at the top and bottom of the frame and shall be adjustable in depth to provide front and rear support for equipment.
- 8. Equipment Mounting Rails shall be spaced horizontally to support 19" wide compliant rack-mount equipment.
- 9. Mounting rails shall be square-punched according to the Universal hole pattern and shall accept cage nut hardware with various threads. Rack units (RU) shall be marked and start at the bottom of the rail.
- 10. The cabinet shall include an interchangeable top panel with cable access ports located near the front and rear corners of the frame. Each cable access port shall be plastic with a brush seal to allow easy addition and removal of cables while limiting bypass airflow.
- 11. The cabinet shall be designed to allow baying with or without side panels installed.
- 12. The cabinet shall include a single front door with a high air flow perforated metal panel, hidden tamper-resistant hinges with quick-release hinge pins and a swing handle. The door shall be removable and reversible to open from the right or left. The door shall open a minimum of 120° when the cabinet is bayed with other cabinets. The front door shall have a single-point slam latch with a keyed lock.
- 13. The cabinet shall include a high flow perforated metal double rear door with a swing handle. The doors shall be removable. The doors shall open a minimum of 120° when the cabinet is bayed with other cabinets. The double rear door shall have a two-point cam latch with a keyed lock.
- 14. The mounting rails, top panel, side panels and doors shall be mechanically bonded to the cabinet frame. The cabinet frame shall have a prepared location for attaching a grounding lug.
- 15. The cabinet shall be UL Listed. UL Listing will be stated in the manufacturer's product literature.
- 16. The cabinet shall include (4) leveling feet, (4) clamps for securing the leveling feet to the floor and a grounding lug for bonding the cabinet frame to the Telecommunications Grounding Busbar. The manufacturer of the cabinet shall sell compatible casters and equipment mounting hardware as an accessory.

2.3 19" 2-POST TELECOM RACKS

- A. Manufacturer List:
 - 1. B-Line
 - 2. Chatsworth
 - 3. Ortronics
 - 4. Middle Atlantic Products
- B. Description:
 - 1. Compliant 19" open frame rack shall have a self-aligning design to speed field assembly.

- 2. Overall dimensions of rack shall be 19.62" W x 15.25" D (5.5" deep at top) with a useable rack height of 45 rack units.
- 3. Weight capacity shall be 800 lbs., evenly distributed with the base securely fastened, and 1600 lbs., evenly distributed with the base of the rack securely fastened and the top of the rack braced to a structural building.
- 4. Relay rack channels shall be constructed of 11-gauge steel with tapped 12-24, holes in universal spacing, top angles shall be 0.125" thick aluminum which can be easily field drilled for cable ladder installation.
- 5. Gusseted foot base shall have taper on feet to allow rack to self-stabilize on uneven floors.
- 6. Open frame rack shall be finished in a durable black powder coat.

2.4 19" WALL MOUNT RACKS – SWING OUT FRAME

- A. Manufacturer List:
 - 1. B-Line
 - 2. Chatsworth
 - 3. Ortronics
 - 4. Middle Atlantic Products
- B. Description:
 - 1. The rack shall consist of a wall-mount frame and a swing gate. The swing gate shall support 19" wide equipment, as specified below, and pivot open to provide easy access to the back of equipment.
 - 2. Wall mounted rack door that may be hinged to either side providing convenient access to the back of mounted equipment.
 - 3. The swing gate shall be connected to the wall-mount frame on one side at the top and the bottom of the swing gate with pivot bolts. The swing gate shall swing open to 150° minimum.
 - 4. Constructed of a steel frame and aluminum door with steel hinge pins.
 - 5. Mounting holes on 16" (406mm) centers.
 - 6. Door can be completely removed from frame after installation.
 - 7. ECA-310-E compliant with universal 5/8" (16mm), 5/8" (16mm), 1/2" (13mm) mounting hole spacing.
 - 8. 19" width.
 - 9. Mounting height of 54" (1371mm) or 79" (2006mm).
 - 10. Minimum depth of 25" (635mm).
 - 11. The rack will be rated to support 150 pounds of equipment. Load rating will be stated in the manufacturer's product literature.
 - 12. Integrated cable tie/cable wrap tie-down points.
 - 13. Finish: Flat Black Powder Coat

2.5 TYPE 4X SINGLE DOOR WALL MOUNTED ENCLOSURE

A. Manufacturer List:

- 1. B-Line
- 2. Chatsworth
- 3. Ortronics
- 4. Middle Atlantic Products
- B. Construction
 - 1. Size shall be as listed on drawings
 - 2. Enclosure shall be UL 508 Listed, Type 4X
 - 3. Door and sides of body shall have a smooth #4 brushed finish
 - 4. Enclosure and door shall be fabricated from Type 304 or Type 316L stainless steel
 - 5. All continuous welded seams shall be finished smooth
 - 6. Enclosure shall be of a Body flange trough design formed around body opening to divert liquid contaminants away from door opening
 - 7. Integral ground stud shall be provided in enclosure body
 - 8. .312-18 collar studs are provided for mounting optional equipment panels
 - 9. Doors shall be secured to the body with a spring-loaded hidden hinge design on one side and slotted quarter-turn flush latch(es) on the opposite side
 - 10. Door shall open minimum 150° for easy access
- C. Swing-Out Rack Frames
 - 1. Swing-out rack frame shall allow mounting of 19" rack mount equipment. Flexible pivoting framework shall provide access to back of equipment or other internal components.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 EQUIPMENT CABINETS, 2-POST TELECOM RACKS & WALL MOUNT RACKS

- A. Installation:
 - 1. Assemble racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
 - 2. Anchor all racks and cabinets to the floor/wall per the structural requirements and cross brace to the cable runway system above.
 - 3. Racks shall be bonded to the TGB using appropriate hardware provided by the Design Builder.
 - 4. Seismically brace the products indicated in this specification adhering to construction regulations relative to the buildings seismic zone as required by building codes and the recommendations of a licensed structural engineer.

5. Cable runway may be attached to the top of the rack to deliver cables to the rack. The rack should not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer.

3.3 WALL MOUNT RACKS – SWING OUT FRAME

A. Attach the rack to the wall so that the swing gate can be opened fully without obstruction by adjacent racks, or other building, storage or architectural components. Follow the manufacturer's assembly and installation instructions when securing the rack to the wall. The rack shall be installed on a plywood backboard bolted to a reinforced wall, or attached to a masonry wall. The rack shall not be attached to sheet rock (gypsum wall board).

3.4 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.5 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 271116 - COMMUNICATION CABINETS RACKS & ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Equipment Cabinets
- B. 2-Post Telecom Racks
- C. Wall Mount Racks Swing Out Frame
- D. Wall Mount IDF Enclosure
- E. Type 4X Single Door Wall Mounted Enclosure

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for network cabinets, racks, and telecommunications enclosure components utilized to house various telecommunications infrastructure components within technology distribution spaces.
1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 – 1.8

2.2 19" EQUIPMENT CABINETS

- A. Manufacturer List:
 - 1. B-Line
 - 2. Chatsworth
 - 3. Ortronics
 - 4. Middle Atlantic Products

B. Description:

- 1. Cabinet dimensions:
 - a. Minimum of forty-five (45) rack units (RU) marked in a contrasting color.
 - b. Standard 19" compliant rack width
 - c. Depth 42"
- 2. Equipment cabinet components shall be black in color. Finish shall be powder coat.
- 3. Rated load for equipment cabinets shall be no less than 2000 pounds.
- 4. Each cabinet enclosure shall have a rectangular frame with removable top panel, side panels and doors. Installed cabinets shall include thermal, power, and cable management accessories that control airflow through the cabinet and keep network and power cables separate and organized.
- 5. Provide minimum 20 RU of various configurable size blanking panels for each equipment cabinet.
- 6. The cabinet frame shall be rectangular with four corner posts, manufactured from steel and aluminum with welded and bolted frame construction. The horizontal frame members shall be aluminum extrusion with grooves that accept captive hardware to allow

attachment of equipment mounting rails and thermal, cable and power management accessories. The captive hardware will slide within the groove allowing rails and accessories to be adjusted in depth without removal from the cabinet. The slide extrusions will be marked with a scale that allows easy top-to-bottom alignment of mounting rails and other accessories when adjusted in depth.

- 7. Each cabinet shall include two pairs of equipment mounting rails. Mounting rails shall bolt to the side of the cabinet frame at the top and bottom of the frame and shall be adjustable in depth to provide front and rear support for equipment.
- 8. Equipment Mounting Rails shall be spaced horizontally to support 19" wide compliant rack-mount equipment.
- 9. Mounting rails shall be square-punched according to the Universal hole pattern and shall accept cage nut hardware with various threads. Rack units (RU) shall be marked and start at the bottom of the rail.
- 10. The cabinet shall include an interchangeable top panel with cable access ports located near the front and rear corners of the frame. Each cable access port shall be plastic with a brush seal to allow easy addition and removal of cables while limiting bypass airflow.
- 11. The cabinet shall be designed to allow baying with or without side panels installed.
- 12. The cabinet shall include a single front door with a high air flow perforated metal panel, hidden tamper-resistant hinges with quick-release hinge pins and a swing handle. The door shall be removable and reversible to open from the right or left. The door shall open a minimum of 120° when the cabinet is bayed with other cabinets. The front door shall have a single-point slam latch with a keyed lock.
- 13. The cabinet shall include a high flow perforated metal double rear door with a swing handle. The doors shall be removable. The doors shall open a minimum of 120° when the cabinet is bayed with other cabinets. The double rear door shall have a two-point cam latch with a keyed lock.
- 14. The mounting rails, top panel, side panels and doors shall be mechanically bonded to the cabinet frame. The cabinet frame shall have a prepared location for attaching a grounding lug.
- 15. The cabinet shall be UL Listed. UL Listing will be stated in the manufacturer's product literature.
- 16. The cabinet shall include (4) leveling feet, (4) clamps for securing the leveling feet to the floor and a grounding lug for bonding the cabinet frame to the Telecommunications Grounding Busbar. The manufacturer of the cabinet shall sell compatible casters and equipment mounting hardware as an accessory.

2.3 19" 2-POST TELECOM RACKS

- A. Manufacturer List:
 - 1. B-Line
 - 2. Chatsworth
 - 3. Ortronics
 - 4. Middle Atlantic Products
- B. Description:
 - 1. Compliant 19" open frame rack shall have a self-aligning design to speed field assembly.

- 2. Overall dimensions of rack shall be 19.62" W x 15.25" D (5.5" deep at top) with a useable rack height of 45 rack units.
- 3. Weight capacity shall be 800 lbs., evenly distributed with the base securely fastened, and 1600 lbs., evenly distributed with the base of the rack securely fastened and the top of the rack braced to a structural building.
- 4. Relay rack channels shall be constructed of 11-gauge steel with tapped 12-24, holes in universal spacing, top angles shall be 0.125" thick aluminum which can be easily field drilled for cable ladder installation.
- 5. Gusseted foot base shall have taper on feet to allow rack to self-stabilize on uneven floors.
- 6. Open frame rack shall be finished in a durable black powder coat.

2.4 19" WALL MOUNT RACKS – SWING OUT FRAME

- A. Manufacturer List:
 - 1. B-Line
 - 2. Chatsworth
 - 3. Ortronics
 - 4. Middle Atlantic Products
- B. Description:
 - 1. The rack shall consist of a wall-mount frame and a swing gate. The swing gate shall support 19" wide equipment, as specified below, and pivot open to provide easy access to the back of equipment.
 - 2. Wall mounted rack door that may be hinged to either side providing convenient access to the back of mounted equipment.
 - 3. The swing gate shall be connected to the wall-mount frame on one side at the top and the bottom of the swing gate with pivot bolts. The swing gate shall swing open to 150° minimum.
 - 4. Constructed of a steel frame and aluminum door with steel hinge pins.
 - 5. Mounting holes on 16" (406mm) centers.
 - 6. Door can be completely removed from frame after installation.
 - 7. ECA-310-E compliant with universal 5/8" (16mm), 5/8" (16mm), 1/2" (13mm) mounting hole spacing.
 - 8. 19" width.
 - 9. Mounting height of 54" (1371mm) or 79" (2006mm).
 - 10. Minimum depth of 25" (635mm).
 - 11. The rack will be rated to support 150 pounds of equipment. Load rating will be stated in the manufacturer's product literature.
 - 12. Integrated cable tie/cable wrap tie-down points.
 - 13. Finish: Flat Black Powder Coat

2.5 TYPE 4X SINGLE DOOR WALL MOUNTED ENCLOSURE

A. Manufacturer List:

- 1. B-Line
- 2. Chatsworth
- 3. Ortronics
- 4. Middle Atlantic Products
- B. Construction
 - 1. Size shall be as listed on drawings
 - 2. Enclosure shall be UL 508 Listed, Type 4X
 - 3. Door and sides of body shall have a smooth #4 brushed finish
 - 4. Enclosure and door shall be fabricated from Type 304 or Type 316L stainless steel
 - 5. All continuous welded seams shall be finished smooth
 - 6. Enclosure shall be of a Body flange trough design formed around body opening to divert liquid contaminants away from door opening
 - 7. Integral ground stud shall be provided in enclosure body
 - 8. .312-18 collar studs are provided for mounting optional equipment panels
 - 9. Doors shall be secured to the body with a spring-loaded hidden hinge design on one side and slotted quarter-turn flush latch(es) on the opposite side
 - 10. Door shall open minimum 150° for easy access
- C. Swing-Out Rack Frames
 - 1. Swing-out rack frame shall allow mounting of 19" rack mount equipment. Flexible pivoting framework shall provide access to back of equipment or other internal components.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 EQUIPMENT CABINETS, 2-POST TELECOM RACKS & WALL MOUNT RACKS

- A. Installation:
 - 1. Assemble racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
 - 2. Anchor all racks and cabinets to the floor/wall per the structural requirements and cross brace to the cable runway system above.
 - 3. Racks shall be bonded to the TGB using appropriate hardware provided by the Design Builder.
 - 4. Seismically brace the products indicated in this specification adhering to construction regulations relative to the buildings seismic zone as required by building codes and the recommendations of a licensed structural engineer.

5. Cable runway may be attached to the top of the rack to deliver cables to the rack. The rack should not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer.

3.3 WALL MOUNT RACKS – SWING OUT FRAME

A. Attach the rack to the wall so that the swing gate can be opened fully without obstruction by adjacent racks, or other building, storage or architectural components. Follow the manufacturer's assembly and installation instructions when securing the rack to the wall. The rack shall be installed on a plywood backboard bolted to a reinforced wall, or attached to a masonry wall. The rack shall not be attached to sheet rock (gypsum wall board).

3.4 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.5 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 271119 - COMMUNICATION TERMINATION BLOCKS AND PATCH PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Optical Fiber Termination panels.
- B. Copper horizontal cabling F/UTP Angled Patch Panels.
- C. Telecom room rack to cabinet copper horizontal cabling F/UTP Patch Panels.
- D. Resource Termination Panels
- E. Copper backbone cabling Wall-mounted 110 Frame System.

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for wall and rack/cabinet-mounted blocks, termination panels and patch panel components utilized to terminate various telecommunications infrastructure cabling and connectivity.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 OPTICAL FIBER DISTIBUTION UNITS (FDU)

- A. Manufacturer
 - 1. Corning Cable Systems
 - 2. Ortronics
 - 3. Siemon
- B. Indoor FDU description:
 - 1. 19-inch Rack mountable FDU with minimum 144-positions with integrated splicing for termination inside Telecom rooms.
 - 2. Maximum 4U (Rack Units) height.
 - 3. Single mode termination: Fusion splice both ends of each single mode fiber optic strand onto factory connectorized single mode pigtails mounted in connector housings assembled by the manufacturer of the single mode fiber optic cable.
 - a. Splice-On Connectors or Pigtail Splice is acceptable
 - 4. Multimode termination: Terminate both ends of each multimode fiber optic strand onto field installable type connectors.
 - a. Fusion splice methodology is acceptable

- 5. FDU housings shall be provided for cross-connecting or inter-connecting purposes between OSP, Indoor riser backbone, and/or distribution cables and the active network electronic switches, as noted in the TC-series drawings.
- 6. All FDU's shall be complete factory-provided assemblies that contain all components including LC duplex connector adapter panels and internal/external bend radius, strain relief and cable clamp components that are provided in a housing which includes accessible rear access.
- 7. All FDU trays and associated bulkhead inserts shall have factory numerical labeling included in the design and presentation to the user side of the panel.
- 8. The FDU bulkheads that house the terminating modules for the fiber backbone cabling and any horizontal optical fiber cabling shall accept ANSI/TIA-568-C standard-compliant LC-connectors compatible with the optical fiber strands being terminated.
- C. Outdoor FDU description:
 - 1. Outdoor rated, wall mountable FDU with minimum 24-positions with integrated splicing for termination at outdoor locations. Maximum dimensions 13"H x 12" W x 7" D.
 - 2. Single mode termination: Fusion splice both ends of each single mode fiber optic strand onto factory connectorized single mode pigtails mounted in connector housings assembled by the manufacturer of the single mode fiber optic cable.
 - a. Splice-On Connectors or Pigtail Splice is acceptable
 - 3. Multimode termination: Terminate both ends of each multimode fiber optic strand onto field installable type connectors.
 - a. Fusion splice methodology is acceptable
 - 4. FDU housings shall be provided for cross-connecting or inter-connecting purposes between OSP, Indoor riser backbone, and/or distribution cables and the active network electronic switches, as noted in the TC-series drawings.
 - 5. FDU's shall be complete factory-provided assemblies that contain all components including LC or ST connector adapter panels as required per location and internal/external bend radius strain relief and cable clamp components that are provided in a housing which includes an accessible rear access hatch.
 - 6. All FDU trays and associated bulkhead inserts shall have factory numerical labeling included in the design and presentation to the user side of the panel.
 - 7. FDU bulkheads that house the terminating modules for the fiber backbone cabling and any horizontal optical fiber cabling shall accept ANSI/TIA-568-C standard-compliant connectors compatible with the optical fiber strands being terminated.

2.3 COPPER HORIZONTAL CABLING F/UTP PATCH PANELS

- A. Manufacturer List:
 - 1. Superior Essex Category-6A F/UTP
 - 2. Siemon Category-6A F/UTP
 - 3. Commscope Category-6A F/UTP
 - 4. Belden Category-6A F/UTP

- B. Description:
 - 1. All patch panels are to be rack/cabinet mountable within industry standard TIA 19" mounting rails unless otherwise noted.
 - 2. All patch panels are to provide adequate space for individual port labeling on the front and cable/connector labeling on the back.
 - 3. All installed F/UTP patch panels shall consist of twenty-four (24) or forty-eight (48) port patch panels with ports for each cable as indicated in the TC-series drawings.
 - 4. The performance criteria for the F/UTP patch panels must meet or exceed the performance parameters for frequency, attenuation, near end cross-talk (NEXT), attenuation to cross-talk ratio (ACR), power sum NEXT (PS-NEXT), power sum ACR (PS-ACR), equal level far end cross-talk (ELFEXT), power sum far end cross-talk (PS-FEXT), and return loss (RL) as set forth in ANSI/TIA-568-C Category-6A standards.
- C. Accessory Products:
 - 1. Patch panel cable management bars shall be provided to support cable routing to each termination panel.
 - 2. Provide any accessory products related to the F/UTP patch panels to provide a complete and functional infrastructure system.
 - 3. Provide complete with all required mounting hardware, fittings and cables needed to form a bonded (grounded) system including manufacturer provided star washers.

2.4 TELECOM ROOM RACK TO CABINET COPPER F/UTP PATCH PANELS AND FDU'S

- A. Manufacturer List:
 - 1. Corning Cable Systems
 - 2. Superior Essex
 - 3. Siemon
 - 4. Commscope
 - 5. Belden
- B. Description:
 - 1. All patch panels are to be rack/cabinet mountable within industry standard TIA 19" mounting rails unless otherwise noted.
 - 2. All patch panels mounted in equipment cabinets shall be flat.
 - 3. All patch panels are to provide adequate space for individual port labeling on the front and cable/connector labeling on the back.
 - 4. All installed copper F/UTP patch panels shall be twenty-four (24) or forty-eight (48) port patch panels as indicated in the TC-series drawings.
 - 5. Optical Fiber FDU's shall be a maximum 144 Strand or as indicated in the TC-series drawings.
 - 6. The performance criteria for the F/UTP patch panels must meet or exceed the performance parameters for frequency, attenuation, near end cross-talk (NEXT), attenuation to cross-talk ratio (ACR), power sum NEXT (PS-NEXT), power sum ACR (PS-ACR), equal level far end cross-talk (ELFEXT), power sum far end cross-talk (PS-FEXT), and return loss (RL) as set forth in ANSI/TIA-568-C Category-6A standards.

- C. Accessory Products:
 - 1. Patch panel cable management bars shall be provided to support cable routing to each termination panel.
 - 2. Provide any accessory products related to the patch panels to provide a complete and functional infrastructure system.
 - 3. Provide complete with all required mounting hardware, fittings and cables needed to form a bonded (grounded) system.
 - 4. Cabling connecting each telecom room rack to cabinet patch panels shall be 4-pair F/UTP Category-6A rated cable. Furnish and install 4-pair F/UTP Category-6A rated horizontal cable as indicated.

2.5 COPPER BACKBONE CABLING WALL-MOUNTED 110 FRAME SYSTEM

- A. Manufacturer List:
 - 1. Superior Essex
 - 2. Siemon
 - 3. Commscope
 - 4. Belden
- B. Description:
 - 1. All wall-mounted voice field termination blocks shall be fifty (50), one hundred (100), three hundred (300), or nine hundred (900) pair tower frame assemblies with 110-style insulation displacement contact (IDC) type termination and connector blocks installed to terminate the voice pairs and outside plant cable, as indicated in the TC-series drawings.
 - 2. The wiring blocks shall be fire retardant, molded plastic consisting of horizontal index strips for terminating twenty-five (25) pairs of conductors each. These index strips shall be marked with the industry standard, five colors on the pair index teeth, separating the tip and ring of each pair, to establish pair location.
- C. Accessory Products
 - 1. Provide any accessory products related to the 110 frame systems (including C-3, C-4, and C-5 clips) required to provide a complete and functional infrastructure system.
 - 2. Provide complete with all required mounting hardware, fittings and cables needed to form a bonded (grounded) system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 FDU'S, F/UTP & UTP PATCH PANELS

- A. Install all optical fiber F/UTP and UTP termination panels according to manufacturer's instructions and per all ANSI/TIA-568-C standards as shown in the TC-series drawings.
- B. The installation and performance parameters of all installed cable termination panels shall be verified by the Design Builder through ANSI/TIA-568-C testing procedures.
- C. Label all cable termination panels to identify each port and each specific panel in accordance with the ANSI/TIA-606-B labeling scheme approved by Owners Representative.
- D. Copper Category-6A F/UTP cables terminate on twenty-four (24) or forty-eight (48) port patch panels as indicated in the TC-series drawings.
- E. Fiber optic cables terminate on 19-inch Rack mountable FDU with maximum 144-positions with integrated splicing that accepts duplex LC-type connectors as indicated in the TC-series drawings.
- F. The installation and performance parameters of all installed cable termination panels shall be verified by the Design Builder through ANSI/TIA-568-C testing procedures.
- G. Spare port

3.3 WALL-MOUNT 110 FRAME SYSTEM

- A. Install all wall-mounted 110 frames according to the manufacturer's instructions and per all ANSI/TIA-568-C standards as shown in the TC-series drawings.
- B. The installation and performance parameters of all installed category-5e backbone cable termination panels shall be verified through ANSI/TIA-568-C testing procedures.
- C. Sufficient slack shall be left on all cables terminating within the 110-frame systems to allow relocation of each binder group to adjacent vertical frames or to any space within the indicated frame.
- D. Label all category-5e backbone cable termination panels in accordance with the ANSI/TIA-606-B labeling scheme approved by Owners Representative.

3.4 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.5 CLOSEOUT ACTIVITIES

A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.

B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 271123 - COMMUNICATION CABLE MANAGEMENT AND RUNWAY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Vertical Cable Management
- B. Horizontal Cable Management
- C. Cable Runway System

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for cable management components utilized inside each telecommunications distribution space to support the management of horizontal workstation cabling, backbone cabling, and patch cords.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 VERTICAL CABLE MANAGEMENT

- A. Manufacturer List:
 - 1. Chatsworth Products
 - 2. B-line Cooper Industries
 - 3. Middle Atlantic Products

B. Description:

- 1. All vertical cable management on 19" relay racks shall be six inch (0'-6"), ten inch (10") or twelve (12") in width as noted in the TC-series drawings.
- 2. All vertical cable management on 19" relay racks shall be eighty-four inches (84") in height unless otherwise noted in the TC-series drawings.
- 3. Vertical cable management shall be double sided and shall provide sufficient depth to allow for standard copper and fiber bend radii internally and when entering and/or leaving the cable management frame. Dual hinged, removable, full-length doors shall be provided on the front and back of the management.
- 4. All components of the cable management system shall be black in color.
- C. Accessory Products:
 - 1. Provide any accessory products related to the cable management components to provide a complete and functional infrastructure system.

2.3 HORIZONTAL CABLE MANAGEMENT

- A. Manufacturer List:
 - 1. Chatsworth Products

- 2. B-line Cooper Industries
- 3. Middle Atlantic Products
- B. Description:
 - 1. All horizontal cable management on 19" relay racks shall be provided in rack unit dimensions as noted in the TC-series drawings.
 - Horizontal cable managers shall have sufficient depth and surfaces to allow for Category-6A copper cables bend radii. Single sided horizontal cable managers to be minimum 3.5" D.
 - 3. Horizontal cable management shall have dual hinged, removable covers.
 - 4. Transition cable management shall be two rack unit (2U) deep upper jumper tray provided with a one and half inch (1.5") bend radius component compliant with ANSI/TIA-568-C bend radius requirements.
 - 5. All components of the cable management system shall be black in color.
- C. Accessory Products:
 - 1. Provide any accessory products related to the cable management components to provide a complete and functional infrastructure system.

2.4 CABLE RUNWAY SYSTEM

- A. Manufacturer List:
 - 1. Chatsworth Products
 - 2. B-line Cooper Industries
 - 3. Middle Atlantic Products
- B. Description:
 - 1. C-channel cable runway: UL listed, 1 ¹/₂"" x 0.375" aluminum side rails, with 17/64" diameter holes at 1.571" intervals and rungs on 9" centers; aluminum finish, complete with all required mounting hardware, fittings and cables needed to form a bonded (grounded) system.
 - 2. Cable runway system shall include structural engineered and approved components to provide and install the necessary seismic zone support system including end caps, wall angle support brackets, bonding straps, butt splice kits, junction splice kits, and top rack-to-runway mounting kits.
 - 3. The cable runway system shall include a corner section at each intersection that creates a radius "L", "X", and/or "T" formed when two (2) or more pieces of cable runway are connected together with a junction splice assembly.
 - 4. All components of the cable runway system shall be black in color.
- C. Accessory Products:
 - 1. Provide any accessory products related to the cable runways system to provide a complete and functional infrastructure system. The cable runway accessories include, but are not limited to:

- a. Cable runway bend radius drop assemblies (sized per runway section);
- b. Cable runway movable cross member assemblies to support cable runway bend radius drop assemblies;
- c. Runway butt-splice, swivel splice and foot kits; Heavy duty stringer splice kits and brackets shall be used to attach end to end horizontal cable runway segments.
- d. Cable runway corner brackets (sized per runway and site conditions);
- e. Rack-to-runway mounting plates (sized per runway section);
- f. Cable runway elevation kits (sized per site conditions);
- g. Wall angle support brackets (sized per runway section);
- h. Threaded rod assemblies with rod protectors for overhead attachment;
- i. Slotted Support brackets for runway attachment to threaded rod assemblies;
- j. Runway end termination kits.
- k. Vertical wall-mounting brackets;
- 1. Cable retaining posts (6" as required);
- m. Runway bonding kits;
- n. Protective end caps.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 VERTICAL AND HORIZONTAL CABLE MANAGEMENT

A. Process:

- 1. Install all vertical and horizontal cable management per the manufacturer's recommended installation instructions, as indicated in the TC-series drawings.
- 2. All cable bundles inside the telecommunications rooms shall be secured with Velcro[™] cable wraps; plastic wire ties are not acceptable.
- 3. Cable ties and Velcro[™] wraps shall not be pulled tight enough to kink the cable jacket.

3.3 CABLE RUNWAY SYSTEM

- A. Process:
 - 1. Install all vertical and horizontal cable runways per the manufacturer's recommended installation instructions, as indicated in the project drawings.
 - 2. Coordinate the cable runway rungs with the vertical cable manager locations to provide for an unobstructed opening above the vertical cable managers. The specified C-channel cable runway rungs can be relocated to accommodate this requirement.
 - 3. Install radius runway drop-out fittings at all instances of cable runway grids where cable bundles enter or exit the cable runway system. Multiple drop-out fittings need to be placed

next to each other to accommodate large cable bundles. Install drop-out wing sections at the ends of the waterfall drop-out fittings to ensure cable radius requirements are met where cables exit or enter the cable runway grid from the sides of the runway stringers.

- 4. Install radius runway drop-out fittings at all instances on both sides above front end of vertical cable managers of cable runway to accommodate patch cord routing in both directions.
- 5. Install cable-retaining posts on both sides of the cable runway grid. Retaining posts to be installed at all 90-degree corners, ends of each runway section and at 24" intervals along straight sections. Retaining posts to be installed on both sides of the runway ladder.
- 6. Open ended cable runway sections shall be closed with runway termination kits.
- 7. Support vertical cable runway sections to the plywood backboards with runway hold down clamp kits.
- 8. Provide vertical cable runway sections from slab level to slab level in each telecom room where cables enter the telecom room through the floor slab and exit the telecom room through the ceiling slab.
- 9. Provide vertical cable runway sections from slab level to the horizontal cable runway grid in each telecom room where cables enter the telecom room through the floor slab and do not continue through the ceiling slab.
- 10. Inside telecom spaces the primary cable transport system shall be the overhead cable runway system, as shown in the TC-series drawings. Design Builder-installed cable runway system shall include all components to complete the installation whether indicated in the contract documents or implied by the design.
- 11. Install all components of the cable runway system under the codes, standards, guidelines, and manufacturer recommendations.
- 12. Vertical support to the slab above shall be provided if a cable runway section spans a distance greater than four (4) feet.
- 13. Diagonal braces and threaded rod stiffeners shall be installed as additional structural support assembly as required by the Seismic Requirements for Non-Structural Components for all structural bracing and support of telecommunications equipment.

3.4 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.5 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 271313 - COMMUNICATION COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Backbone Multi-Pair UTP Cable

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for Multi-pair UTP backbone cabling from MDF space to IDF and specialty locations.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 BACKBONE MULTI-PAIR UTP CABLE

- A. Manufacturer List:
 - 1. Belden
 - 2. Superior Essex
 - 3. Commscope
- B. Description:
 - 1. All voice and data ISP and OSP copper backbone cable is to be rated per the environmental conditions in which installed and verified by the Design Builder prior to installation. Per code, plenum cable is to be installed at all times when a communications cable is exposed in a plenum air space. It is the responsibility of the Design Builder to bid, purchase, install, and verify the rating of the ISP and OSP cable for the specific environmental conditions.
 - 2. Backbone cables that are exposed to moisture shall be either indoor/outdoor or outdoor rated and contain moisture-blocking materials to prevent moisture damage to cable performance. Select the appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
 - 3. Backbone multi-pair UTP cable shall be Category-5e copper UTP, twenty-four (24) AWG cable. The total pair count of each Category-5e cable shall be provided as noted in the project drawings. Multiple 25-Pair cables may be required.
 - 4. The performance criteria for the UTP backbone cable shall be in accordance with the specific standards for the particular cable's rating. All backbone cables shall perform up to, or beyond the current specification parameters for the published Category-5e rating by ANSI/TIA-568-C.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 COPPER BACKBONE CABILING

- A. Install all copper backbone cable per the manufacturer's installation instructions and ANSI/TIA-568-C standards, and in quantities indicated in the TC-series drawings.
- B. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly.
- C. Backbone cable shall be visually inspected for sufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to Owners Representative.
- D. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in BICSI best practices.
- E. Install backbone cables with attention paid to aesthetic means and methods when routing cabling within IT spaces.
- F. No backbone cable shall be left unsupported for more than five (5) feet vertically or horizontally at any time.
- G. All backbone cables shall be clearly labeled on both ends and in an accessible location no more than one (1) foot from each cable end.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 271323 - COMMUNICATION OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Backbone Single-mode Optical Fiber Cable
- B. Backbone LOMMF Optical Fiber Cable

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for Optical Fiber backbone cabling to distribute network signals from MDF space to IDF locations and from the Entrance facility to MDF.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 BACKBONE SINGLE-MODE OPTICAL FIBER CABLE

- A. Manufacturer List:
 - 1. Corning Cable Systems
 - 2. Superior Essex
 - 3. Siemon Company
- B. Description:
 - 1. All single-mode optical fiber cable shall be capable of Ethernet signal transmission at 10 Gb/s up to 10,000 meters in the 1310nm operating window. Maximum attenuation for a single-mode indoor/outdoor cable shall be no greater than 0.5dB per kilometer using 1310nm and 1550nm wavelengths.
 - 2. Each optical fiber strand shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification and all ANSI/TIA-568-C performance parameters.
 - 3. All optical fibers inside each individual cable shall be provided in counts indicated in the TC-series drawings and usable to the fullest capacity specified by the manufacturer and meet required specifications at all times.
 - 4. Indoor backbone single-mode optical fiber cables shall be:
 - a. Individual jacketed, tight buffered fiber type.
 - b. The individual fibers are grouped in jacketed subunits color coded per ANSI/TIA-598-C.
 - c. Have integrated dielectric central and strength members.
 - d. The fiber core is protected by a flexible, spirally wrapped interlocking armored metal made of aluminum or galvanized steel without interruption from end to end for protection and strength. The metallic armor shall also be wrapped in a yellow colored flame retardant outer sheath to designate the type of optical fiber.

- 5. Outside Plant (OSP) backbone single-mode optical fiber cables shall be:
 - a. Flame-retardant UV-resistant indoor/outdoor rated cables.
 - b. Individual jacketed, tight buffered fiber type.
 - c. The individual fibers are grouped in jacketed subunits color coded per TIA-598-C.
 - d. Have dielectric integrated central strength member with surrounding waterswellable waterblocking strength members.
- 6. The optical fiber cables shall be rated per the installation environment as required by the local Authority Having Jurisdiction and/or National Fire Codes. Select an appropriate cable construction, including external jacket properties, when installing optical fiber cables in aerial, outdoor, underground and corrosive environments.
- 7. All SMF shall meet or exceed TIA compliant network cable-testing device certification by an independent laboratory, such as ETL, for verification of high speed, ANSI/TIA-568-C compliant performance.
- C. Accessory Products:
 - 1. Provide any accessory products related to the optical fiber backbone cabling required to provide a complete and functional infrastructure system.

2.3 BACKBONE LASER-OPTIMIZED MULTIMODE OPTICAL FIBER CABLE (OM4)

- A. Manufacturer List:
 - 1. Corning Cable Systems
 - 2. Superior Essex
 - 3. Siemon Company
- B. Product Options:
 - 1. The manufacturers noted above shall be the only manufacturers acceptable to Owners Representative and A/E.
- C. Description:
 - All LOMMF cables shall be capable of Ethernet signal transmission at 10 Gb/s up to 550 meters at 4700 MHz/km effective modal bandwidth, while allowing the use of low-cost, 850 nm vertical cavity surface emitting laser (VCSEL). Maximum attenuation for a LOMMF cable shall be no greater than 3.0dB per kilometer using 850nm and 1.0dB per kilometer using 1300nm wavelengths respectively.
 - 2. Each optical fiber strand shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification and all ANSI/TIA-568-C performance parameters.
 - 3. All optical fibers inside each individual cable shall be provided in counts indicated in the TC-series drawings and be usable to the fullest capacity specified by the manufacturer and meet required specifications at all times.
 - 4. Indoor backbone 50 µm multi-mode optical fiber cable shall be:
 - a. Individual jacketed, tight buffered fiber type.

- b. The individual fibers are grouped in jacketed subunits color coded per ANSI/TIA-598-C.
- c. Have integrated dielectric central and strength members.
- d. The fiber core is protected by a flexible, spirally wrapped interlocking armored metal made of aluminum or galvanized steel without interruption from end to end for protection and strength. The metallic armor shall also be wrapped in the industry standard aqua colored, flame retardant outer sheath to designate the type of optical fiber.
- 5. Outside Plant (OSP) backbone 50 µm multi-mode optical fiber cable shall be:
 - a. Flame-retardant UV-resistant indoor/outdoor rated cables.
 - b. Individual jacketed, tight buffered fiber type.
 - c. The individual fibers are grouped in jacketed subunits color coded per TIA-598-C.
 - d. Have dielectric integrated central strength member with surrounding waterswellable waterblocking strength members.
- 6. The optical fiber cables shall be rated per the installation environment as required by the local Authority Having Jurisdiction and/or National Fire Codes. Select an appropriate cable construction, including external jacket properties, when installing optical fiber cables in aerial, outdoor, underground and corrosive environments.
- D. Accessory Products:
 - 1. Provide any accessory products related to the optical fiber backbone cabling required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 BACKBONE OPTICAL FIBER (SMF AND LOMMF) CABLE

- A. Install all horizontal cable per the manufacturer's recommended installation instructions, under the guidelines of ANSI/TIA-568-C and BICSI best practices, and in quantities indicated in the TC-series drawings.
- B. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly.
- C. Backbone cable shall be visually inspected for sufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to Owners Representative.

- D. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in BICSI best practices.
- E. Install backbone cables with attention paid to aesthetic means and methods when routing cabling within IT spaces. No backbone cable shall be left unsupported for more than five (5) feet vertically or horizontally at any time.
- F. Fiber optic cables shall be placed in neat bundles separated from other communications cabling. Fiber optic cables shall be neatly placed and lashed with Velcro ties to the horizontal and vertical cable management and runways at minimum 4-foot intervals, not to exceed every 4th rung, plus all locations where the cables change direction.
- G. Provide radius drop out fittings at all locations where fiber optic cables transition from vertical to horizontal cable management systems.
- H. All backbone cable shall be securely fastened to the termination shelf with a manufacturers strain relief bracket and termination panel cable clamp in a way that does not damage the optical fiber strands or impede the performance of the media. This secure fastening method shall also serve to insure a secure termination environment.
- I. A minimum of three feet (3'-0") of each optical fiber strand shall be left protected within the termination shelf for any future re-termination of a particular optical fiber strand.
- J. All backbone cables shall be clearly labeled on both ends and in an accessible location no more than one (1) foot from each cable end.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 271324 - COMMUNICATION OPTICAL FIBER SPLICING AND TERMINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Fusion Splicing Device

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for optical fiber cable termination and splicing for each strand of optical fiber inside a patch bay or at each workstation outlet location.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 FUSION SPLICING DEVICE

- A. Manufacturer List:
 - 1. Corning Cable Systems
 - 2. Or Equal
- B. Description:
 - 1. Splicer electrodes shall contain an arc-stabilizing feature to prevent spontaneous position shift of the arc emission zone to reduce the average splice loss by up to 50% and also the standard deviation compared to standard electrodes. The splicer shall require minimal maintenance, allowing up to 7000 splices between cleanings.
 - 2. Procedures such as pre-alignment, cleaning, gap-setting, cleave angle monitoring, core-tocore alignment and glass fusion shall be microprocessor-controlled. Multiple splice programs with individual parameter settings shall be selectable, with seven pre-set singlemode and two multimode programs.
 - 3. Course pre-alignment shall be performed automatically; therefore, accurate manual prealignment of the fibers shall not be necessary. Precise pre-alignment in z-axis shall be automatically performed with two-step motors. Fine positioning and final alignment of the fibers in three (x, y and z) directions shall be automatically performed with piezo-ceramic actuators, which have a positioning resolution better than 0.1 µm.
 - 4. Upon completion of the splice, the splice loss shall be evaluated automatically. The splice loss value shall be displayed on the LCD display in decibels (dB).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 FUSION SPLICER DEVICE

- A. Follow manufacturer's instructions at all times when operating the optical fiber fusion splicing device. Pay particular attention to cleanliness and axis alignment.
- B. The technician shall utilize the integrated tensile testing function of the splicing device after each splice to analyze the strength of the fiber joint. The tensile testing load shall be 1.5 N (0.34 lbf) and shall be applied for approximately one second. Any splice failing the tensile test shall be respliced immediately

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 271333 - COMMUNICATION COAXIAL BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. RG-11 Coaxial Cabling
- B. QR 540 Coaxial Cable

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for coaxial backbone cabling to distribute RF-based network signals between telecommunications distribution spaces.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 RG-11 COAXIAL CABLE

- A. Manufacturer List:
 - 1. Commscope
 - 2. Superior Essex
- B. Description
 - 1. RG-11 coaxial cable shall exhibit a nominal impedance of seventy-five (75) Ohms.
 - 2. Typical attenuation for RG-11 coaxial cables shall be 3.5dB (± 0.5 db) per 100 feet (100') of cable at a seven hundred and fifty megahertz wavelength. All coaxial cables shall be swept-tested to 2.2 GHz.
 - 3. The coaxial center conductor shall be solid gauge that is encased by a foam Teflon® dielectric used to meet or exceed electrical and fire-safety and code compliance and performance.
 - 4. RG-11 coaxial cable shall exhibit stable performance in a building environment, as well as in an exterior exposed environment, and shall have a minimum sixty percent (60%) primary aluminum braided sheath covering an aluminum foil quad shield design.
 - 5. RG-11 coaxial cables that are exposed to moisture shall contain moisture-blocking materials to prevent moisture damage to cable performance.
 - 6. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
- C. Accessory Products:
 - 1. Provide any accessory products related to the coaxial backbone cabling required to provide a complete and functional infrastructure system.

2.3 QR 540 COAXIAL CABLING

- A. Manufacturer List:
 - 1. Commscope Products
- B. Product Options:
 - 1. QR 540 JCAR Indoor Riser (CATVR)
 - 2. QR 540 JCASS Underground
- C. Description
 - 1. QR 540 coaxial cable shall exhibit a nominal impedance of seventy-five (75) Ohms.
 - 2. Typical attenuation for QR 540 coaxial cables shall be 1.80dB (± 0.5 db) per 100 feet (100') of cable at a seven hundred and fifty megahertz wavelength.
 - 3. The coaxial center conductor shall be solid gauge that is encased by a dielectric used to meet or exceed electrical and fire-safety and code compliance and performance.
 - 4. QR 540 coaxial cable shall exhibit stable performance in a building environment, as well as in an underground exposed environment. Coaxial cables that are exposed to moisture shall contain moisture-blocking materials to prevent moisture damage to cable performance.
 - 5. Select an appropriate cable construction considering code requirements and environmental conditions when installing cables in aerial, outdoor, underground and corrosive environments.
- D. Accessory Products:
 - 1. Provide any accessory products related to the coaxial backbone cabling required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 BACKBONE COAXIAL CABILING

- A. Install all backbone coaxial cable per BICSI Best Practices, the manufacturer's installation instructions and ANSI/TIA-568-C standards, and in quantities indicated in the TC-series drawings.
- B. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly.

- C. Backbone coaxial cable shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the owner.
- D. Install backbone coaxial cables with attention paid to aesthetic means and methods when routing cabling within IT spaces. No backbone cable shall be left unsupported for more than five (5) feet vertically or horizontally at any time.
- E. All backbone coaxial cables shall be clearly labeled on both ends and in an accessible location no more than one (1) foot from each cable end.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

SECTION 271334 - COMMUNICATION COAXIAL SPLICING AND TERMINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. RG-11 Connectors
- B. RG-6 Connectors
- C. QR 540 Connectors

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for the termination of coaxial station and backbone cabling to distribute RF-based network signals between telecommunications distribution spaces and to/from coaxial workstation outlets.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 RG-11 F-TYPE CONNECTORS

- A. Manufacturer List:
 - 1. Belden
 - 2. Thomas & Betts
- B. Description:
 - 1. RG-11 coaxial connectors shall be sealed to prevent moisture from migrating into the connector and have three hundred sixty (360) degree radial compression.
 - 2. All coaxial connections shall have a minimum cable retention rating of forty (40) pounds and be manufactured with RG-11 F-type interface that is compatible with components specifically manufactured for RG-11 F-type threaded ports.
 - 3. All modular outlet coaxial connectors shall function to the specified performance parameters for video signal traffic that is connected via video patch cords in the IDF(s), Head End and/or MDF/DCC.
 - 4. Ensure connector size and type is compatible with the specified RG-11 backbone cable.
 - 5. Utilize corrosion resistant connectors when applicable.

C. Accessory Products:

1. Provide any accessory products related to the coaxial cabling termination connectors required to provide a complete and functional infrastructure system.

2.3 RG-6 F-TYPE CONNECTORS

- A. Manufacturer List:
 - 1. Belden

- 2. Thomas & Betts
- B. Description
 - 1. RG-6 coaxial connectors shall be sealed to prevent moisture from migrating into the connector and have three hundred sixty (360) degree radial compression.
 - 2. All coaxial connections shall have a minimum cable retention rating of forty (40) pounds and be manufactured with RG-6 F-type interface that is compatible with components specifically manufactured for RG-6 F-type threaded ports.
 - 3. All modular outlet coaxial connectors shall function to the specified performance parameters for video signal traffic that is connected via video patch cords in the IDF(s), Head End and/or MDF/DCC.
 - 4. Ensure connector size and type is compatible with the specified RG-6 backbone cable.
 - 5. Utilize corrosion resistant connectors when applicable.
- C. Accessory Products:
 - 1. Provide any accessory products related to the coaxial cabling termination connectors required to provide a complete and functional infrastructure system.

2.4 QR 540 CONNECTORS

- A. Manufacturer List:
 - 1. Corning Gilbert Products
 - 2. Belden
 - 3. Thomas & Betts
- B. Product Options:
 - 1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirements.
- C. Description
 - 1. QR 540 coaxial connectors shall be 2-piece connector construction with a bandwidth range from 5 MHz to 1 GHz. Nominal impedance shall be 75 ohms.
 - 2. The connector shall be constructed from ASTM 6000 series aluminum alloy with gold chromate conversion coating for corrosion resistance. Contact pins and support sleeves shall be brass with bright acid tin plating for RF conductivity.
 - 3. All modular outlet coaxial connectors shall function to the specified performance parameters for video signal traffic that they support.
 - 4. Ensure connector size and type is compatible with the specified QR 540 backbone coaxial cable.
 - 5. Utilize corrosion resistant connectors when applicable.
- D. Accessory Products:
 - 1. Provide any accessory products related to the coaxial cabling termination connectors required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 RG-11, RG-6, QR 540 CONNECTORS

- A. Install all connectors and required couplers per the manufacturer's installation instructions and ANSI/TIA-568-C standards, and in quantities indicated in the TC-series drawings.
- B. The installation and performance parameters of all installed connectors shall be verified by the Design Builder through ANSI/TIA-568-C testing procedures for each connector.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.
SECTION 271513 - COMMUNICATION COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Category 6A Four-Pair UTP Cabling

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for four-pair UTP copper horizontal workstation cabling to distribute network signals from telecommunications distribution spaces to workstation outlet locations.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 FOUR PAIR UTP CABLING

- A. Manufacturer List:
 - 1. Superior Essex Category-6A UTP
 - 2. Siemon Category-6A UTP
 - 3. Commscope Category-6A UTP
 - 4. Belden Category-6A UTP

B. Description

- 1. All augmented Category-6A performance four (4) pair UTP cable shall consist of eight (8) twenty-four (24) gauge, or greater, thermoplastic insulated solid twisted conductors that utilize the industry standard color code designations.
- 2. The performance criteria for four (4) pair UTP cable shall be meet or exceed specific ANSI/TIA-568-C standards for Category-6A cable rating and shall show stable performance with documented electrical characterization out to 500 MHz.
- 3. Cables shall be rated per the installation environment as required by the local AHJ and building codes.
- 4. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
- C. Accessory Products:
 - 1. Provide any accessory products related to the UTP copper 4-pair cabling required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
 - 1. Electrical requirements (conduit installation and capacity)
 - 2. The telecommunications rooms are the size shown on the project drawings.
 - 3. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
 - 4. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 FOUR PAIR UTP CABLING INSTALLATION

- A. Install all horizontal station cabling per the manufacturer's recommended installation instructions, under the guidelines of ANSI/TIA-568-C and BICSI best practices, and in quantities indicated in the TC-series drawings.
- B. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in BICSI best practices. Also refer to the cable manufacturer's specifications for exact cable requirements per the particular cable type.
- C. All cables shall be visually inspected for sufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to Owner.
- D. Design Builder shall ensure that all industry standards and best practices are met, with special regard to maximum pair un-twist. No twisted pair cables shall have more than three-eight inch (3/8") of pair un-twist. The cable jacket shall be maintained as close as possible to the connecting hardware.
- E. Install the horizontal cabling with attention paid to aesthetic means and methods when routing cabling within IT spaces. All horizontal cabling should terminate in their respective floor serving technology space; specifically cables from floor outlets need to terminate in their corresponding floor telecom room.
- F. All cabling distributed horizontally through metal stud framing shall have plastic protective bushings inserted to protect cables prior to installation.
- G. All cables shall be clearly labeled on both ends and in an accessible location no more than six inches (0'-6") from the cable ends.

H. Owner reserves the right to specify a new location for any outlet or equipment without increasing Design Builder unit cost – providing that the new location is specified prior to roughing-in of technology cable and is not farther than ten (10) feet away from the original location specified.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

END OF SECTION

SECTION 271523 - COMMUNICATION OPTICAL FIBER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Horizontal Single-mode Optical Fiber Cable
- B. Horizontal LOMMF Optical Fiber Cable

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for optical fiber cabling to distribute optical network signals between telecommunications distribution spaces.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 HORIZONTAL SINGLE-MODE OPTICAL FIBER CABLE

- A. Manufacturer List:
 - 1. Corning Cable Systems
 - 2. Superior Essex
 - 3. Siemon Company
- B. Description:
 - 1. All single-mode optical fiber cable shall be capable of Ethernet signal transmission at 10 Gb/s up to 10,000 meters in the 1310nm operating window. Maximum attenuation for a single-mode indoor/outdoor cable shall be no greater than 0.5 dB per kilometer using 1310nm and 1550nm wavelengths.
 - 2. Each optical fiber strand shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification and all ANSI/TIA-568-C performance parameters.
 - 3. All optical fibers inside each individual cable shall be provided in counts indicated in the T-series drawings and usable to the fullest capacity specified by the manufacturer and meet required specifications at all times.
 - 4. Indoor horizontal single-mode optical fiber cables shall be:
 - a. Individual jacketed, tight buffered fiber type.
 - b. The individual fibers are grouped in jacketed subunits color coded per ANSI/TIA-598-C.
 - c. Have integrated dielectric central and strength members.
 - d. Flame retardant outer jacket in a yellow color to designate the type of optical fiber.
 - 5. The optical fiber cables shall be rated per the installation environment as required by the local Authority Having Jurisdiction and/or National Fire Codes. Select an appropriate cable construction, including external jacket properties, when installing optical fiber cables in aerial, outdoor, underground and corrosive environments.

- 6. All SMF shall meet or exceed TIA compliant network cable-testing device certification by an independent laboratory, such as ETL, for verification of high speed, ANSI/TIA-568-C compliant performance.
- C. Accessory Products:
 - 1. Provide any accessory products related to the optical fiber cabling required to provide a complete and functional infrastructure system.

2.3 HORIZONTAL LASER-OPTIMIZED MULTIMODE OPTICAL FIBER CABLE (OM4)

- A. Manufacturer List:
 - 1. Corning Cable Systems
 - 2. Superior Essex
 - 3. Siemon Company
- B. Description:
 - All LOMMF cables shall be capable of Ethernet signal transmission at 10 Gb/s up to 550 meters at 4700 MHz/km effective modal bandwidth, while allowing the use of low-cost, 850 nm vertical cavity surface emitting laser (VCSEL). Maximum attenuation for a LOMMF cable shall be no greater than 3.0dB per kilometer using 850nm and 1.0dB per kilometer using 1300nm wavelengths respectively. (OM4)
 - 2. Each optical fiber strand shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification and all ANSI/TIA-568-C performance parameters.
 - 3. All optical fibers inside each individual cable shall be provided in counts indicated in the TC-series drawings and be usable to the fullest capacity specified by the manufacturer and meet required specifications at all times.
 - 4. Indoor horizontal 50 µm multi-mode optical fiber cable shall be:
 - a. Individual jacketed, tight buffered fiber type.
 - b. The individual fibers are grouped in jacketed subunits color coded per ANSI/TIA-598-C.
 - c. Have integrated dielectric central and strength members.
 - d. Flame retardant outer jacket in an industry standard aqua color to designate the type of optical fiber.
 - 5. The optical fiber cables shall be rated per the installation environment as required by the local Authority Having Jurisdiction and/or National Fire Codes. Select an appropriate cable construction, including external jacket properties, when installing optical fiber cables in aerial, outdoor, underground and corrosive environments.
- C. Accessory Products:
 - 1. Provide any accessory products related to the optical fiber cabling required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
 - 1. Electrical requirements (conduit installation and capacity)
 - 2. The telecommunications rooms are the size shown on the project drawings.
 - 3. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
 - 4. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 HORIZONTAL OPTICAL FIBER (SMF AND LOMMF) CABLE

- A. Install all horizontal cable per the manufacturer's recommended installation instructions, under the guidelines of ANSI/TIA-568-C and BICSI best practices, and in quantities indicated in the TC-series drawings.
- B. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly.
- C. Cable shall be visually inspected for sufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to Owners Representative.
- D. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in BICSI guidelines.
- E. Install cables with attention paid to aesthetic means and methods when routing cabling within IT spaces. No cable shall be left unsupported for more than three (3) feet vertically or horizontally at any time.
- F. Fiber optic cables shall be placed in neat bundles separated from other communications cabling. Fiber optic cables shall be neatly placed and lashed with Velcro ties to the horizontal and vertical cable management and runways at minimum 4-foot intervals, not to exceed every 4th rung, plus all locations where the cables change direction.
- G. Provide radius drop out fittings at all locations where fiber optic cables transition from vertical to horizontal cable management systems.
- H. All cable shall be securely fastened to the termination shelf with a manufacturers strain relief bracket and termination panel cable clamp in a way that does not damage the optical fiber strands or impede the performance of the media. This secure fastening method shall also serve to insure a secure termination environment.

- I. A minimum of three feet (3'-0") of each optical fiber strand shall be left protected within the termination shelf for any future re-termination of a particular optical fiber strand.
- J. All cables shall be clearly labeled on both ends and in an accessible location no more than one (1) foot from each cable end.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

END OF SECTION

SECTION 271533 - COMMUNICATION COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. RG-6 Coaxial Cable

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for coaxial horizontal workstation cabling to distribute RF-based network signals between telecommunications distribution spaces and various workstation outlet locations.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 RG-6 COAXIAL CABLE

- A. Manufacturer List:
 - 1. Belden Coaxial Cable
 - 2. Superior Essex Coaxial Cable
 - 3. Commscope Coaxial Cable

B. Description:

- 1. RG-6 coaxial cable shall exhibit a nominal impedance of seventy-five (75) Ohms.
- 2. Typical attenuation for RG-6 coaxial cables shall be 5.5dB (± 0.5 db) per 100 feet (100') of cable at a seven hundred and fifty (750) megahertz wavelength. All coaxial cables shall be swept-tested to 2.2 GHz.
- 3. The coaxial center conductor shall be solid gauge that is encased by a foam dielectric used to meet or exceed electrical and fire-safety and code compliance and performance.
- 4. RG-6 coaxial cable shall exhibit stable performance in a building environment, as well as in an exterior exposed environment, and shall have a quad shield design.
- 5. It is the responsibility of the Design Builder to bid, purchase, install, and verify the rating of the ISP and OSP cable for the specific construction conditions.
- 6. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
- C. Accessory Products
 - 1. Provide any accessory products related to the coaxial horizontal cabling required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.
 - 1. Electrical requirements (conduit installation and capacity)
 - 2. The telecommunications rooms are the size shown on the project drawings.
 - 3. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
 - 4. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 RG-6 HORIZONTAL CABLE

- A. Install all RG-6 coaxial per the manufacturer's installation instructions and ANSI/TIA-568-C standards, and in quantities indicated in the TC-series drawings.
- B. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly.
- C. RG-6 coaxial cable shall be visually inspected for sufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the owner.
- D. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in BICSI best practices.
- E. Install RG-6 coaxial cables with attention paid to aesthetic means and methods when routing cabling within IT spaces. No cable shall be left unsupported for more than five (5) feet vertically or horizontally at any time.
- F. All RG-6 coaxial cables shall be clearly labeled on both ends and in an accessible location no more than one (1) foot from each cable end.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

END OF SECTION

SECTION 271543 - COMMUNICATION FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Copper UTP Connectors
- B. Indoor Multimode Optical Fiber Connectors (Field Termination Type)
- C. Outdoor Multimode Optical Fiber Connectors (Field Termination Type)
- D. Single Mode Optical Fiber Pigtail Connector Assemblies
- E. Outlet Housing Components (faceplates etc.)
- F. Optical Fiber Couplers at workstation outlet locations

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for horizontal workstation cable termination components and outlet housing component. Includes wall-mount, floor-mount, and ceiling-mount components to support the various workstation outlets throughout the cabling plant.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 COPPER F/UTP CONNECTORS

- A. Manufacturer List:
 - 1. Ortronics Category- 6A UTP Connectors
 - 2. Siemon Category- 6A UTP Connectors
 - 3. Belden Category- 6A UTP Connectors
- B. Description:
 - 1. All UTP connectors shall be rated to perform at or above current ANSI/TIA-568-C performance parameters of the UTP cabling it is terminating within the communications system.
 - 2. All UTP connectors shall have an eight (8) Position, eight (8)-Contact (8P8C) module that accepts 8P8C plugs.
 - 3. When utilized as part of a channel or permanent link, all high performance modular connectors shall match the horizontal cable performance transmission requirements before and after installation as specified in ANSI/TIA-568-C Commercial Building Telecommunications Cabling Standard (horizontal cable section) in all noted performance parameters.
- C. Accessory Products:
 - 1. Provide any accessory products related to the UTP connectors required to provide a complete and functional infrastructure system.

2.3 INDOOR MULTIMODE OPTICAL FIBER CONNECTORS (FIELD TERMINATION TYPE)

- A. Manufacturer List:
 - 1. Corning
 - 2. Ortronics
 - 3. Belden
- B. Description:
 - 1. All indoor multimode optical fiber connectors shall be LC-type connectors, rated and approved by the manufacturer to perform at the level designated by the optical fiber strands being terminated.
 - 2. The connector shall be field installable type.
 - 3. Connector shall have a fiber stub in the ceramic connector ferrule that is bonded in the ferrule micro-hole, the connector shall not require end face polishing in the field, and the end tip shall be Ultra Physical Contact (UPC) type.
 - 4. The connector crimp-on mechanism shall protect the bare fiber from the ingress of air or waterborne contaminants.
 - 5. When tested in accordance with FOTP-171, the connector shall be consistently capable of insertion losses ≤ 0.1 dB (typical) and shall be ≤ 0.5 dB (maximum) when installed in accordance with the manufacturers recommended procedure.
- C. Accessory Products:
 - 1. Provide any accessory products and tool kits related to the termination of the optical fiber connectors to provide a complete and functional infrastructure system.

2.4 OUTDOOR MULTIMODE OPTICAL FIBER CONNECTORS (FIELD TERMINATION TYPE)

- A. Manufacturer List:
 - 1. Corning
 - 2. Ortronics
 - 3. Belden
- B. Description:
 - 1. All outdoor multimode optical fiber connectors shall be ST-type connectors, rated and approved by the manufacturer to perform at the level designated by the optical fiber strands being terminated.
 - 2. The connector shall be field installable.
 - 3. Connector shall have a fiber stub in the ceramic connector ferrule that is bonded in the ferrule micro-hole, the connector shall not require end face polishing in the field, and the end tip shall be Ultra Physical Contact (UPC) type.
 - 4. The connector crimp-on mechanism shall protect the bare fiber from the ingress of air or waterborne contaminants.

- 5. When tested in accordance with FOTP-171, the connector shall be consistently capable of insertion losses ≤ 0.1 dB (typical) and shall be ≤ 0.5 dB (maximum) when installed in accordance with the manufacturers recommended procedure.
- C. Accessory Products:
 - 1. Provide any accessory products and tool kits related to the termination of the optical fiber connectors to provide a complete and functional infrastructure system.

2.5 SINGLE MODE OPTICAL FIBER PIGTAIL CONNECTOR ASSEMBLIES

- A. Manufacturer List:
 - 1. Corning
 - 2. Ortronics
 - 3. Belden
- B. Description:
 - 1. Single-mode Optical fiber pigtail connector assemblies housed in manufacturers connector panels.
 - 2. Duplex LC style connectors.
 - 3. Maximum insertion loss across mated pair shall be less than 0.3 dB, tested per FOTP-171 Method A. Typical Insertion loss should be maximum of 0.15 dB.
 - 4. Minimum return loss shall be less than 60.5 dB, tested per FOTP-171. Typical return loss should be 60 dB.
 - 5. Pigtails shall have minimum 2 meters of attached cordage.
 - 6. Pigtails shall be assembled and tested by the connector manufacturer.
- C. Accessory Products:
 - 1. Provide any accessory products and tool kits related to the termination of the optical fiber connectors to provide a complete and functional infrastructure system.

2.6 SINGLE MODE OPTICAL FIBER FUSION SPLICE-ON CONNECTOR ASSEMBLIES

- A. Manufacturer List:
 - 1. Corning
 - 2. Ortronics
 - 3. Belden
- B. Description:
 - 1. Single-mode optical fiber fusion splice-on connector assemblies.
 - 2. Duplex LC style connectors.
 - 3. Maximum insertion loss across mated pair shall be less than 0.3 dB, tested per FOTP-171 Method A. Typical Insertion loss should be maximum of 0.15 dB.

- 4. Minimum return loss shall be less than 60.5 dB, tested per FOTP-171. Typical return loss should be 60 dB.
- C. Accessory Products:
 - 1. Provide any accessory products and tool kits related to the termination of the optical fiber connectors to provide a complete and functional infrastructure system.

2.7 OUTLET HOUSING COMPONENTS

- A. Manufacturer List:
 - 1. Ortronics
 - 2. Siemon
 - 3. Belden
- B. Description:
 - 1. All outlet housings at the various technology outlet locations shall provide the designated number modular insert ports as indicated in the TC-series drawings.
 - 2. All flush-mounted faceplates shall be provided per the port configuration as shown on the telecom drawings.
 - 3. Faceplates for wall-mounted phones shall be one (1) port single gang faceplates that have wall-mount lugs allowing vertical phone mounting.
 - 4. Faceplates for flush floor mounted outlets shall be coordinated with the floor box or poke thru device that will be selected and installed outside the scope of this section.
 - 5. System furniture faceplates shall be capable of fitting in the furniture system selected by Owners Representative. Furniture faceplates shall be provided per the port configurations shown on the telecom drawings. Furniture faceplate extenders shall be used (if required) to maintain proper bend radii within the furniture raceway/pathway.
 - 6. Surface mounted boxes shall be capable of the quantity of outlet jack requirements at each outlet locations indicted in the TC-series drawings.
 - 7. All outlet-housings shall provide a clear ANSI/TIA-606-B labeling location for both the individual outlet port and the entire outlet housing location, unless otherwise indicated in the project drawings.
- C. Accessory Products:
 - 1. Provide any accessory products related to the workstation outlet housing components required to provide a complete and functional infrastructure system.

2.8 OPTICAL FIBER COUPLERS AT WORKSTATION OUTLET LOCATIONS

- A. Manufacturer List:
 - 1. Ortronics
 - 2. Siemon
 - 3. Belden

- B. Description:
 - 1. The optical fiber couplers shall be LC-style small form factor and manufactured by the same manufacturer of the workstation outlet housing.
 - 2. Ensure coupler size and type is compatible with the specified optical fiber cable and outlet housing at each outlet location.
 - 3. Provide angled type couplers.
 - 4. Optical fiber couplers shall not limit the functionality or performance of the optical fiber cables or connectors when installed at each outlet location.
- C. Accessory Products:
 - 1. Provide any accessory products related to the workstation outlet optical fiber termination connectors and coupler components required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 COPPER F/UTP CONNECTORS

- A. Process:
 - 1. Install all connectors per ANSI/TIA-568-C standards, BICSI Best Practices, and manufacturer instructions.
 - 2. The installation and performance parameters of all installed couplers and connectors shall be verified by the trade Design Builder through ANSI/TIA-568-C testing procedures.

3.3 OUTLET HOUSINGS

A. Process:

- 1. Color of all outlet housing components shall be coordinated with Owners Representative before purchase and installation.
- 2. All technology outlets located on walls shall be flush mounted, level and plumb.
- 3. All technology outlets shall be mounted at right angles and parallel to the floor, unless installation requirements or design dictate otherwise.
- 4. Install blank inserts in outlet housing spaces that are not being filled with cable termination modules. Blank inserts shall match the workstation housing color, unless otherwise indicated in the TC-series drawings.

- 5. All outlets located in systems furniture may be served from a wall adjacent to the furniture cluster or a floor box. If the cable is exposed prior to entering furniture raceway, install spiral wrap tubing to protect the cable per the manufacturer's recommendations.
- 6. All outlet housings as well as each individual utilized port must be labeled in accordance with Owners Representative -approved labeling scheme.

3.4 OPTICAL FIBER CONNECTORS AND COUPLERS

A. Process:

- 1. Install all couplers per ANSI/TIA-568-C standards, BICSI Best Practices, and manufacturer instructions.
- 2. The installation and performance parameters of all installed couplers and connectors shall be verified by the trade Design Builder through ANSI/TIA-526 testing procedures.

3.5 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.6 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

END OF SECTION

SECTION 271619 - COMMUNICATION PATCH CORDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

- A. Copper FTP Patch Cords
- B. Optical Fiber Jumpers

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 Communications General Requirements for list of Reference Standards, Codes, and Documents. PART 1.3
 - 1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for optical fiber jumpers and copper patch cords.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications General Requirements. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications General Requirements. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

- A. Refer to Section 27 00 00 Communications General Requirements. PART 1.7 1.8
 - 1. No Substitution without pre-approval

2.2 COPPER FTP PATCH CORDS

- A. Manufacturer List:
 - 1. Belden
 - 2. Ortronics/Superior Essex
 - 3. Siemon
 - 4. Commscope
- B. Description:
 - 1. CAT6A UTP Copper patch cords for equipment patching: Modular 8P8C male plug connector's equipped with (8) eight gold anodized pins shall be factory terminated at each end of the patch cord. Modular plugs shall be snag free in design or utilize a molded plastic boot to cover the modular plug tab.
 - 2. All copper UTP patch cords shall have stranded conductors that match the ANSI/TIA-568-C performance characteristics of the Category-6A cable specified and installed.
 - 3. All copper patch cord lengths for patching inside the telecom rooms are to be provided appropriate to patching from network equipment ports to the copper patch panels ports within the MDF and IDF.
- C. Accessory Products:
 - 1. Provide any accessory products related to the optical fiber cabling required to provide a complete and functional infrastructure system.

2.3 OPTICAL FIBER JUMPERS

- A. Manufacturer List:
 - 1. Corning Cable Systems
 - 2. Belden
 - 3. Ortronics/Superior Essex
 - 4. Siemon

- B. Description:
 - 1. All optical fiber jumpers shall conform to the requirements of the ANSI/TIA-568-C standard performance parameters for the multimode or single-mode optical fiber specified and installed, and shall have the same manufacturer, cable type, connector and polish as noted for the backbone/horizontal fiber.
 - 2. MDF / IDF optical fiber jumper lengths shall be provided appropriate to patching from network equipment ports to the Fiber Distribution Unit (FDU) ports within the MDF and IDF(s).
 - 3. Workstation optical fiber jumpers lengths shall be provided appropriate to patching from the workstation outlet to the station computer or other IP end device Network Interface Card (NIC).
 - 4. It is the responsibility of the Design Builder to verify lengths and counts of optical fiber patch cords with Owners Representative prior to purchase.
 - 5. All 50 µm OM4 LOMMF jumper colors are to be industry standard Aqua and provided in a duplex configuration.
 - 6. All single-mode jumper colors are to be industry standard yellow and provided in a duplex configuration.
 - 7. Any optical fiber jumper purchased without written authorization by Owners Representative are purchased at the Design Builder's own risk.
- C. Accessory Products:
 - 1. Provide any accessory products related to the optical fiber cabling required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 PATCH CORDS

- A. Install all horizontal cable per the manufacturers' instructions and per all ANSI/TIA-568-C standards, and BICSI best practices.
 - 1. CAT6A UTP Equipment cords:
 - a. Provide (2) copper patch cords (one for each end of the cable termination) for every CAT6A UTP cable installed.
 - b. CAT6A UTP Zone Patch Cords: The corresponding number of zone patch cord cables for every copper CAT6A UTP station cable installed in floor mounted outlet that needs to be connected with a zone patch cord to a table surface mounted monument. See architectural and AV documents for locations.

- 2. Fiber Optic jumpers:
 - a. Provide (2) Fiber Optic Jumpers (one for each end of the cable termination) for every horizontal fiber installed.
 - b. Provide (X) 10-foot LOMMF jumpers and (X) 10-foot SMF jumpers for every IDF room.
 - c. Provide (X) 10-foot LOMMF jumpers and (X) 10-foot SMF jumpers for the MDF room.
- B. Provide unit pricing for one (1) each of the following patch cords:
 - 1. Three-foot (3') copper UTP Category-6A;
 - 2. Five-foot (5') copper UTP Category-6A;
 - 3. Seven-foot (7') copper UTP Category-6A;
 - 4. Three meter (3m) Singlemode duplex
 - a. LC to LC
 - b.
 - 5. Five meter (5m) Singlemode duplex a. LC to LC
 - b.
 - 6. Seven meter (7m) Singlemode duplex a. LC to LC
 - b.
 - 7. Three meter (3m) OM4 LOMMF duplex
 - a. LC to LC
 - b. SC to LC
 - c. ST to LC
 - 8. Five meter (5m) OM4 LOMMF duplex
 - a. LC to LC
 - b. SC to LC
 - c. ST to LC
 - 9. Seven meter (7m) OM4 LOMMF duplex
 - a. LC to LC
 - b. SC to LC
 - c. ST to LC
- C. Provide new, sealed patch cords in lengths, colors and counts approved in writing by Owners Representative.

3.3 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components.

B. Scheduling for re-installation work shall be coordinated in writing with Owners Representative prior to beginning the work.

3.4 CLOSEOUT ACTIVITIES

- A. Design Builder shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.
- B. Design Builder to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

END OF SECTION

SECTION 274116 INTEGRATED AUDIO VISUAL SYSTEMS AND EQUIPMENT

1. GENERAL

1.1 SUMMARY

- A. System Summary
 - 1. The audiovisual systems within this project are intended to provide the audiovisual capabilities required for effective communication located in spaces planned within the Long-Term Care, Domiciliary and Nielson buildings.
 - 2. The systems include the following.
 - a. Paging and BGM (Background Music) system
 - b. IPTV/Hospitality TV
 - 1) Resident Room TVs
 - 2) Household TVs
 - 3) Digital Signage
 - 4) IPTV for AV-enabled spaces
 - c. Chapel
 - d. Theater
 - e. Classroom & Multi-Purpose Room, Typical
 - f. Pub
 - g. Restorative Space, Typical
 - h. Main Dining Room
 - i. Fitness Room
 - j. Staff Lounge (Neilson Bldg only)
 - 3. Audiovisual equipment shall be housed in vertical equipment cabinet within the local proximity IT IDF or Main Server room, unless local room space includes dedicated AV equipment closet or cabinet.

1.2 SYSTEM DESCRIPTION

- A. Paging and BGM
 - 1. The paging system shall use a series of independent zones to allow flexibility in paging scanners. A separate zone in the "plaza area" will be required for special events.
 - 2. Multiple types of loudspeakers products shall be used. Refer to plans for locations and types. Loudspeaker types must provide uniform coverage in corridors, public restrooms, staff areas, meeting spaces, amenities spaces, resident household dining, resident household corridors and theater.
 - 3. Paging system shall include audio digital signal processor, capable of custom software configuration to support flexible zoning of paging, VoIP interfacing, background music

sources, priority of paging over background music sources, contact closure tie to building fire alarm system and system equalization and limiting.

- 4. The system shall be able to route a BGM source to any or all zones and shall be configured to do so via the head end software configuration.
- 5. Connections to the speakers shall use mixture of typical loudspeaker cabling and standard category cabling collocated with the IT cable in the IT cable tray.
- 6. One paging station shall be provided, located at each building entrance lobby information desk, with paging zoning possible to:
 - a. Common corridor zones only (no paging within resident households).
 - b. Emergency only condition, to all Zones.
 - c. Other specific zones, as directed by the Owner.
- 7. Support for use of VoIP telephones for making pages via VoIP interface to Paging system digital signal processor. Coordinate VoIP phone numbers with Owner's IT administrator. Support of a minimum of 4 VoIP lines.
- 8. Computer running the paging management software.
 - a. Management software shall be used to schedule music, paging, adjust grouping of zones.
- 9. Paging system is not intended as the primary means of mass notification during an emergency event, however under NFPA 72, the Owner may request permission from the local Authority Having Jurisdiction to authorize using the Paging system as alternate to fire visual/speaker devices. Should this condition be authorized, then the design and features of the Paging must meet voice notification system conditions listed under NFPA 72.
- 10. Paging system shall include wired contact closure tie to the fire alarm system. Contact closure shall support automated emergency muting of background music, however, should the Owner direct, the system shall also support emergency paging during fire alarm event in support of mass notification.
- 11. Paging Zones located within resident Households shall not be used for daily paging, but rather will be only used as backup solution in event of emergency, and should other means of staff-to-staff or staff-to-residents communication systems have failed.
- B. IPTV/Hospitality TV
 - 1. Currently, the Owner's campus of buildings and residents are supported by a coaxial CATV service provider.
 - 2. For this project, for new and renovated buildings, the Owner has directed an IPTV-Hospitality TV solution. This IPTV solution will support resident room TVs, resident common area TVs, digital signage TVs and all amenities TVs (Pub, Hair salon, etc.) and AV-enabled spaces e.g. Theater and meeting rooms.
 - 3. The TV channel content source can be coaxial CATV service provider or Internet Service Provider.

- 4. Provide IPTV processor headend, capable of custom software configuration and input of both CATV service provider input of TV channel content, as well as input of local Owner content channels supporting hospitality features and also digital signage features.
- 5. Provide one IT-networked digital signage media player for each Digital Signage display (see plan drawings for locations). Media player must support Owner updates, content slides creation and schedule via owner-accessible online application. Media player output shall be input source to the IPTV system, from within the main IT Server room).
- 6. Provide all IT network Category 6 (or better) cabling in support of IPTV, RJ45 wall plate terminations behind the TV location, Category 6 patch cords, and RJ45 patch bay mounted within IT equipment cabinets (coordinated with Owner IT administrator).within local IT IDF Room.
- 7. For each resident room, provide one hospitality-type TV capable of supporting IPTV. Image size 42" diagonal, minimum 1080p resolution, with integral stereo loudspeakers, smart TV capability, IT ethernet port, and spare HDMI input for local resident source, USB input and integral software player for resident USB storage device, and with IR remote control and wall mount bracket assembly.
- 8. For each Household den and living room provide the following audiovisual system solution supporting the following:
 - a) Provide one AV system switcher, capable of supporting remote control via RS232 or Ethernet, a least four HDMI 1.4/2.x inputs, with stereo audio de-embed of video inputs. Inputs support IPTV Tuner, PC NUC for software conferencing, Blueray DVD and Auxiliary user HDMI source.
 - b) Provide software-configured button controller supporting selection of video system inputs, volume control, TV channel selection and Blueray DVD player functions.
 - c) Provide large-screen TV with HDMI inputs, Image size 70" diagonal minimum, minimum 1080p resolution, smart TV capability, IT ethernet port, and two spare HDMI inputs for local resident sources, USB input and integral software player for resident USB storage device, and with IR remote control wall mount bracket assembly.
 - d) The den and living room TVs are also intended to support remote software-based video/audio conferencing for use by residents, as managed by the Staff Also include A/V soundbar which includes integral stereo loudspeakers, integral web conferencing video camera, integral digital microphone array and USB3.0 connection to Owner-provided PC NUC computer with software conferencing application (e.g. WebEx, Skype, etc.). PC NUC should include wireless keyboard and mouse.
 - e) Provide one Bluray DVD player.
 - f) Provide one IPTV Tuner
 - g) Provide assistive listening system, with IR emitter and eight IR receivers with inductive neckloops and stereo muff headphones.
 - h) Provide AV equipment cabinet, located within associated furniture credenza. All user system controls must be accessible from front of AV equipment cabinet. Cabinet should include AC power line/surge protection conditioning and AC power distribution.
- 9. For each Household dining room and for all Digital Signage locations, provide one hospitality-type TV capable of supporting IPTV. Image size 55" diagonal minimum,

minimum 1080p resolution, smart TV capability, IT ethernet port, and spare HDMI input for local resident source, USB input and integral software player for resident USB storage device, and with IR remote control wall mount bracket assembly.

For Digital Signage, coordinate orientation of TV as portrait or landscape orientation. Assume landscape orientation, unless otherwise directed by Owner. Owner must consider orientation of produced content on digital signage media players.

10. For each household and common barber/beauty salon, provide one hospitality-type TV capable of supporting IPTV. Image size 42" diagonal, minimum 1080p resolution, with integral stereo loudspeakers, smart TV capability, IT ethernet port, and spare HDMI input for local resident source, USB input and integral software player for local USB storage device, and with IR remote control and wall mount bracket assembly.

Coordinate location of TV and IPTV wall plate drop within the barber/beauty salon with Owner and Architect.

- 11. Provide IPTV tuner for the Theater and each/all meeting spaces with integrated AV systems. Coordinate with the Owner and AV Design-Builder.
- 12. Coordinate providing electrical receptacle supporting each IPTV location with Division 27 Electrical.
- C. Chapel
 - 1. Provide AV equipment cabinet, located within associated Storage Room. All user system controls must be accessible from front of AV equipment cabinet. Cabinet should include AC power line/surge protection conditioning and AC power distribution.
 - 2. Provide voice and music audio mixing, processing and amplification system. System must include sufficient inputs in support of at least two wireless microphones, two wired microphones and two stereo line-level audio inputs. A mixer/amplifier with local system equalization is acceptable. System must also support both amplified (distributed loudspeakers) and assistive listening.
 - 3. Provide two wireless microphones, each with headworn microphone transmitters.
 - 4. Provide assistive listening system, with IR emitter transmitter and eight IR receivers, each with inductive neckloops and stereo muff headphones.
 - 5. Future AV connectivity is shown on AV drawings in support of AV camera live streaming application. Coordinate with Owner, if this application is required.
 - 6. Future AV connectivity is shown on AV drawings in support of portable large video displays on carts for display of content during services. Content would originate from portable mobile or laptop computer device with HDMI output.
- D. Theater

- 1. Provide AV equipment cabinet, located within Theater. All user system controls must be accessible from front of AV equipment cabinet. Cabinet should include AC power line/surge protection conditioning and AC power distribution.
- 2. Provide AV Surround Sound Receiver, pro-consumer-grade, with multiple HDMI inputs, integral multi-channel simulated and actual surround sound processing, with HDMI video output, auxiliary analog audio output in support of assistive listening system, integral 5.1 (or 7.1) surround sound audio amplifiers. Receiver must support at least four HDMI 1.4/2.x inputs, with integral stereo and surroound audio de-embed of video inputs. Inputs support IPTV Tuner, Auxiliary Gaming device input, Blueray DVD and Auxiliary user HDMI source.
- 3. Provide assistive listening system, with IR emitter transmitter and eight IR receivers, each with inductive neckloops and stereo muff headphones.
- 4. Provide one Bluray DVD player.
- 5. Provide one IPTV Tuner
- E. Classrooms & Multi-Purpose Rooms, Typical
 - 1. For each Classroom provide the following audiovisual system solution supporting the following:
 - a. Provide one AV system presentation switcher, capable of supporting remote control via RS232 or Ethernet, with mix of at least eight HDMI 1.4/2.x and/or HDBaseT inputs and mix of HDMI and/or HDBaseT outputs. AV system presentation matrix switcher shall also include integral stereo and mono audio mixer/audio DSP with integral stereo audio deembed of video inputs. Inputs support Portable Lectern AV source (via HDBaseT), wireless video sharing receiver, IPTV Tuner, PC NUC for software conferencing, Blueray DVD and Auxiliary user HDMI source. Outputs will support local video image projection, IPTV encoder and audio feed to local distributed ceiling loudspeakers.
 - b. Provide all required HDBaseT signal extender transmitters for lectern floor box and HDBaseT scaling receiver for video projector. Extend RS232 remote control via HDBaseT extender.
 - b. Provide software-configured button controller supporting selection of video system inputs, volume control, TV channel selection and Blueray DVD player functions.
 - c. Provide large-screen TV with HDMI inputs, Image size 84" diagonal minimum, minimum 1080p resolution, smart TV capability, IT ethernet port, and two spare HDMI inputs for local resident sources, USB input and integral software player for resident USB storage device, and with IR remote control wall mount bracket assembly.
 - d. Support remote software-based video/audio conferencing for use by residents, as managed by the Staff Also include A/V soundbar which includes integral stereo loudspeakers, integral web conferencing video camera, integral digital microphone array and USB3.0 connection to Owner-provided PC NUC computer with software conferencing application (e.g. WebEx, Skype, etc.). PC NUC should include wireless keyboard and mouse.
 - e. Provide one Bluray DVD player.
 - f. Provide one IPTV Tuner
 - g. Provide one wireless video sharing receiver
 - h. Provide assistive listening system, with IR emitter and eight IR receivers with inductive neckloops and stereo muff headphones.

- i. Provide AV equipment cabinet, located within associated furniture credenza. All user system controls must be accessible from front of AV equipment cabinet. Cabinet should include AC power line/surge protection conditioning and AC power distribution.
- F. Pub
 - 1. The Pub is intended a multi-zone, multi-purpose environment. The Pub zones are divided into two Pub/Bar zones, one interior dining/meeting/social space and the exterior patio.
 - 2. Provide one AV system matrix switcher, capable of supporting remote control via RS232 or Ethernet, a least eight input HDMI 1.4/2.x inputs and eight HDBaseT outputs, with stereo audio de-embed of video inputs. Inputs support four IPTV Tuners, HDBaseT wall plate HDMI source from the interior dining/meeting/social space. Outputs include four TVs in the Pub, and two TVs in the interior dining/meeting/social space.
 - 3. Stereo audio outputs from the four six video displays should be summed to mono and then feed an audio digital signal processor for volume control and zone routing. Processor should also support local inputs for microphone and line-level stereo audio sources from the interior dining/meeting/social space and the exterior patio.
 - 4. For the interior dining/meeting/social space and the exterior patio (within weather proof wall box) provide one two-microphone plus stereo audio input wall plate supporting live musician and other events.
 - 5. Provide software-configured touch screen controller supporting selection of video system inputs and outputs, volume control for each zone, TV channel selection.
 - 6. Within the pub, provide total of four (two each side) large-screen TV with HDMI inputs, Image size 55" diagonal minimum, minimum 1080p resolution, smart TV capability, IT ethernet port, and two spare HDMI inputs for local resident sources, USB input and integral software player for resident USB storage device, and with IR remote control wall mount bracket assembly.
 - 7. Within the interior dining/meeting/social space provide total of two large-screen TV with HDMI inputs, Image size 55" diagonal minimum, minimum 1080p resolution, smart TV capability, IT ethernet port, and two spare HDMI inputs for local resident sources, USB input and integral software player for resident USB storage device, and with IR remote control wall mount bracket assembly.
 - 8. Exterior patio should include two weather-resistant loudspeakers.
 - 9. Provide four IPTV Tuners on rack mounted shelves.
 - 10. For the interior dining/meeting/social space, provide assistive listening system, with IR emitter and eight IR receivers with inductive neckloops and stereo muff headphones.
 - 11. Provide AV equipment cabinet, located within the Pantry. All user system controls must be accessible from front of AV equipment cabinet. Cabinet should include AC power line/surge protection conditioning and AC power distribution.
- G. Restorative Space, Typical
 - 1. Provide AV equipment cabinet, castered, located within Restorative space. All user system controls must be accessible from front of AV equipment cabinet. Cabinet should include AC power line/surge protection conditioning and AC power distribution.
 - 2. Provide voice and music audio mixing, processing and amplification system. System must include sufficient inputs in support of at least one wireless microphone, and one stereo line-level audio inputs. A mixer/amplifier with local system equalization is acceptable. System must also support both amplified (distributed loudspeakers) and assistive listening.

- 3. Provide one wireless microphones, each with headworn microphone transmitters.
- 4. Provide assistive listening system, with IR emitter transmitter and eight IR receivers, each with inductive neckloops and stereo muff headphones.
- 5. Future AV connectivity is shown on AV drawings in support of portable large video displays on carts for display of content during services. Content would originate from portable mobile or laptop computer device with HDMI output.
- H. Main Dining Hall
 - 1. During typical use as the Main Dining Hall, audiovisual technologies will be limited to include Background music & Paging and distributed Digital Signage TVs and with distributed loudspeakers.
 - 2. Periodically, the Main Dining Room will also support special events and social functions. Presentation of video content will be supported with ceiling mounted video projector and motorized projection screen. A portable lectern will be supported by an AV/IT/Electrical floor box e.g. Wiremold RFB9, with AV connectivity for video, audio and control. Voice amplification of wireless and wired microphones is also required.
 - 3. Provide one AV system presentation matrix switcher, capable of supporting remote control via RS232 or Ethernet, with mix of at least eight HDMI 1.4/2.x and/or HDBaseT inputs and mix of HDMI and/or HDBaseT outputs. AV system presentation matrix switcher shall also include integral stereo and mono audio mixer/audio DSP with integral stereo audio de-embed of video inputs. Inputs support Portable Lectern AV source (via HDBaseT), wireless video sharing receiver, IPTV Tuner, PC NUC for software conferencing, Blueray DVD and Auxiliary user HDMI source. Outputs will support local video image projection, IPTV encoder and audio feed to local distributed ceiling loudspeakers.
 - 4. Provide all required HDBaseT signal extender transmitters for lectern floor box and HDBaseT scaling receiver for video projector. Extend RS232 remote control via HDBaseT extender.
 - 5. Provide software-configured touch panel controller, located recessed in wall within the Main Dining Room and software-configured remote control processor supporting selection of video system inputs, volume control, motorized projection screen raise-lower-stop functions, video projection power on, power off and mute functions, IPTV channel selection and Bluray DVD player functions.
 - 6. Within the dining/meeting/social space provide total of two large-screen TV with HDMI inputs, Image size 55" diagonal minimum, minimum 1080p resolution, smart TV capability, IT ethernet port, and two spare HDMI inputs for local resident sources, USB input and integral software player for resident USB storage device, and with IR remote control wall mount bracket assembly. These local TVs will also be controlled by the local AV control system for automated IPTV channel selection and explicit power on and power off.
 - 7. Provide motorized projection screen, tab-tensioned, 16:9 aspect ratio, high contrast gray fabric, 100" diagonal image size. Including optional low voltage control interface supporting RS232, and with local low-voltage wall push-button controller. Including conduit path from projection screen low voltage controlled to AV equipment cabinet location. Remotely controlled by AV control system.

- 8. Provide one pendant hung video projector, with HDMI 1.4/2.x inputs, minimum 1080p resolution, minimum 5000 ANSI lumen brightness, Laser lamp, IT ethernet and RS232 ports, with IR remote control, with pendant hung structural mounting assembly.
- 9. Owner IT will provide PC to support remote software-based video/audio conferencing for use during presentations, as managed by the Staff. PC computer with software conferencing application (e.g. WebEx, Skype, etc.). PC should include wireless keyboard and mouse.
- 10. Provide one wide-angle conferencing video camera, with integral audio microphone with ambient noise cancelling capability, extend via USB extender to PC NUC, mounted at approximately 96" above finished floor facing presenter and projected image.
- 11. Provide AV USB bridging interface for sharing presented video+audio content with remote participants and also for send and receive audio with local Audio DSP.
- 12. Provide one wireless video sharing receiver.
- 13. Provide one Bluray DVD player, rack mounted in AV equipment cabinet, remote controlled.
- 14. Provide one IPTV Tuner, rack mounted in AV equipment cabinet, remote controlled.
- 15. Provide assistive listening system, with IR emitter and eight IR receivers with inductive neck loops and stereo muff headphones.
- 16. Provide AV equipment cabinet, located within AV equipment closet. Cabinet should include AC power line/surge protection conditioning and AC power distribution.
- I. Fitness Room(s)
 - 1. The Fitness Center will include two IPTVs, stereo recessed ceiling loudspeakers, one wall Bluetooth + 3.5mm analog stereo audio wall plate receiver, audio mixer/amp and simple button controller.
 - 2. Provide one stereo audio mixer/amp, with analog stereo line level input and 50Wx2 stereo output.
 - 3. Provide software-configured button remote controller supporting volume control functions.
 - 4. Provide total of two large-screen TV with HDMI inputs, Image size 55" diagonal minimum, minimum 1080p resolution, smart TV capability, IT ethernet port, and two spare HDMI inputs for local resident sources, USB input and integral software player for resident USB storage device, and with IR remote control wall mount bracket assembly.
 - 5. AV equipment shall be mounted in same AV equipment cabinet as Main Dining Room. All user system controls must be accessible from front of AV equipment cabinet. Cabinet should include AC power line/surge protection conditioning and AC power distribution.
- J. Staff Lounge (Neilson Bldg)
 - 1. Provide one AV system presentation switcher, capable of supporting remote control via RS232 or Ethernet, with mix of at least eight HDMI 1.4/2.x and/or HDBaseT inputs and mix of HDMI and/or HDBaseT outputs. AV system presentation matrix switcher shall also include integral stereo and mono audio mixer/audio DSP with integral stereo audio de-embed of video inputs. Inputs support wall plate AV source (via HDBaseT), wireless video sharing receiver, IPTV Tuner, PC NUC for software conferencing, Blueray DVD and Auxiliary user HDMI source. Outputs will support local video image displays, and audio feed to local distributed ceiling loudspeakers.
 - 2. Provide all required HDBaseT signal extender transmitters for lectern floor box and HDBaseT scaling receiver for each video display. Extend RS232 remote control via HDBaseT extender.

- 3. Provide software-configured button controller supporting selection of video system inputs, volume control, TV channel selection and Blueray DVD player functions.
- 4. Provide two large-screen TV with HDMI inputs, Image size 55" diagonal minimum, minimum 1080p resolution, smart TV capability, IT ethernet port, and two spare HDMI inputs for local resident sources, USB input and integral software player for resident USB storage device, and with IR remote control wall mount bracket assembly.
- 5. Support remote software-based video/audio conferencing for use by residents, as managed by the Staff Also include A/V soundbar which includes integral stereo loudspeakers, integral web conferencing video camera, integral digital microphone array and USB3.0 connection to Owner-provided PC NUC computer with software conferencing application (e.g. WebEx, Skype, etc.). PC NUC should include wireless keyboard and mouse.
- 6. Provide one Bluray DVD player.
- 7. Provide two IPTV Tuners
- 8. Provide one wireless video sharing receiver
- 9. Provide software-configured touch panel controller, located recessed in wall within the Staff Lounge and software-configured remote control processor supporting selection of video system inputs, volume control, video display power on, power off and mute functions, IPTV channel selection and Bluray DVD player functions.
- 10. Provide assistive listening system, with IR emitter and eight IR receivers with inductive neckloops and stereo muff headphones.
- 11. Provide AV equipment cabinet. Cabinet should include AC power line/surge protection conditioning and AC power distribution.

1.3 RELATED WORK

- A. Provide in accordance with Section 26 05 00 Common Work Results for Electrical
- B. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems

1.4 CONDITIONS AND REQUIREMENTS

A. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems

1.5 STANDARDS

A. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems

1.6 DEFINITIONS

A. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems

1.7 SUBMITTALS

- A. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual System
 - 1. Provide product data for:
 - a. Visual display equipment
 - 1) Displays
 - 2) Projectors
 - 3) Display Mounts
 - 4) AVoIP encoders and Decoders
 - b. Audio Equipment
 - 1) Loudspeakers
 - 2) Control Panels
 - 3) Audio Amplifiers
 - 4) Audio Mixers and processors
 - 5) Signal conversion and transmission
 - a) DVI/HDMI and UTP Category cable converters
 - b) All cable types required for video signal transmission
 - 6) Safety certifications (UL, TUV, CE etc.)
 - 7) Paging System processing and head end
 - 8) Paging system admin phones and software
 - c. Miscellaneous
 - 1) Equipment Racks and accessories
 - 2) Wall plates & Floor Boxes
 - a) Jack and outlet configuration
 - b) Materials
 - c) Finishes [for selection by Architect].
 - d) Dimensions
 - 3) Safety certifications (UL, TUV, CE etc.)
 - 4) Control panels and processors
- B. Drawings & Documentation
 - 1. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems
- C. Software Documentation
 - 1. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems.

1.8 INSTALLATION AND COMMISSIONING

A. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems

1.9 PERFORMANCE TEST

A. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems

1.10 EQUIPMENT NAMEPLATES

A. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems

1.11 QUALITY ASSURANCE

A. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems

1.12 DELIVER STORAGE AND HANDLING

A. Provide in accordance with Section 27 41 00, General Conditions and Requirements for Audiovisual Systems

2. PRODUCTS

2.1 ALL ELECTRONIC PRODUCTS

A. Shall be capable of operating continuously for 12 hours over the external ambient temperature range of $+10^{\circ}$ C to $+65^{\circ}$ C (20% to 95% humidity, non-condensing) without permanent damage.

2.2 MISCELLANEOUS

- A. A 20A rack mount power conditioner with 6 switched and 2 always on receptacles shall be located in the equipment rack
- B. Audiovisual equipment racks and cabinets. Sizes to be verified by Design-Builder based on equipment shown in drawings.
2.3 OWNER-PROVED EQUIPMENT

A. None

2.4 WIRE AND CABLE

A. Section 27 41 00 – General Conditions and Requirements of Audiovisual systems

3. EXECUTION

3.1 MOUNTING HEIGHTS

- A. Section 27 41 00 General Conditions and Requirements of Audiovisual systems
- B. Coordinate locations of the following with mounting heights as indicated on drawings.
 - 1. Technical wall plates
 - a. AV input/output connections
 - b. Flat panel display panel connections
 - c. Annotation panel connections
 - 2. Pull boxes
- C. Install all technical panels plumb.
- D. Install equipment racks in location shown on drawings
- E. Arrange for adequate ventilation and access.

3.2 CABLE SUPPORT

- A. Supporting method in accordance with Section 26 05 00
- B. Section 27 41 00 General Conditions and Requirements of Audiovisual systems
 - 1. Individual runs throughout building Support cable at 600mm on center and 100mm at any change in direction. Support from building structure. Cables on top of ceiling tiles will be rejected. Cable supported by ceiling grid support wires will be rejected.
 - 2. Cable Bundles Where multiple cable combine support at 300mm on center and 100mm at any change in direction. Support from building structure. Cables on top of ceiling tiles will be rejected. Cable supported by ceiling grid support wires will be rejected.

3.3 CABLE SEPARATION

- A. Section 27 41 00 General Conditions and Requirements of Audiovisual systems
 - 1. Cable separation of cables for runs greater than 7.5 m.
 - a. Microphone Level 300mm from all other circuits.
 - b. Line Level and Control 300 mm from any circuit with signal of 20dB or greater than Line Level and Control cables.
 - c. Speaker level circuits 300mm from other circuits.
 - d. Video and Data 300 mm from any circuit with signal of 20dB or greater than Video and Data.
 - e. AC Power Circuits 300mm from all other circuits.

3.4 RACK CABLING

- A. Section 27 41 00 General Conditions and Requirements of Audiovisual systems
 - 1. Neatly train and lace cables.
 - 2. Route Cables from components to lacing bars installed on rear rack rail.
 - 3. Provide services loops for each cable.
 - 4. Cable separation of cables for runs within Equipment rack.
 - a. Microphone Level 50mm from all other circuits.
 - b. Line Level and Control 50 mm from any circuit with signal of 20dB or greater than Line Level and Control cables.
 - c. Speaker level circuits 50mm from other circuits.
 - d. Video and Data 50 mm from any circuit with signal of 20dB or greater than Video and Data.
 - e. AC Power Circuits 50mm from all other circuits.

3.5 APPROVED WIRE TERMINATION MEANS

- A. Section 27 41 00 General Conditions and Requirements of Audiovisual systems
 - 1. Solder Connections For connectors utilizing Solder Cups
 - 2. Terminal strip Connectors For termination of blunt cut cables, cable to be tinned prior to termination
 - 3. Multi Pin connectors Utilize connector manufacturers crimper
 - 4. Crimp Cap Terminations For Loudspeaker circuits at individual devices. Distribution cable termination to utilize terminal strip connectors.

END OF SECTION 27 41 16

SECTION 275223 - NURSE CALL & WANDER MANAGEMENT

PART 1 GENERAL

1.1 SUMMARY

- A. This specification provides the minimum requirements for a supervised audio-visual Voice over IP-based (VoIP) Nurse Call System. The Nurse Call System shall include, but not be limited to all equipment, materials, labor, documentation, and services necessary to furnish and install a complete, operational VoIP-based Nurse Call System.
- B. This specification provides minimum requirements for Wander Management, including, but not limited to all equipment, materials, labor, documentation, and services required to furnish and install as complete and operational Wander Management system solution. Wander Management solution must be compatible with, and configured with Security system door access control system provided under Division 28 00 00 and with Nurse Call and Electronic Healthcare Records (EHR) solutions.
- C. This specification notes Owner-provided Electronic Healthcare Records (EHR) product solution, for purpose of ensuring that the provided Nurse Call and Wandering Management must be seamlessly integrated with the Owner's EHR solution.

1.2 DEFINITIONS

- A. Owner: The facility purchasing and taking possession of the Nurse Call and patient Wandering Management and EHR systems upon installation.
- B. Manufacturer: The company responsible for the production and design of the Nurse Call and Wandering Management systems.
- C. Vendor: The company which (re)sells the Nurse Call and Wandering Management systems to end users.
- D. Design-Builder: The company contracted to facilitate, in part or in whole, the installation of the Nurse Call and Wandering Management systems.
- E. Staff Console: A central point to monitor and respond to calls placed with the Nurse Call and Wandering Management systems. The Staff Console, also called a master station, displays incoming calls from patients and connected healthcare equipment, and provides a means for the user to prioritize, triage and/or respond to selected events.
- F. Audio Station: A device used to place and annunciate calls through the Nurse Call System. Also, a primary point of two-way communication between patients or visitors and staff or between staff. Audio Stations can be standard (no touch-screen interface) or graphical (touch screen interface).
- G. Smart Bed Connector: Provides the interface for connecting beds, pillow speakers and medical devices to the Nurse Call System.
- H. Call Switches: Initiating devices that provide the ability to call for assistance from

the patient room and allow for communication through the Nurse Call System.

- I. Corridor Lights: Also called done / zone lights, a set of configurable LED lights which provide a visual signal to indicate the status and location of various events occurring in a nursing unit.
- J. Pillow Speakers: A hand-held device used to place calls and indicated patient requests (e.g. medication or bathroom requests) through the Nurse Call System as well as control entertainment and lighting from the patient bed.
- K. Electronic Whiteboard: A real-time dashboard, typically displayed on large central monitors, displaying Nurse Call System, patient and smart bed information.
- L. Smart Bed: A hospital bed capable of sharing bed status, patient weight, patient presence, and alarm data with the Nurse Call System.
- M. Wrist Bracelet: wrist brackets in similar form to athletic training data bracelets, with integral wireless data identification of wearer's cataloged identity, with wireless frequency transmitter capable of being detected by compatible electronic proximity sensor/detectors, with integral battery capable of powering the device for 10-years.
- N. Electronic Proximity Sensor: Wall or Ceiling installed electronic device capable of detecting wireless radio transmission of Wander Management wrist brand. Cabled to either Wander Management control processor, or direct to Division-28 security access control system.
- O. Electronic Healthcare Records (EHR): online, IT cloud-based patient healthcare records system, including software application licensing, IT network electronics in support of EHR, nurse/staff accessible computer interfaces and reliable Internet service in support of EHR.
- P. EHR Kiosk: Nurse/staff accessible computer interfaces in support of electronic healthcare records application, either wall or desktop mounted, located at intersections of household corridors and nursing stations, with IT network and electrical services. Coordinate locations with Owner.
- Q. Mobile Phone: Owner-provided mobile phone device/mobile computer with touch screen, capable of cellular phone voice communications, WiFi access to local and cloud-based application servers and the Internet, and the running of healthcare application software specific to HER, Nurse Call and Wandering Management.

1.3 SUBMITTALS

- A. The Vendor will provide product data for each component, including manufacturer's specifications.
- B. The Vendor will provide drawings detailing the system including, but not limited to, the following:
- C. The Vendor shall provide a single-line block diagram showing cabling interconnection of all components for this specific system.
- D. The Vendor shall provide a CAD drawing of the floor/floors where the Nurse Call System will be installed.

- E. The Vendor will provide wiring diagrams detailing wiring for power, signal, and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
- F. The Vendor shall provide a report of field tests and observations.
- G. The Vendor will provide maintenance data for system to include in the operation and maintenance manual.
- H. The Vendor shall ensure in writing that proposed provided Nurse Call and Wandering Management solution is compatible with Owner's current electronic healthcare records system, known as PointClickShare.

1.4 QUALITY ASSURANCE

- A. The complete Nurse Call System shall be provided by a single manufacturer and obtained through the Original Equipment Manufacturer (OEM) as the single source.
- B. The complete Wandering Management System shall be provided by a single manufacturer and obtained through the Original Equipment Manufacturer (OEM) as the single source.
- C. The Manufacturer shall be a firm experienced in manufacturing, installing and maintaining Nurse Call and Wander Management Systems. The Manufacturer of the Nurse Call and the Wander Management System equipment shall be regularly involved in the design, manufacture, and distribution of all products specified in this document. These processes shall be monitored under a quality assurance program that meets ISO requirements.
- D. All equipment and components shall be the Manufacturer's most recently released model.
- E. The Manufacturer's authorized representative who is trained, certified and/or approved for managing installation shall be responsible for the satisfactory installation of the complete Nurse Call and the Wander Management System. All equipment and components shall be installed in strict compliance with the Manufacturer's recommendations.
- F. The Manufacturer's representative shall provide equipment and components, which comply with the requirements of these specifications. Equipment or components, which do not provide the performance and features required by these specifications, will not be accepted, regardless of Manufacturer.
- G. All Nurse Call and the Wandering Management system components, inclusive of staff locating, shall be the catalogued products of a single Supplier. All products shall be listed by the Manufacturer for their intended purpose.
- H. All Wander Management System components, inclusive of staff locating, shall be the catalogued products of a single Supplier. All products shall be listed by the Manufacturer for their intended purpose.
- I. The manufacturer shall maintain technical support services capable of providing users of the system with training, parts, and emergency maintenance and repair both

on site and remotely.

- J. All connected nurse call components shall be tested to ensure that a fully functioning system is designed and installed.
- K. The VoIP-based Nurse Call and the Wander Management System shall utilize Ethernet topology, switches, and devices. These devices shall make up a UL 1069 Listed nurse call LAN/WAN (Local Area Network/Wide Area Network).
- L. The system solution should conform to FDA Class II exempt medical device standards.
- M. The system solution shall support compliance with HIPPA requirements for sharing and displaying patient information.
- N. The system solution must conform to applicable codes, rules, regulations, and laws of the hospital authority and local jurisdiction for hospital nurse call systems. Manufacturer will provide proof of certification for regulatory compliance from issuing authority.
- O. The system solution, inclusive of electrical components, infrastructure components, devices and accessories, shall comply in all respects and shall be labeled in accordance with the requirements of the specifications, manufacturer's recommendations and Underwriters Laboratories Inc. (UL) 1069 Standard for Hospital Signaling and Nurse Call Equipment.
- P. All required Security access control and visual monitoring in support of Nurse Call and Wandering Management shall be coordinated with and provided by Division 28- Electronic Safety and Security.
- Q. All components used must be RoHS (Reduction of Hazardous Substances) compliant.
- R. Provided product system solution must be seamlessly integrated with, and compatible with Owner's current online Electronic Healthcare Records application product known as PointClickShare.

1.5 MANUFACTURER

- A. For purposes of the Design-Build bridging documents, the Basis of Design is based on the Hill-Rom Voalte product series, however other cost-effective proposed product solutions meeting, or exceeding the minimum standards for this project will be considered for approval by the Owner.
- B. For purposes of the Design-Build bridging documents, the Basis of Design of the Wander Management solution is based on the Accutech ResidentGuard product series, however other cost-effective proposed product solutions meeting, or exceeding the minimum standards for this project will be considered for approval by the Owner.
- C. For purposes of compatibility, provided Nurse Call and Wandering Management product system solution must be compatible with Owner's current online Electronic Healthcare Records application product known as PointClickShare.

1.6 SYSTEM DESIGN & CONFIGURATION

- A. The Nurse Call, Wander Management and EHR system kiosks shall be capable of supporting up to 2,000 Internet Protocol (IP) addressable devices (graphical audio stations, staff consoles, room control boards) across a single enterprise.
- B. IP addressable devices shall be TCP/IP (Transmission Control Protocol/Internet Protocol) based and their IP addresses should be issued via Dynamic Host Configuration Protocol (DHCP).
- C. Preset host file lookup shall be resolved using Domain Name System (DNS).
- D. The Nurse Call, Wandering Management and EHR system cabling should be of standard Ethernet topology utilizing dedicated minimum CAT6 home runs to each location.
- E. The Nurse Call System shall support fiber cable for interconnections between Power over Ethernet switches.
- F. Nurse Call System architecture shall utilize an internal power supply; not external power supplies. Any systems requiring power supplies to be installed separately from the control equipment will not be accepted.
- G. Systems requiring separate cabling for main power shall not be accepted. Separate cabling for Uninterruptible Power Supply (UPS) backup in IT Closets (Intermediate Distribution Frame or Main Distribution Frame) is permitted.
- H. A backup, battery power supply should be available in the event that the main power supply should fail.
- I. Head end equipment / controller equipment shall be standard 19" rack mountable.
- J. Servers used to support the Nurse Call System shall use a Windows Server OS and a SQL database.
- K. The Nurse Call System shall support the option to use distributed server setup.
- L. The Nurse Call System shall support the use of virtual machines in the Owner's existing data center. Any virtual machines used for the Nurse Call System shall support high availability.
- M. The Nurse Call, Wandering Management and EHR System shall support the use of LAN and WAN connections. WAN connections must meet the following latency requirements:
- N. Real Time Locating System 10 milliseconds or less, bidirectional.
- O. VoIP 100 milliseconds or less, unidirectional.
- P. It should be possible to configure the Nurse Call, Wandering Management and EHR System using a modular, flexible Graphical User Interface (GUI) application that provides the ability to:
- Q. Manage (add, delete, modify) staff assignments by unit, patient room.

- R. Assign and remove patient safety status for falls, skin and/or pulmonary risk(s).
- S. View electronic whiteboard data.
- T. Configure Nurse Call System automated reminders.
- U. Utilize active directory for single sign on access to the GUI and reporting applications.
- V. Configure the display of patient data to comply with HIPPA regulations.
- W. Provide an audit trail for changes made in the application when an active directory integration is in place.
- X. The Nurse Call System shall be network-based and incorporate decentralized, distributed intelligence architecture.

PART 2 PRODUCTS – MANUFACTURER FURNISHED EQUIPMENT

1.1. GENERAL CONDITIONS

- A. The Nurse Call System shall allow both data and voice to be distributed over a common network infrastructure. The Nurse Call System shall consist of (include):
 - (1) Staff Consoles
 - (2) Patient and Staff Audio Stations (Standard and/or Graphical)
 - (3) Smart Bed Connectors
 - (4) Call Switches
 - (5) Remote Audio Devices
 - (6) Corridor (Dome / Zone) Lights
 - (7) Room Control Boards (RCB)
 - (8) Power over Ethernet (PoE) Switches
 - (9) Bed Interface Device (pillow speaker, bed and auxiliary input)
 - (10) Configuration Software
 - (11) Electronic Whiteboard
 - (12) Real-Time Locating System infrastructure. Reporting Software and Smart Beds.
- B. The Wander Management System shall allow both data and voice to be distributed over a common network infrastructure. The Wander Management System shall consist of (include):
 - (1) Resident/Patient wearable bracelets
 - (2) Sensors, located near exit doors

- (3) Power over Ethernet (PoE) Switches
- (4) Wander Management system processor, software configurable.
- (5) Configuration Software
- (6) Real-Time Locating System infrastructure. Reporting software.
- (7) Automated integration with Division-28 Security access control
- **C.** The Owner-provided EHR application shall be supported by electronic touchsensitive EHR PC-kiosks, at locations coordinated with the Owner, allowing secure data to be distributed over a common network infrastructure.

2.1 STAFF CONSOLES

- A. All staff consoles must have antimicrobial additives in the plastics to prevent biodegradation due to bacterial residue.
- B. All staff consoles must have at least a 10 inch (25.4 cm) full color LCD touchscreen interface.
- C. The touch screen shall utilize programmable soft keys as opposed to a mechanical dial/touchpad.
- D. The staff console shall support the connection of an external keyboard.
- E. The staff console display shall provide an adjustable tilt mechanism for viewing clarity.
- F. The call pending screen on the staff console shall allow at least six calls to be visible without the need to scroll. The staff console shall provide a simple scrolling function to view additional calls when more than six pending calls are present.
- G. The staff console shall provide visibility to patient data without the use of a separate PC. Patient data and staff location should display automatically (without need of a user-initiated query) upon receipt of a call from a patient.
- H. The staff console shall provide a cleaning mode which, when activated, will temporarily disable the front panel buttons or touch screen for 15 seconds, and display a message to indicate that the device is in cleaning mode.
- I. The staff console must be capable of desk-mounted or wall-mounted installation.
- J. The staff console must monitor single or multiple nursing units based on facility configuration. Monitoring configuration must be adjustable by nursing unit.
- K. The staff console should provide two-way full-duplex staff-to-patient and staff-tostaff voice communications. Systems utilizing one-way (half-duplex) audio will not be accepted.
- L. Staff consoles should include a handset for private communication and should also support speaker phone for monitoring events.
- M. Staff consoles shall have the ability to adjust talk and listen volume levels on a

room-by-room basis. Nurse Call Systems using group or zone-wide audio adjustments will not be accepted.

- N. Staff consoles shall be capable of placing a call to staff using the display screen.
- O. The staff console shall visually display and audibly annunciate patient calls, system alerts, and calls / alarms from connected healthcare equipment.
- P. The user should be able to prioritize, select and respond to each event.
- Q. Audible call annunciation shall be configurable and shall indicate priority level.
- R. Incoming calls shall be displayed in the colors assigned to their specific priority levels.
- S. The staff console shall provide visual identification of the calling station(s) and display call information including room number, priority, call type, wait time, status, patient name, patient risk, patient notes, assigned caregiver(s), and location of assigned caregiver(s).
- T. Staff console shall have the ability to classify a normal, incoming call as another call type.
- U. The staff console shall facilitate text message / SMS delivery of the specific call type (ex. pain request) to the applicable caregiver on a wireless phone
- V. The staff console must log all calls, including incoming calls, altered call types and cancelled calls, for reporting purposes.
- W. The staff console shall be IP-based, utilizing VoIP technology.
- X. The staff console shall connect to the nurse call network and receive data utilizing CAT5e/6 cable and powered Ethernet. No separate power supply, external transformer or wiring shall be used.

2.2 AUDIO (PATIENT / STAFF) STATIONS

- A. Audio stations shall have antimicrobial additives embedded in the plastic to prevent breakdown due to bacterial residue.
- B. Audio stations shall provide two-way full-duplex staff-to-patient and staff-to-staff voice communications with two built-in speakers and a separate microphone.
- C. Audio stations must be equipped with two call buttons and a cancel button, at a minimum.
- D. Any audio station may be configured to act as a patient or staff station.
- E. Staff / duty stations have all the functionality of an audio station with the exception of a code blue lever.
- F. The Nurse Call System shall allow for each patient room to have a dedicated audio line to prevent "line busy" indication when calling back into patient locations.
- G. Standard and graphical options for patient and staff stations must be available and able to co-exist within the same unit and Nurse Call System.

- H. Audio stations shall mount in a 3-gang back box.
- I. Audio stations shall provide a cleaning mode which, when activated, will temporarily disable the front panel buttons or touch screen for 15 seconds, and display a message indicating that the device is in cleaning mode.
- J. Audio stations shall have a dedicated code blue lever for actuating a code blue call.
- K. Audio stations shall have two speakers to provide clear audio throughout the patient room
- L. Audio stations shall not have call devices (beds, other equipment) connected directly to the audio station via a cable.
- M. Audio stations shall have a visible LED to indicate call and communication status.
- N. Audio stations shall not have dual in-line package (DIP) switches that require manual setting by field personnel. Audio stations utilizing manual DIP switches will not be considered.
- O. Audio stations shall be hot swappable and not require system shutdown or removal of power prior to replacement.
- P. All audio stations shall be supervised so that if a device is not able to function the device becomes powered down for example then it will send an alert through the Nurse Call System.

2.3 GRAPHICAL AUDIO STATIONS

- A. The Nurse Call System shall provide the option for graphical touch screen audio stations in patient rooms. There should be no requirement to mount a standard patient station in the same room as a graphical station. Systems that require a standard and graphical station in patient rooms will not be considered.
- B. One graphical station should act as both a nurse call station and a workflowenhancing device capable of managing both patient-focused and staff-focused applications.
- C. The graphical station shall include configurable action request buttons to route nonpatient calls to appropriate facility staff (e.g. the "clean room" button routes a call to janitorial staff). These calls will include the type of request and the room number.
- D. The graphical station shall provide automated reminders which notify staff of recurring patient care actions (e.g. nurse rounding reminders).
- E. Reminders will automatically send a notification to the configured destination (e.g. staff console, staff handset) including room number and time until call is due, when a call is due or, if configured, in advance of a call coming due.
- F. Reminder time parameters shall be configurable by the user via the Nurse Call System software application. The settings shall include event frequency and required length of time in the patient room to complete an event.
- G. When used with integrated staff locating, the Nurse Call System shall be capable of

resetting the time for any pending reminders when the appropriate staff member is located in the corresponding patient room.

- H. The graphical station shall be capable of setting patient risk status for falls, pulmonary and skin risks. When used with a Hill-Rom® smart bed, upon selecting a risk category for a patient room, the Nurse Call System will automatically enable any configured safety alert and alarm parameters (e.g. initiating a nurse call when bed rails are lowered for a patient who is a falls risk) and enable the bed exit alarm.
- I. Graphical audio stations shall have the ability to scroll up or down to view a list of information contained on the display.
- J. Graphical audio station shall display a list of available locations, rooms and staff which can be selected and called directly from any graphical station.
- K. Each graphical audio station shall allow the ability to open a dedicated audio path. Systems requiring an audio bus topology that share voice paths over multiple rooms shall not be accepted.
- L. Graphical audio stations shall have the ability to display active calls by indicating the room number, bed number and type of call on the display. These calls may be answered from any graphical station on the unit.
- M. When used with integrated staff locating the graphical audio station shall provide a list of available staff with name, title, and current location.
- N. The graphical audio station shall provide an out-of-room mode.
- O. When enabled, the out-of-room mode will place recurring reminders on hold, automatically complete on-demand reminders, and disable risk-based alarms.
- P. When disabled, reminder and alarm settings will be activated to their original state.
- Q. A single graphical audio station must be capable of managing activity for a patient room with up to two beds. Systems that require a graphical audio station per bed and cannot accommodate two beds on one graphical station will not be accepted.

2.4 SMART BED CONNECTORS

- A. The Nurse Call System shall use bed connectors, such as Audio Station Bed Connectors (ASBC), and locate them near the patient bed to allow for flexible placement of audio stations
- B. The bed connector shall connect a pillow speaker, a bed and an auxiliary equipment jack input to the nurse call network.
- C. Bed connectors shall provide relay contact isolation for entertainment and lighting controls.

2.5 ANCILLARY CALL SWITCHES

- A. Call switches shall be furnished as specified and placed in ancillary areas accessible by staff as indicated by local building codes.
- B. Call switches shall have a call lever or button, a red, call placed LED, and an

optional call cancel button.

- C. Where indicated, call switches shall provide a cord attached to the lever to allow a patient who has fallen to pull the cord to activate a call.
- D. Call switches shall be supervised by the system to alert staff in the event of a cable or switch failure.

2.6 LAVATORY AND SHOWER/ BATH CALL SWITCHES

- A. When a lavatory or shower / bath call switch is activated, visual indication of the call displays at the dome light associated with the patient room, and an appropriate call indication registers on the staff console, as well as on any installed annunciators.
- B. The lavatory call switches have a nurse call lever, a red, call placed LED, and a call cancel button.
- C. Shower / bath switches have a blue nurse call lever and a red call placed LED.
- D. A cord attached to the lavatory or the shower / bath call switch lever lets a patient who has fallen place an emergency call using the cord.
- E. Lavatory call switches should connect to the assigned room box via a category 5e/6 UTP cable and RJ45 connector.
- F. Shower / bath switches may be mounted on the wall inside the shower.
- G. Shower / bath switches shall be water resistant.

2.7 BATHROOM LAVATORY STATION (REMOTE AUDIO DEVICES)

- A. When a bathroom / lavatory station is activated, visual indication of the call displays at the dome light associated with the patient room, an appropriate call indication registers on the staff console, as well as on any installed annunciators, and full audio is enabled between the patient and the staff member answering the call.
- B. The bathroom / lavatory station shall be capable of two-way audio communication.
- C. The lavatory call switches have a nurse call lever, a red call placed LED, and a call cancel button.
- D. A cord attached to the lavatory call switch lever lets a patient who has fallen place an emergency call using the cord.
- E. Lavatory call switches should connect to the assigned room box via a category 5e/6 UTP cable and RJ45 connector.

2.8 CORRIDOR (DOME / ZONE) LIGHTS

- A. Corridor lights shall use Light Emitting Diode (LED) technology. Corridor lights that utilize incandescent bulbs will not be accepted.
- B. Corridor lights shall be capable of mounting in a 1-gang back box.

- C. Corridor lights shall have eight separate bulbs divided into eight distinguishable sections capable of indicating multiple, simultaneous events.
- D. Each corridor light section shall be capable of indicating at least seven colors.
- E. Corridor lights shall be configurable via programming to allow for multiple illumination, color and/or flash patterns to designate call priority, call type, staff presence and/or patient risk status.
- F. Corridor lights shall allow for a selection of configurable overlays to be used to clearly distinguish between call type or staff presence information. (e.g. a flashing 'N' to indicate a nurse is needed).
- G. Corridor lights shall be capable of audible annunciation for specific, configurable call types. Separate annunciation device(s) connected to the corridor light will not be accepted.

2.9 ROOM CONTROL BOARDS (RCBs)

- A. RCBs shall be mounted in protective enclosures when mounted above ceiling.
- B. The Nurse Call System shall support a dedicated RCB setup which maintains single-point-of-failure. Any systems designed with a daisy-chain or similar setup which does not ensure single-point-of-failure will not be accepted.
- C. The RCB shall accommodate connection to up to two audio stations, the corridor light, lavatory switch, bath / shower switch system alarm interface, and stat clock interface.
- D. The RCB shall be powered by the home run cable connected to the Power over Ethernet switch. The RCB connects to the Power over Ethernet switch with a Category 5e/6 UTP cable (home run cable).
- E. The RCB shall utilize LEDs to indicate power and status. Additionally, all connection points for the room devices shall have LEDs to indicate if the communication channels are active.
- F. The RCB shall have a heartbeat light to indicate that software is active.

2.10 POWER OVER ETHERNET (PoE) SWITCHES

- A. PoE switches must be UL1069 approved.
- B. The Nurse Call System shall be compatible with Cisco Catalyst 4500 series utilizing the WS-x4748 UPOE+E line card, Cisco Catalyst 3850 series UPoE Switches, and Hill-Rom's proprietary PoE switch.
- C. PoE switches shall have a minimum of 24 ports with a maximum power output of 1800 watts.
- D. PoE switches shall mount in a standard 19" network rack and shall be 1RMU high.
- E. PoE switches connect, at a minimum, to RCBs, staff consoles, annunciators, and other PoE Switches.

- F. PoE switches shall follow standard Ethernet deployment standards.
- G. PoE switches shall use RSTP protocol for redundant links for each switch or stack of switches in the Nurse Call System.

2.11 PILLOW SPEAKERS

- A. Connection to the bed connector shall utilize a standard Champ 50 series 2-type AMP connector.
- B. All pillow speakers shall have a minimum four button capacity.
- C. All pillow speakers shall have the option to display labels designating Nurse Call, TV channel and reading light buttons.
- D. Additional buttons for pain and bathroom visit requests should be available on the pillow speaker.
- E. The Nurse Call System should have the ability to route pain and bathroom request calls differently from a standard pillow-speaker-initiated patient call.
- F. Pillow speakers shall have LEDs to indicate successful call placement and an open audio channel.
- G. Pillow speakers shall have a speaker for entertainment audio and nurse call audio.
- H. When the audio channel between staff and the patient is opened, audio to the patient shall go through the pillow speaker.
- I. Microphones shall be built into the pillow speaker to enhance audio through the patient station.
- J. Volume can be adjusted on a per room basis, directly from the pillow speaker.
- K. Pillow speaker housing shall be a high impact UL recognized, 94-VO rated, or better, polystyrene.
- L. Pillow speaker internal switches shall be Micro Brand switch rated for 10 million cycles.

2.12 ELECTRONIC WHITEBOARD

- A. The electronic whiteboard shall display Nurse Call System data including patient room number, patient name, patient notes, assigned patient risk protocol, assigned staff, nurse call type, call wait time, and staff presence.
- B. The electronic whiteboard shall be displayed using a LAN PC or smart LCD display.

2.13 WANDER MANAGEMENT

- C. Staff shall issue Wander Management electronic wireless transmitter wrist bracelets to patients. Wrist bracelets are battery powered (with 10-year life battery).
- D. Electronic proximity sensors capable of sensing Wander Management electronic

wireless transmitter wrist bracelets, shall be located near household exit doors, and configured to communicate with Wander Management processor.

- E. Wander Management processor shall be software configurable for configuration of desired actions during an event in which a wrist bracelet is detected in close proximity to a household exit or elevator.
- F. Wrist bracelets are intended for purposes of supporting automated interaction with wander patient/resident proximity sensors.
- G. During an event of detection of patient/resident in close proximity to an exit, the Wander Management system will:
 - (1) Automatically issue command to Division-28 security access control system to immediately lock the adjacent exit door(s), and other exit doors and elevators, as defined by the Owner.
 - (2) Automatically issue alert to nearby staff for the event, including display of the patient/resident name and portrait image on the Staff's wireless PDA.
 - (3) App on Staff's wireless PDA will continue the alert until Staff cancels the alert.
 - (4) Should the alert not be cancelled in pre-determined time period, alert will be expanded to adjacent Household and later to all Households.
- H. Should a life-safety emergency condition be in progress immediately prior to, or during the Wander Management alert, the conditions of the life safety event shall take priority over security access control of all exit doors over the pre-defined conditions for Wander Management alerts.

2.14 INTEGRATIONS

- A. The Nurse Call and Wander Management System shall be capable of direct integrating with:
 - i. Staff wireless mobile phones and pendants, with application software installed and configured for each mobile device.
 - ii. Staff locating systems
 - iii. ADT systems for patient information and patient-to-staff assignments
 - iv. 3rd party locating applications
 - v. Bed exit and fall prevention alarm systems
 - vi. Patient equipment (ex. Pump, vent, etc.)
 - vii. EMR, bi-directionally
 - viii. PC monitors and large screen monitors, such as Flat Panel LCD or Plasma display, for display of electronic white board data.
 - ix. Wander Management patient/resident bracelets

- x. Wander Management electronic patient proximity sensors
- B. The Nurse Call and Wander Management System provider shall have experience partnering and integrating with primary third-party system providers.
- C. The Nurse Call and Wander Management System provider shall be capable of providing remote diagnostics and issue resolution for any integrations established with the Nurse Call and Wander Management System.
- D. Wireless handset Integrations shall use the native interface of the handset provider.
- E. The integration with the wireless provider shall enable the Nurse Call & Wander Management System to identify when a wireless handset is on or off the network and properly automate and route call escalations.
- F. The integration with the wireless provider shall allow the user options such as call decline and call back when the handset receives a message from the Nurse Call System.
- G. ADT integration for staff assignments shall employ a full feature interface engine to send, receive, or send and receive information.
- H. The Nurse Call System shall support a direct integration with a patient smart bed and an EMR system. At a minimum, this shall enable:
 - (1) Receiving patient risk from the EMR into the Nurse Call System.
 - (2) Sending nurse call data to the EMR.
 - (3) Sending patient weight and/or bed head-of-bed angle to the EMR.
- I. The Nurse Call System shall be capable of smart bed side-rail communication including:
 - (1) Visual notification of a disconnected smart bed via a centralized display on the unit.
 - (2) Visual and audible annunciation of bed exit calls.
 - (3) Visual and audible annunciation of patient calls.
- J. The Nurse Call & Wander Management System shall take data feeds from medical devices and send relevant alerts through the Nurse Call & Wander Management System.
- K. The Nurse Call & Wander Management System shall share RTLS locator badge and wireless phone information when integrated with these systems.

2.15 COMPLEMENTARY PRODUCTS

- A. REAL TIME LOCATING EQUIPMENT
- B. The Real Time Locating System (RTLS) shall be web-based.
- C. RTLS shall be capable of the following:

- D. Monitor the location and movement patterns of staff.
- E. Integrate with the Nurse Call System to automatically cancel a normal patient call, or action request calls, and illuminate the corridor light once an assigned staff member is present in a patient room. Priority or urgent calls should be manually cancelled in all circumstances.
- F. Expand the platform to support Hand Hygiene Compliance Tracking.
- G. Interface with 3rd party RTLS partners for applications such as Patient Wandering, Asset Tracking and Temperature Monitoring.
- H. RTLS shall display staff presence in an area each time the locator badge signal is picked up by an infrared receiver. This location is displayed on each staff console and graphical audio station within the unit.
- I. Each RTLS staff locator badge shall have a unique identification number which can be assigned to a single staff member.
- J. RTLS hardware shall be used to define distinct patient rooms, hallways and staff locations. Devices shall be able to segregate spaces to the level of a "patient room" even in the even if that "room" does not have walls (i.e. patient bay with curtain only).

2.16 **REPORTING**

- A. The Nurse Call and Wander Management System shall make optional reporting software available to the Owner.
- B. Reporting software shall utilize Nurse Call and Wander Management System data to generate reports related to event occurred, calls placed, call type, call time, call duration, , patient and staff assignment, and staff activity.
- C. When the Nurse Call System is used in conjunction with smart beds, the reporting software shall allow the user to generate reports related to patient safety events utilizing bed data history.
- D. When the Nurse Call and Wander Management System is used in conjunction with RTLS, the reporting software shall allow the user to generate reports on staff location in relation to nurse call activity, call response time, and rounding data.
- E. Reporting software shall display reports as visual dashboards, scorecards, tables or graphs.

2.17 SMART BEDS (If Applicable)

- A. Smart Bed application only required if specifically elected by the Owner.
- B. The Nurse Call System shall facilitate delivery of alerts to assigned caregivers via staff wireless devices when bed status monitoring settings are out of compliance. Alerts shall be configurable for bed exit sensors, head rails position, foot rails position, bed position, and brake status.
- C. The Nurse Call System shall display smart bed data on the electronic whiteboard. Smart bed data shall include head of bead angle, patient weight, bed exit alarm

status, side rail positions, bed position, brake status, bed maintenance indicator, and bed exit history.

- D. When used in conjunction with smart beds and RTLS, the Nurse Call System shall auto-disable safety alerts based on staff presence in the patient room.
- E. The Nurse Call System shall be capable of enabling smart bed alerts and alarms when the user assigns a risk status to a patient room using either the Nurse Call System software application or a graphical audio station in the patient room and the patient is detected in the bed.
- F. The Nurse Call System shall integrate with a smart bed without requiring a direct, wired connection to an audio station.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The installer must install the Nurse Call and Wander Management System equipment in compliance with the manufacturer's installation and implementation specifications.
- B. Manufacturer shall effectively coordinate the installation process. This would include but not be limited to reviewing correct placement of cables, correct mounting of devices, and monitoring the installing Design-Builder's compliance with the installation schedule.
- C. Install wiring in compliance with ANSI/TIA-569 Commercial Building Standards Telecom Pathways and Spaces.
- D. The Nurse Call and Wander Management System must be tested per the manufacturer's instructions to confirm that it was installed and is functioning as designed.
- E. Submit a report containing an as-built package with all test results and drawings.
- F. It is further intended that upon completion of this work, the installer shall provide complete information and drawings describing and depicting the entire system(s) as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system(s) at a future date, and complete documentation of system certification.
- G. The Manufacturer shall offer the Owner the option to purchase evidence-based training led by experienced clinicians.
- H. All required empty conduit pathways, cable raceway, junction and wall boxes and electrical services in support of Nurse Call and Wandering Management shall be coordinated with and provided by Division 26- Electrical.
- I. All required Information Technology services including cabling, cabling terminations, cable pathways, network switches and servers in support of Nurse Call and Wandering Management shall be coordinated with and provided by Division 27- Communications.

2.18 SUPPORT

- A. 24x7x365 technical support telephone line staffed by experienced and trained product support specialists, free of charge for customers with SMA.
- B. Technical support shall be capable of handling first-line support of Nurse Call and Wander Management System and/or 3rd party, integrated systems.
- C. The Nurse Call and Wander Management System shall be capable of remote issue diagnosis and resolution for 90% or more of the expected issues that may arise. Systems requiring onsite diagnosis and remedy in more than 10% of cases will not be considered.
- D. Nurse Call and Wander Management System shall not require the use of specialized tool kits to perform routine maintenance, calibration or physical checks of the system.

END OF SECTION

SECTION 28 00 00

ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

A. General requirements for security system work per Division 28.

1.2 GENERAL CONDITIONS

- A. Applicable requirements of Division 01 General Conditions shall be considered a part of this section and shall have the same force as if printed herein full.
- B. The work to be done under this section of the Specifications shall include the furnishing of labor, material, equipment, and tools required for the complete installation of the work indicated on the Drawings, as specified herein, or as noted in other sections of Division 28 Electronic Safety and Security.
- C. All materials, obviously a part of the electronic security infrastructure and necessary to its proper operation, but not specifically mentioned or shown on the Drawings, shall be furnished and installed without additional charge.
- D. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawings and Specifications, the higher cost and/or higher level of functionality shall be included to meet the design intent.

1.3 WORK INCLUDED

- A. The Work shall include installation and commissioning of the following:
 - 1. Integrated Security Management system consisting of:
 - A. Access Control and Alarm Monitoring System
 - B. Video Surveillance System
 - C. Intercom Communications System
 - D. Digital Alarm Panel
 - E. Uninterruptible Power System
 - 2. Security Equipment Racks, Cabinets, and Consoles
 - 3. Wire and cable to install all equipment as specified herein
 - 4. Miscellaneous conduit and back boxes (not shown on the Documents as provided, but required for a complete installation)

1.4 **REFERENCES**

- A. All work shall be in accordance with, but not limited to, the following:
 - 1. The National Electrical Code
 - 2. American National Standards Institute (ANSI)
 - 3. National Electrical Manufacturers Association (NEMA)
 - 4. Telecommunications Industries Association (TIA)
 - 5. Electronic Industries Association (EIA)
 - 6. Institute of Electrical & Electronics Consultants (IEEE)
 - 7. Underwriters Laboratories (UL)
 - 8. American Standards Association (ASA)
 - 9. Federal Communications Commission (FCC)
 - 10. Occupational Safety and Health Administration (OSHA)
 - 11. American Society of Testing Material (ASTM)
 - 12. Americans with Disabilities Act (ADA)
 - 13. Local city and county ordinances
- B. In the event of conflicts, the more stringent provisions shall apply.

1.5 **DEFINITIONS**

- A. The following definitions of terms supplement those of the General Requirements and are applicable to all sections of Division 28 Electronic Safety and Security.
 - 1. Provide: As used herein shall mean furnish, install, and test (if applicable) complete.
 - 2. Infrastructure: As used herein shall mean cable, conduit, and raceway with all required boxes, fittings, connectors, and accessories; completely installed.
 - 3. Work: As used herein shall be understood to mean the materials completely installed, including the labor involved to meet the design intent.
- B. As used in the Documents for the Work, certain non-technical words and phrases shall be understood to have specific meanings as follows, regardless of indications to the contrary in the General Conditions or other documents governing the Work.
 - 1. "Furnish" Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the Work. Purchasing shall include payment

of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims, or encumbrances.

- 2. "Install" Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the Work.
- 3. "New" Manufactured within the past year and never before used.
- C. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Documents for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
 - 1. "As indicated" As shown on, and/or in accordance with, the Documents.
 - 2. "Circuit" Any specific run of circuitry.
 - "Circuitry" Any Work which consists of wires, cables, raceways, and/or specialty wiring method assemblies complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices, and connections except where limited to a lesser meaning by specific description.
 - 4. "Concealed" (as applied to circuitry) Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.
 - 5. "Documents" The term "Documents" means all security and security related drawings, specifications, and associated sketches, details, riser diagrams, etc.
 - 6. "Exposed" (as applied to circuitry) Not covered in any way by building materials.
 - 7. "Patch Panel" A system of terminal blocks, patch cords, and backboards that facilitate administration of cross-connecting cables.
 - 8. "Raceway" Any pipe, duct, extended enclosure, or conduit (as specified for a particular system) which is used to contain wires and which is of such nature as to require that the wires be installed by a pulling in procedure. Where the word "conduit" is used without specific reference to type, it shall be understood to mean "raceway".
 - 9. "Relocate existing" Remove existing item from present location. Reinstall, reconnect, and test existing item and make ready for use at new location as indicated.
 - 10. "Remove existing "- Remove existing item and return item to Owner.
 - 11. "Replace" Remove existing item and return item to Owner. Provide new item as indicated.
 - 12. "Riser" Shall refer to the portion of the installation that transmits between building floors or between security system rooms; also referred to as "Backbone Cabling".

- 13. "Security Closet" The enclosed area or room specifically designated for the routing, termination, and/or cross connecting of security system cable to other security system cable and/or equipment.
- 14. "Security system Wiring" see "Circuitry".
- 15. "Security system Work" See "Work".
- 16. "Standard" (as applied to wiring devices) Not of a separately designated individual type.
- 17. "Wiring" See "Circuitry".
- 18. "IT" Information Technology
- D. As used in the Drawings and Specifications for the Work, certain non-technical words and phrases shall be understood to have specific meanings as follows, regardless of indications to the contrary in the General Conditions or other documents governing the Work.
 - 1. "Furnish" To purchase, procure, acquire, and deliver complete with related accessories.
 - 2. "Install" To set in place, join, unite, fasten, link, attach, set up or otherwise connect together and test, before turning over to the Owner, all parts, items, or equipment supplied by the Design-Builder.
 - 3. "Provide" To furnish, transport, install, erect, connect, test and turn over to the Owner complete and ready for regular operation.
 - 4. "Connect" To install all required patch cords, equipment cords, cross connect wire, etc. to complete an electrical or optical circuit.
 - 5. "Cabling" A combination of all cables, wires, cords and connecting hardware required for a complete and operational system.
 - 6. "Circuit" Any specific run of circuitry
 - "Circuitry" Any Work which consists of wires, cables, raceways, and/or specialty wiring method assemblies complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices, and connections except where limited to a lesser meaning by specific description.
 - 8. "Concealed" (as applied to circuitry) Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.
 - 9. "Exposed" (as applied to circuitry) Not covered in any way by building materials.
 - 10. "Normal Work Conditions" Locations within building confines that are not damp, wet, or hazardous and that are not used for air handling.

- 11. "Patch Panel" A System of terminal blocks, patch cords, and backboards that facilitate administration of cross-connecting cables.
- 12. "Raceway" Any pipe, duct, extended enclosure, or conduit (as specified for a particular System) which is used to contain wires and which is of such nature as to require that the wires be installed by a "pulling in" procedure.
- 13. "Riser" Shall refer to the portion of the installation that transmits between building floors (or between security System rooms), also referred to as "Backbone Cabling".
- 14. "Security Closet" The enclosed area or room specifically designated for the routing, termination, and/or cross connecting of security System cable (i.e. riser cable) to other security System cable and/or equipment.
- 15. "Security System Wiring" see "Circuitry"
- 16. "Security System Work" See "Work"
- 17. "Standard" (as applied to wiring devices) Not of a separately designated individual type.
- 18. "System" See "SMS"
- 19. "Wiring" see "Circuitry"
- 20. "Workstation" The location where security System monitoring equipment is provided.
- 21. "ACAMS" Access Control and Alarm Monitoring System.
- 22. "SMS" Security Management System.
- 23. "ACP" Access Control Panel
- 24. "VSS" Video Surveillance System
- 25. "IDS" Intrusion Detection System
- 26. "IP" Internet Protocol
- 27. "PoE" Power over Ethernet
- 28. "SCC" Security Command Center
- 29. "NVR" Network Video Recorder
- 30. "PTZ" Pan, Tilt and Zoom

1.6 CONFIDENTIALITY REQUIREMENT

A. The Work is critical to the security of the Owner's facility. All Documents and other material and information about the Work are confidential information and must remain secure and

confidential at all times. Confidential information must not be deliberately or inadvertently disclosed to anyone other than the Design-Builder's personnel and subDesign-Builders who require disclosure to perform their portion of the Work.

B. The Design-Builder shall keep track of all confidential information at all times and shall ensure that all copies are accounted for at all times. The Design-Builder shall not permit any persons to have access to the confidential information of the Work unless and until the Design-Builder has assured itself of the trustworthiness of such persons.

1.7 GENERAL REQUIREMENTS

- A. The Design-Builder represents that they are familiar with, and have expertise in the Work of this nature and scope. The Design-Builder further agrees that they shall provide all Work as may be required to make a complete job of that which may not be fully defined in the Documents.
- B. The Design-Builder shall comply with all of the regulations of municipal, city, local and other government agencies having jurisdiction concerning the work of the Design-Builder. The Design-Builder shall give all notices and comply with all laws, ordinances, codes, rules, and regulations bearing on the conduct of the Work. If the Design-Builder performs any work, which is contrary to such laws, ordinances, codes, rules and regulations, they shall make all changes for compliance and bear all associated costs.
- C. The Design-Builder shall be responsible to provide and maintain a storage facility. If this storage facility is required to be on-site it shall be the Design-Builder's responsibility to coordinate the size and spatial requirements with the Owner. The Design-Builder shall assume full responsibility for the storage facility and all contents, unless otherwise indicated by the Owner.
- D. The Design-Builder shall utilize good housekeeping practice with respect to their work including cleanup of all dirt and debris created by the Design-Builder during installation operations on a daily basis.
- E. The Design-Builder shall provide all protection necessary to safeguard their work from damage by their operations and the operations of others. Unless the Design-Builder proves to the Owner's satisfaction that the Work has been damaged by others, the Design-Builder shall promptly repair, adjust, and clean all defective installations and bear all associated costs.
- F. All of the Design-Builder's work shall be tested and inspected by all authorities having jurisdiction and in accordance with all Specifications. The Design-Builder shall coordinate and cooperate fully and shall provide at no additional cost to the Owner, manpower, blueprints, facilities, scaffolds, etc. to reasonably assist the inspectors.
- G. The Design-Builder shall examine the site and the Documents and review with the Owner the designated areas of access, delivery, and storage for the Design-Builder's use. The Design-Builder agrees that such areas are satisfactory and sufficient for their needs in the completion of their work and in conformance with the terms of this Contract.
- H. Should any questions of union jurisdiction arise, the Design-Builder shall immediately take steps to settle such disputes and shall use such labor as may be determined to have

jurisdiction, at no additional cost to the Owner. Should the Design-Builder fail to take expeditious action, they shall be responsible for any time lost because of delays arising from such a dispute.

- I. The Owner reserves the right to furnish any materials necessary for the Project.
- J. All permits required for any part of the Design-Builder's work shall be procured and paid for by the Design-Builder. The Design-Builder shall determine all permits required and transmit this information to the Owner.
- K. The Design-Builder warrants that both they and their sub-Design-Builders are licensed as required by the authorities having jurisdiction and as required by local ordinances.
- L. The Design-Builder must state if they intend to utilize a sub-Design-Builder, and provide said sub-Design-Builder's name and address. The sub-Design-Builder shall comply with all the same rules, regulations, laws, codes, licenses, etc. as required by the Design-Builder and as specified herein. The Owner reserves the right to approve or disapprove any sub-Design-Builder proposed by Design-Builder.
- M. The Owner shall provide to the Design-Builder AutoCAD backgrounds for all required floor plans for the facility. All pre-fabrication and record drawings required for the Project and as stated herein, shall be completed within the latest version of AutoCAD.
- N. The Design-Builder, upon receiving notice from Owner that the Design-Builder has furnished inferior, improper or unsound work or materials (including equipment), or work or materials at variance with that which is specified, will, within 24 hours, proceed to remove such work or materials and make good all other work or materials damaged thereby, and, at the option of the Owner, the Design-Builder shall immediately replace such work or materials with work or materials as specified. The removal, replacement, and repair shall be performed at such times and with manpower sufficient, in the judgment of the Owner, so as to avoid disturbance to occupants, or other ongoing work for the Project.
 - 1. If the Design-Builder does not remove such unsound Work within a reasonable time, the Owner may remove it and may store the material at the expense of the Design-Builder. If the Design-Builder does not pay the expenses of such removal within ten (10) days' time thereafter, the Owner may, upon written notice, sell such materials at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs and expenses that should have been borne by the Design-Builder and all expenses of the sale.
 - 2. The Owner shall have the authority at all times, until final completion and acceptance of the Work, to inspect and reject work and materials which in its judgment are not in conformity with the Documents, and its decision in regard to character and value of Work shall be final and conclusive on both contracting parties. If the Owner permits said Work or materials to remain, the Owner shall be allowed the difference in value or shall at its election have the right to have said Work or materials repaired or replaced, as well as the damage caused thereby, at the expense of the Design-Builder, at any time within one (1) year after the completion of the entire project, or within such longer period as may be covered by any guaranty; and neither payments made to the Design-

Builder, nor any other acts of the Owner, shall be construed as evidence of acceptance, waiver, or estoppel.

- 3. Any expense incurred by the Owner in connection with the foregoing, shall be borne by the Design-Builder, and the Owner may withhold money due to the Design-Builder or recover money already paid to the Design-Builder, to the extent of such expense.
- O. To the extent that they govern the Work, the Documents also govern change order Work, if any.
- P. The Documents for the Work utilize symbols and schematic diagrams that have no dimensional significance. The Work shall be installed to fulfill the diagrammatic intent expressed on the Documents, field layouts, and shop drawings of all trades.
- Q. Certain details appear on the Documents for the Work that is specified with regard to the dimensioning and positioning of the Work. These are intended only for general information purposes. They do not obviate field coordination for individual items of the indicated Work.
- R. Information as to general construction and architectural general construction and architectural features and finishes shall be derived from the structural and architectural Documents only.
- S. Ratings of devices, materials, and equipment specified without reference to specific performance criteria shall be understood to be nominal or nameplate ratings established by means of industry standard procedures.
- T. It is the intent of the Documents to provide a complete operating security system. All Work necessary to provide such a system shall be performed. Any discrepancies shall be brought to the Consultant's attention.
- U. The Work called for under this Contract shall be carried on simultaneously with the Work of other trades and Owner functions in such a manner as to not delay the overall progress of the construction project. The Design-Builder is responsible for all coordination of the Work with other trades.
- V. Include in the Work all necessary supervision and issuing of all coordination information to any other trades who are supplying work to accommodate the security system installation.
- W. For items of equipment which are to be installed but not purchased as part of the Work, the Work shall include:
 - 1. Coordination of delivery
 - 2. Unloading from delivery trucks
 - 3. Safe handling and field storage up to the time of permanent placement in the project
 - 4. Correction of any damage to the item(s)
 - 5. Mounting in place and connection(s) as specified

- X. Items which are to be installed but not purchased as part of the Work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the Work will be considered only if presented in writing within one (1) week of the date of delivery to the project of the items in question. The Work includes all procedures necessary to put in satisfactory operation all items for which no claims have been submitted as outlined above.
- Y. Where cabling is specified to be provided by others, the Design-Builder shall identify the cable types, quantities, and lengths required and provide them to be ordered. It is the Design-Builder's responsibility to ensure that the information is complete and accurate. Any errors or omissions in the ordering information will be the responsibility of the Design-Builder.

1.8 PROJECT DRAWINGS

- A. Drawings are generally diagrammatic and show design intent, the arrangement and location of pathways, outlets, support structures, and equipment. Carefully investigate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, advise and secure approval before proceeding with such work.
- B. It shall be understood that the Specifications and Drawings are complementary. Where there are conflicts between the Documents or within the Specifications or Drawings themselves, the overall design intent shall govern.
- C. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, request Drawings, equipment location Drawings, foundation Drawings, and any other data required to locate the concealed conduit before the floor slab is poured.
- D. Materials, equipment, or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.
- E. The right is reserved to make reasonable changes in locations of equipment indicated on Drawings prior to rough-in without increase in contract cost.
- F. The size or number of conduit runs indicated shall not be reduced without written approval.
- G. Any work installed contrary to contract Drawings shall be subject to change as directed, and no extra compensation will be allowed for making these changes.
- H. The location of equipment, support structures, outlets, and similar devices shown on the Drawings are approximate only. Do not scale Drawings. Obtain layout dimensions for equipment from architectural plans unless indicated on the Drawings.
- I. Schematic diagrams shown on the Drawings indicate the required functions only. The technology of a particular manufacturer may be used to accomplish the functions indicated

without exact adherence to the schematic Drawings shown. Additional labor and materials required for such deviations shall be furnished at no additional expense.

- J. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering cabling and associated hardware. Provide notification of any discrepancies.
- K. Portions of these Drawings and Specifications are abbreviated and may include incomplete sentences. Omissions of words or phrases such as "shall," "shall be," "as indicated on the Drawings", "In accordance with", "a", "the", and "all are intended" shall be supplied by inference.

1.9 QUALITY ASSURANCE

- A. Design-Builder Qualifications
 - 1. Work specified herein shall be the responsibility of a single Security Design-Builder. Bid submission shall document a minimum of five years' experience in the fabrication, assembly, and installation of systems of similar complexity as specified herein. The documentation shall include the names, locations, and points of contact for at least three installations of the type and complexity specified herein.
 - 2. The Design-Builder shall have local in-house engineering and project management capabilities consistent with the requirements of the Work.
 - 3. By submitting a bid, the Design-Builder thereby certifies that it is qualified in all areas pertaining to, directly or indirectly, the Work. In the event the Design-Builder becomes unable to complete the Work in accordance with the Documents, or the satisfaction of the Owner, it shall be the responsibility of the Design-Builder to retain the services of applicable manufacturers' representatives to expeditiously complete the Work in accordance with the Owner is construction schedule with no additional cost to the Owner.
 - 4. The Design-Builder shall maintain, or establish and maintain, a fully staffed office including a service center capable of providing maintenance and service to the Project. The Design-Builder shall staff the service center with factory trained technicians and adequately equip the office to provide emergency service within four (4) hours after being called, 24 hours per day.
 - 5. The Design-Builder shall provide factory-certified technicians to install, commission, and maintain the Work. All installing personnel shall be licensed as required by local and/or state jurisdictions.
 - 6. The Design-Builder shall ensure compliance with, and have a thorough understanding of, all local codes and contract conditions pertaining to this Project.
 - 7. The Design-Builder shall maintain an inventory of spare parts and other items critical to system operation and as necessary to meet the emergency service requirements of this Project within the local service center.
- B. Product Standards

- 1. All equipment and materials for contained herein shall be the products of recognized manufacturers and shall be new.
- 2. New equipment and materials shall:
 - A. Be Underwriters Laboratories, Inc. (UL.) listed and approved where specifically called for; or where normally subject to such UL labeling and/or listing services.
 - B. Be clearly labeled identifying make, model, and manufacturer.
 - C. Be without blemish or defect.
 - D. Be products that meet with the acceptance of the agency inspecting the security systems work.
- 3. It is the intent of these specifications that wherever a manufacturer of a product is specified, and the terms "other approved" or "approved equal" are used, the substituted item must conform in all respects to the specified item. Consideration will not be given to claims that the substituted item meets the performance requirements with lesser construction. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance.
- 4. Substituted equipment or optional equipment, where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Design-Builder's expense. Any modifications of related systems as a result of substitutions shall be made at the Design-Builder's expense.
- 5. The approval of shop drawings, or other information submitted in accordance with the requirements hereinbefore specified, does not ensure that the Security Consultant, Architect, or the Owner attests to the dimensional accuracy, dimensional suitability of the material, or mechanical performance of equipment. Approval of shop drawings does not invalidate the Documents.
- 6. Substitutions of equipment shown on the schedules or designated by model number in the specifications will not be considered if the item is not a regular catalogued item carried by the manufacturer.
- 7. Manufacturers Recommendations: Where installation procedures of any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations may be cause for rejection of the material.
- 8. The Design-Builder shall provide a complete fit-out of the security closets for review by the Consultant and Owner prior to continuing with the installation of the other security closets. The closet fit-out shall include all cabinets, conduit, blocks, patch panels, frames, labels, etc.

- 9. The Design-Builder shall provide a complete fit-out of all command center equipment for review by the Security Consultant and Owner. The fit-out shall include all devices, console layouts, furniture, labeling, cable support, etc.
- 10. Within the Specifications, certain manufacturers have been listed. These manufacturers are listed for example purposes (unless followed by "No Exceptions"). The Design-Builder may substitute manufacturers and models that may be more cost effective or readily available than that specified. However, all substitutions shall meet or exceed the specified functional and technical requirements. Acceptance of such substitutions is at the discretion of the Consultant and/or Owner.
- 11. All exterior devices shall be sealed and protected against all weather conditions consistent with the region including heat, cold, moisture, dust, etc.

1.10 PROJECT MANAGEMENT

- A. The Design-Builder shall provide a Project Manager to oversee and coordinate all activities on the Project
- B. Project Manager's Duties and Responsibilities:
 - 1. The Design-Builder shall provide to the Owner, as a part of the prefabrication submittal, the name of the Project Manager that will provide all duties and responsibilities as specified herein, during the term of the project.
 - 2. The Project Manager shall maintain the ability of making all managerial decisions on behalf of the Design-Builder on a day-to-day basis, and shall retain the authority of accepting notices of deduction, inspection reports, payment schedules and any other project related correspondence on behalf of the owner.
 - 3. The Project Manager shall schedule and attend project management meetings, during which time all system related issues are discussed, scheduled, confirmed, and/or resolved.
 - 4. The Project Manager shall be available during normal business hours (ex. 08:00 to 17:00) within two (2) hours by telephone during the term of the project.
 - A. After normal business hours, the Project Manager shall be available within four (4) hours by telephone during the term of the project.
 - B. In the event that the Project Manager is not available within the allotted time frame, the Design-Builder may designate another employee to temporarily act as the Project Manager in all correspondence with the Owner.
 - C. The Design-Builder shall ensure that any individual temporarily assuming the duties of the Project Manager is at equal or higher level in the Design-Builder's managerial chain of command.

- 5. Upon notification by the Owner, of any project related installation issue, or issue that may contradict the Specifications as stated herein, the Project Manager shall respond to such issue, verbally and/or in writing within an eight (8) hour period
 - A. Responses to such issues as stated above shall include a clear understanding of the issue, along with a tentative plan of action, reflecting milestones and/or deadlines to resolve the issue.
 - B. Where appropriate, based on the overall importance of the project issue, the Project Manager shall follow-up their initial response with a written response to the issue within 24 hours of identification of the issue.

1.11 SEQUENCING

- A. This implementation plan describes the general approach that shall be followed in order to minimize the time for the access control systems to be operational.
- B. Plan and schedule all work in such a sequence as to minimize the time before the system is operational. The following is a suggested work sequence:
 - 1. Order all equipment needed and notify any subDesign-Builders to schedule their participation.
 - 2. Perform all system layout work.
 - 3. Insure there are an adequate number of power receptacles available to operate all security equipment and coordinate as to where power is available.
 - 4. Provide shop Drawings to verify location of all equipment, conduit runs, power connections, etc. Submit shop Drawings to Project Manager.
 - 5. Coordinate to provide space in each building's Communications Room for mounting of processors.
 - 6. Provide training on how to fill out the programming sheets for access levels.
 - 7. Prepare and pre-test all equipment to the greatest extent possible.
 - 8. Install all equipment.
 - 9. Provide training on the programming other various options.
 - 10. Test and inspect all systems.
 - 11. Perform all other Work as required.
 - 12. Perform the Acceptance Test.
 - 13. Provide training.

14. Provide as-built Drawings.

1.12 SCHEDULING

A. Within five (5) days after being awarded the contract, prepare and submit for information, an estimated progress schedule for the Work. The progress schedule shall be related to the entire project, and shall indicate start and completion dates.

1.13 WARRANTY AND MAINTENANCE

- A. Security Design-Builder shall provide a one year warranty for the Work. The warranty shall cover all Work, systems, and subsystems against defects in materials and workmanship. The Work as specified herein, including all materials and labor, but excepting any existing devices and equipment which are incorporated in the completed Work, shall be warranted to be free from defects in design, workmanship, and materials. Further, the Design-Builder shall warrant that the completed systems, including all components (except those, which are existing or provided by others), are of sufficient size and capacity to fulfill the requirements of the Specifications.
- B. The warranty shall be valid for a period of one year following the date of system acceptance by the Owner. System acceptance shall commence when all parts, components, sub-systems, and systems have been tested, shown to be working in accordance with the Specification, and approved by the Owner
- C. Nothing contained in the Documents shall be construed to establish a shorter period of limitation with respect to any other obligation, which the Design-Builder might have under the Documents or any manufacturer's warranty. The establishment of the time period of one year after the date of final acceptance of the Work or such longer period of time as may be prescribed by law or by the terms of any warranty required by the Documents, relates only to the specific obligation of the Design-Builder to correct the Work, and has no relationship to the time within which its obligation to comply with the Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Design-Builder's liability with respect to its obligations other than specifically to correct the Work or equipment.
- D. Warranty Service:
 - 1. In the event that defects in the materials and/or workmanship are identified during the warranty period, the Design-Builder shall provide all labor and materials as may be required for prompt correction of the defect.
 - 2. During the warranty period, the Design-Builder shall, upon receipt of a request for service from the Owner, deploy service personnel to the Owner's premises within four hours to initiate corrective action.
 - 3. All warranty service and repair work shall be performed by personnel, who have been trained, certified and is experienced in the operation and maintenance of the installed system(s).

- 4. Unless otherwise requested by the Owner, warranty service shall be performed during normal business hours, exclusive of Holidays. In the event that the Owner requests warranty service to be performed during other than normal business hours, the Design-Builder shall be compensated for such service at 150% of his normal hourly service rates as listed in the bid proposal for this project.
- 5. Warranty service shall include the replacement of all parts and/or components as required to restore normal system operation. In the event that system parts or components must be removed for repair, it shall be the responsibility of the Design-Builder to furnish and install temporary parts and/or components as required to restore normal system operation until the repaired parts or components can be repaired and reinstalled.
- 6. It shall be the responsibility of the Design-Builder to maintain an inventory of spare parts or to arrange for manufacturer parts support as required ensuring correction of all critical component failures or malfunctions within 48 hours of the Owner's request for service. Critical parts shall be defined as those, which govern or affect the normal operation of more than one field device.
- 7. The Design-Builder's warranty obligation shall include correction of any software/firmware defects, which may be identified during the warranty period. Any failure of the software/firmware to perform as specified by the software/firmware manufacturer at the time of final acceptance shall be defined as a software/firmware error.
- 8. In the event that the Design-Builder determines and successfully demonstrates to the Owner that service or repairs are required as a result of misuse, abuse, or abnormal wear and tear, the Design-Builder shall be compensated for such service or repairs at the Design-Builder's hourly rates as listed in the bid proposal for the Project. Similarly, such compensation to the Design-Builder shall apply in the event that repairs are required for devices and equipment not provided by the Design-Builder but incorporated in the completed systems.
- 9. Immediately following the completion of a warranty repair or service call, the Design-Builder's service personnel shall submit a written report to the Owner which details the service work performed, the cause of the trouble, and any outstanding work which is required to restore complete and normal operation.
- E. The Owner reserves the right to expand or add to the system during the warranty period using firm(s) other than the Design-Builder for such expansion without affecting the Design-Builder's responsibilities, provided that the expansion is done by a firm which is an authorized dealer or agent for the equipment or system being expanded.
- F. The Design-Builder shall perform preventative maintenance during the warranty period as part of the warranty service. The Design-Builder shall submit a list of items to be included in the preventative maintenance program and the service to be performed.
- G. Include a manufacturer's software maintenance agreement as part of the Warranty. This agreement shall include all software updates, revisions, telephone service assistance, and training for any changes in operation.

- H. Provide written notice to the Owner documenting any Work performed during the warranty period, including any preventative maintenance Work performed.
- I. Provide loaner equipment that is fully compatible with the SMS for any equipment not field repairable.
- J. Loaner equipment for components that must be shipped to/from the manufacturer or distributor shall be on site and operational within 48 hours of the component failure. Furnish lists of equipment that will require shipment from the manufacturer or distributor and lead times associated with that equipment.
- K. Repair or Replacement Service
 - 1. Repair or replacement service during the warranty period shall be performed in accordance with the following schedule:
 - A. Schedule A: 7 days, 24 hours per day with a four (4) hour response time
 - B. Schedule B: Normal business hours, excluding holidays, with a four (4) hour response time
 - 2. Schedule A shall apply for major system components including, but not limited to, the file servers, system workstations, control panels, intercom exchange and master stations, and any other components that would create security vulnerabilities if non-functional.
 - 3. Schedule B shall apply for all other components and devices.
 - 4. As part of the proposal submission, the Design-Builder shall include a labor rate schedule for any warranty service required during hours not covered under Schedule B.
- L. Failure to Perform Service
 - 1. Schedule A Components: The Design-Builder shall provide 14 days of additional total system warranty (at no additional cost to the Owner) for every two (2) consecutive days of system or device failure.
 - 2. Schedule B Components: The Design-Builder shall provide seven (7) days of additional total system warranty (at no additional cost to the Owner) for every two (2) consecutive days of system or device failure.
- M. If the Design-Builder is unable to restore system operation during the warranty period within two (2) business days of a system failure, the Owner reserves the right to require the Design-Builder to provide on-site manufacturer's service technicians at no cost to the Owner.
- N. Provide on-line software maintenance and support during the warranty period including all software and hardware.

1.14 EXTENDED MAINTENANCE
- A. Provide as part of the bid submission a quote for annual costs for the second through fifth years for an extended maintenance agreement to provide repair service including all parts and labor and a preventative maintenance program on the system. Provide a list of all items, schedules, and services included in the preventative maintenance program with the bid. Pricing shall be formatted to provide the Owner with the yearly breakdown of costs.
- B. Provide as part of the bid submission a quote to include annual costs for the second through fifth years for a manufacturer's software maintenance agreement after the warranty period has expired. The software maintenance agreement shall include all software updates, revisions, and unlimited telephone technical support. The software maintenance agreement shall include training for any changes in operation due to software revisions.
- C. The extended maintenance agreement shall include a periodic preventative maintenance program. Submit a list of items to be included in the periodic preventative maintenance program. This program shall be at least as comprehensive as the program provided under the warranty service.

1.15 BID SUBMISSIONS

- A. Instructions to Bidders
 - 1. Bidders are instructed to exclude Sales Tax from their pricing since the Owner maintains a Tax Exempt Status and shall not be subject to such charges.
 - 2. Three (3) copies of the bid proposal shall be submitted to the Owner for review and approval.
 - 3. Complete Bid Forms, Maintenance Agreement, Master Cost Summary, Equipment Lists, Cost Summaries, and Alternate Bid forms (see Attached Appendices). All forms must be filled out completely for the bid to be considered. There will be no exceptions to this requirement. Equipment Lists must include the quantity, model number, manufacturer, and price of each item listed under the equipment description. Use the forms included in this section or duplicate the forms on a spreadsheet.
 - 4. Provide a detailed description of any and all voluntary alternates and include cost changes in the Voluntary Alternate Bid forms. Bidders should submit voluntary alternates that shall either provide for a better System and/or reduce costs without degrading the System. The Design-Builder shall provide an explanation as to why the alternate is being provided, its pros and cons and any impact it may have on others. Voluntary alternates shall be priced separately and shall not be commingled with the requested pricing. All voluntary alternates shall be provided with technical Specifications.
 - 5. Unit Pricing
 - A. Furnish unit pricing and labor rates for each piece of equipment as indicated in the Unit Price Schedules.

- B. Unit prices and labor rates included in the bid submittal shall be used for all additions, deductions, and alterations of the original contract, and any mandatory alternates.
- C. Unit prices shall include all materials, labor, supervision, warranties, freight, insurance, overhead, profit, and taxes necessary for a turnkey "all inclusive" price for the scheduled item. Unit prices shall be used for the life of the Project and as a basis for purchase beyond the Project. An escalation factor based on the published Consumer Price Index (CPI) may be applied to unit prices once each year after Project completion, but the factor, if applicable, must be explained and detailed in each bid submittal.
- 6. All risk of loss or damage to materials shall rest with the Design-Builder until delivery of equipment to Owner designated delivery and storage location. Materials will be subject to inventory by the Owner upon delivery and anytime thereafter without warning or notification.
- 7. Any rates, including hourly rates that the Design-Builder believes should be included in the Bid Forms must be done at this time.
- 8. It is requested that the Design-Builder submit Alternate Pricing for groups of devices and components defined herein. For this reason a Lump Sum price for the entire scope of services as defined in the Contract Documents shall be provided to the Owner as well as the Alternate Pricing that would be deducted should the Owner choose to delete those items as defined.
- B. Compliance
 - 1. Bidders shall submit a Statement of Qualifications with the bid proposal that shall include the following information:
 - A. Company name, address, telephone number, and contact person
 - B. Brief company history
 - C. Resumes of key personnel to include the following:
 - 1. History with firm
 - 2. Project experience to include role performed on various projects
 - D. Local staffing description (job descriptions and numbers of persons in each position)
 - E. Local service capabilities (hours of operation and parts availability)
 - F. Description of local engineering and project management capabilities
 - G. List of references describing three (3) completed projects of similar size and complexity, including names and telephone numbers of the contact persons

- H. Licensing information
- 2. Provide a specification compliance statement indicating deviations from items in the specification. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of exception taken shall be considered compliant.
- 3. Additionally, as described in this Specification, bidders shall submit the following information with their bid proposal:
 - A. Maintenance Proposal and a Sample Maintenance Contract describing the nature of the Maintenance Service to be provided after the warranty period has expired.
 - B. Manufacturer's literature sheets for all standard manufactured items included in the equipment lists and as proposed in the Mandatory and Voluntary Alternate Bid forms.
 - C. Owner shall have the sole option to exercise the Maintenance Proposal submitted by Design-Builder.
 - D. Number all pages of the bid submittal.
- 4. Complete Bid Forms and Pricing Schedules as directed in Section 4 of Specification Section 28 00 00.

1.16 SUBMITTALS

- A. Submit for approval, details of all materials, equipment, and systems to be furnished. Work shall not proceed without approval of the submitted items.
- B. General Description and Requirements
 - 1. Submit pre-fabrication submittals in accordance with the construction schedule.
 - 2. Pre-fabrication submittals shall consist of product data, Shop Drawings, samples, and a detailed completion schedule. Partial submittals will not be accepted without prior written approval.
 - 3. Pre-fabrication submittals shall be furnished in electronic formats as defined by the General Conditions under Part 1 of the Project Specifications.
 - 4. No portion of the Work shall commence nor shall any equipment be procured until approval of the pre-fabrication submittals has been given in writing.
 - 5. A letter of transmittal identifying the name of the Project, Design-Builder's name, and date submitted for review shall accompany pre-fabrication submittals along with a list of items transmitted.

- C. Product data required as part of the pre-fabrication submittal shall include the following:
 - 1. Equipment schedules listing all system components, manufacturer, model number and the quantity of each
 - 2. General functional descriptions for each system
 - 3. Manufacturer's data specification sheets for all system components, including any warranty information (sheets containing more than one device or component model number shall be clearly marked to delineate items included in the Work)
 - 4. A complete list of cable and wiring types, sizes, manufacturer, and model number
 - 5. A complete list of finishes and sample graphics, including custom art work and custom graphics (if applicable)
 - 6. List of parts inventory to provide manufacturer recommended service and maintenance of the Work
- D. Shop Drawings shall include the following:
 - 1. Floor plan drawings indicating device locations with device legends
 - 2. System riser diagram with all devices, wire runs, and wire designations
 - 3. Schematic block diagrams for each system showing all equipment, interconnects, data flow, etc.
 - 4. Wiring diagrams for each subsystem defining the interconnection of all inputs and outputs for all equipment
 - 5. Wiring diagram for fail-safe release of electric locking mechanical
 - 6. Fabrication Shop Drawings for all custom equipment (if applicable)
 - 7. Plans and elevations of the security console(s) and equipment racks quantifying all equipment to be mounted therein
 - 8. Elevations of security closet layouts showing panel locations, power supply locations, conduit, wire ways, wire molds, and all other equipment
 - 9. Submit samples of any equipment components upon request.
 - 10. Samples submitted shall be the latest version of equipment.
 - 11. It is the responsibility of the Design-Builder to confirm all dimensions, quantities, and the coordination of materials and products supplied by the Design-Builder with other trades. Approval of Shop Drawings containing errors does not relieve the Design-Builder from making corrections at their expense.

- 12. Submittals for individual systems and equipment assemblies that consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered, reviewed, or stored and such submittals will not be approved.
- 13. Shop Drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details, and any other details not included in the Construction Drawings.
- E. Any materials and equipment listed that are not in accordance with Specifications requirements may be rejected.
- F. The approval of material, equipment, systems, and Shop Drawings is a general approval subject to the Drawings, Specifications, and verification of all measurements at the job. Approval does not relieve the responsibility of shop drawing errors. Carefully check and correct all Shop Drawings prior to submission for approval.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

- A. Where equipment is identified by manufacturer and catalog number, it shall be as the base of requirements for quality and performance. Where manufacturers for equipment are identified by name, it is allowable to submit for approval, similar equipment of other manufacturers as substitution. The decision as to whether the submitted equipment is acceptable shall be final and binding.
- B. All changes necessary to accommodate the substituted equipment shall be made with no additional expense, and shall be as approved. Detailed Drawings indicating the required changes shall be submitted for approval at the time the substitution is requested.
- C. If substitutions are made in lieu of device specified; form, dimension, design, and profile shall be submitted for approval.
- D. Submit request for approval of substitute materials in writing at least ten days prior to bid opening.

2.2 MATERIALS

- A. All materials used in this work shall be new and shall bear the inspection label of Underwriters Laboratories Inc. or certification by other recognized laboratory as required.
- B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard Institute (ANSI), the Institute of Electrical and Electronic Consultants (IEEE), and the American Society of Testing Materials (ASTM), are made a part of these Specifications and shall apply wherever applicable.
- C. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- D. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer or partner manufacturers that offer a certified solution.
- E. Components of an assembled unit need not be products of the same manufacturer, but must offer a certified end-to-end solution.
- F. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
- G. Components shall be compatible with each other and with the total assembly for the

2.3 GENERAL

- A. Provide all wire and cable required for a complete and functional SMS. IP infrastructure is to be provided by others.
- B. All wire and cable shall be Underwriters Laboratories (UL) approved for its intended application, shall meet all national, state and local code requirements for its application, and shall meet or exceed manufacturers' recommendations for the components connected.
- C. All insulated wire and cable shall conform to the minimum requirements of Insulated Cable Engineers Association (ICEA) Standards.
- D. Wire and cable shall comply with the applicable requirements of the National Electrical Code (NEC), latest edition, in regard to cable construction and usage.
- E. The conductors of wires shall be copper and have conductivity in accordance with the standardization rules of the Institute of Electrical and Electronics Engineers, Inc. (IEEE). The conductor and each strand shall be round and free of kinks and defects.
- F. All cable carrying data or voice transmissions shall be shielded. All other cable shall be shielded where necessary for interference-free signals.
- G. Insulation shall be rated for a minimum of 300 V.
- H. Color-coding shall be accomplished by using solidly colored insulation. Colorcoding shall be standardized with the Owner's security color-coding system, except as required by codes. Grounding conductors shall be colored solid green or identified with green color as required by the National Electric Code (NEC).
- I. All cable jackets shall be color coded as specified by the Owner.
- J. All wire and cable shall be Underwriters laboratories (UL) listed and shall meet all national, state and local code requirements for its application.
- K. All wire and cable shall meet the requirements of the National Electric Code (NEC) in regards to cable construction and application including conductors and jackets.
- L. Establish appropriate grounding practices to eliminate shorts, ground faults, ground loops, RF interference, voltage fluctuations and open circuits.
- M. All conductors shall be copper and shall be sized with consideration for voltage drop on long runs.
- N. All wiring shall be run within conduit (provided by others) or in cable tray systems (provided by others) and in riser closets when no conduit is used.

Cable trays shall be used whenever available. Use of any space other than conduit or cable trays shall be submitted to and approved by the Designer and Security Consultant prior to installation. Use of any exposed wiring not concealed by accessible ceilings or within riser closets shall be submitted to the Designer and approved prior to installation.

- O. Plenum type cable must be used in all return air plenum spaces and where required by code. All cables shall be fastened to structure at least every 2.5 meters where not in conduit. All wire shall be installed parallel and perpendicular to building structure and shall be neatly bundled.
- P. Any cable not run in conduit shall be a kept a minimum of 4 feet from high voltage (120 VAC and above) circuits (i.e. light fixtures, wire run parallel with conduit, transformers, and electric panels etc.)
- Q. Provide code compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where the penetrations are made by or used for installation of the SMS.
- R. Separate 120 VAC and other line voltage cables from low voltage cables within enclosures. No high voltage (120 VAC and above) wire and cable shall be run in the same conduit as security data and security low voltage wire and cable.

2.4 WIRE TYPES AND SIZES

- A. Provide and size all wires as specified on the Drawings and associated wire lists provided by the Designer. All wires shall be run to the device locations as indicated on the Security Device locations and shall be neatly coiled, bundled and placed in a safe location until terminated.
- B. Signal Cabling (Non-Power): Wire size shall be a minimum of 20 AWG, twisted, shielded, stranded, insulated, and jacketed.
- C. Signal/Power (24VAC/VDC) Cabling: Wire size shall be a minimum of 18 AWG, stranded, insulated, and jacketed.
 - 1. Wire size shall be a minimum of 18 AWG, twisted, stranded, insulated and jacketed and shall be used for cable runs less than 500 feet.
 - 2. Wire size shall be a minimum of 16 AWG, twisted, stranded, insulated and jacketed and shall be used for cable runs in excess of 500 feet, but less than 750 feet.
 - 3. Wire size shall be a minimum of 14 AWG, twisted, stranded, insulated and jacketed and shall be used for cable runs in excess of 750 feet, but less than 1,250 feet.
- D. Local Area Network Cable (LAN Cable)

- 1. All augmented Category-6A performance four (4) pair F/UTP cable shall consist of eight (8) twenty-four (24) gauge, or greater, thermoplastic insulated solid twisted conductors that utilize the industry standard color code designations and provided with overall aluminum foil shield and longitudinal drain wire.
- 2. The performance criteria for four (4) pair F/UTP cable shall be meet or exceed specific ANSI/TIA-568-C standards for Category-6A cable rating and shall show stable performance with documented electrical characterization out to 500 MHz.
- 3. Cables shall be rated per the installation environment as required by the local AHJ and building codes.
- 4. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.

E. Splices

- 1. Run all wire and cable continuous from device location to the final point of termination. No mid-run cable splices shall be allowed unless approved by Designer and Security Consultant prior to installation.
- F. Acceptable manufacturers: Belden, Tappan, West Penn or approved equal

2.5 VIDEO SURVEILLANCE SYSTEM

A. General

- 1. Provide VSS components (cameras, NVR's etc.) as indicated in the Drawings and as specified herein.
- 2. The VSS shall be integrated with the Network Video Recorders (NVR's) at the over the IP network (provided by others).
- 3. The VSS shall provide for: non-motion recording to be 10-15 frames per second (fps) with 30 days of video retention.
- 4. The VSS shall provide for monitoring, controlling, switching, and recording of all camera feeds in the System as indicated on the Drawings and Specifications.
- 5. The VSS shall be compatible with local video broadcast standards.
- 6. All VSS equipment shall be color compatible. All recording, playback and viewing of video shall be in color.
- 7. The IP backbone and network cable from IDF's to camera locations shall be provided by the Telecommunications Design-Builder. Patch cables from cameras to associated

data jacks will be provided by the Design-Builder. Provide all other equipment & materials required to connect cameras to the IP network within the IDF rooms. Coordinate cabling requirements with the Telecommunications Design-Builder.

- 8. Fiber optic cabling to exterior cameras shall be provided by the Telecommunications Design-Builder. Provide all other equipment & materials required to connect cameras to the fiber optic cabling and to the IP backbone within the IDF rooms. Coordinate cabling requirements with the Telecommunications Design-Builder.
- B. Network Video Recorder (NVR)
 - 1. Provide new NVR's as indicated in the MDF/IDF rooms at the Long Term Care and Domiciliary buildings.
 - 2. Design-Builder shall be responsible for sizing the Network Video Recorder(s) to ensure it supports and provides a complete and functioning system as described herein.
 - 3. Acceptable Manufacturers: As per the VSS manufacturer's recommendations.
- C. VSS Cameras
 - 1. Provide VSS Cameras as indicated on the Drawings.
 - 2. Fixed IP Security Camera
 - A. Minimum Specifications:
 - 1. Day & Night functionality: Automatic
 - 2. Lens: Varifocal 2.5-6.0 mm, remote focus and zoom, IR corrected, P-Iris control
 - **3**. Video compression: H.264, MPEG-4
 - 4. Max video resolution (pixels): 1280x960 (approx. 1.3 MP) to 160x90
 - 5. Frames per second: 25-30, for all resolutions
 - 6. Video motion detection
 - 7. Security: Multi-level password, IP address filtering, HTTPS encryption
 - 8. Power over Ethernet (IEEE802.3af): Built-in
 - 9. Serial connectors: RJ-45 10BASE-T/100BASE-TX PoE
 - 10. Other: Vandal-resistant IP66-rated casing as required. Built-in heater and fan as required for outdoor applications.
 - 11. Options: Corridor Format where applicable
 - B. Acceptable Manufacturers: Axis or approved equal
 - 3. PTZ IP Security Camera
 - A. Minimum Specifications:
 - 1. Image sensor: 1/2.8" CMOS
 - 2. Video compression: h.264
 - 3. Resolution: 1920x1080
 - 4. Frames per second: 30
 - 5. Video motion detection

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- 6. Power over Ethernet (IEEE802.3af): Built-in
- 7. Zoom: Minimum 30x Optical, 12x digital
- 8. Other: Continuous Motion 24x7, WDR
- 9. Housing: Environmental
- B. Acceptable Manufacturers: Axis or approved equal
- 4. Multi-Sensor IP Security Camera 360°
 - A. Minimum Specifications:
 - 1. Image sensor: $4 \times 1/2.8$ " CMOS
 - 2. Video compression: h.264
 - 3. Resolution: 4 x 1920x1080
 - 4. Frames per second: 30
 - 5. Video motion detection
 - 6. Power over Ethernet (IEEE802.3af): Built-in
 - 7. Other: Continuous Motion 24x7, WDR
 - 8. Housing: Environmental
 - B. Acceptable Manufacturers: Axis or approved equal
- 5. Multi-Sensor IP Security Camera 180°
 - A. Minimum Specifications:
 - 1. Image sensor: 4 x 1/2.9" Progressive Scan RGB CMOS
 - 2. Video compression: h.264
 - **3**. Resolution: 4320 x 1920 to 480 x 270
 - 4. Frames per second: 12.5/15
 - 5. Video motion detection
 - 6. Power over Ethernet (IEEE802.3af): Built-in
 - 7. Other: Continuous Motion 24x7, WDR
 - 8. Housing: Environmental
 - B. Acceptable Manufacturers: Axis or approved equal
- D. VSS Camera Pole Housing & Midspan
 - 1. Housing
 - A. Provide Pole Specific for security cameras as indicated on the Drawings.
 - B. Housing shall provide space for midspan as indicated below
 - C. Acceptable Manufacturer: Axis T91G61 or approved equal
 - 2. Midspan
 - A. Provide midspan for pole mounted security cameras as indicated on the Drawings.
 - B. Acceptable Manufacturer: AXIS T8154 or approved equal
- E. VSS Camera Enclosures
 - 1. Provide VSS camera housings and mounts as indicated on the Drawings and as specified herein.
 - 2. Wiring to all cameras shall pass from the back box through the mount and into the housing. Exposed wiring of any kind shall not be acceptable.

- 3. Provide sun shields for camera housings in outdoor locations exposed directly to sunlight.
- 4. Provide weather and dust proof camera housings with thermostatically controlled heaters and blowers in outdoor locations.
- 5. Provide lightning protection for power, control, and video cables for all exterior cameras.
- F. VSS Camera Enclosure Mounts
 - 1. The Camera Enclosure Mounts shall be provided as indicated on the Drawings and as specified herein. The Camera Enclosure Mounts shall be provided for wall, pendant, corner, pole, and parapet mount applications.
 - 2. The Camera Enclosure Mounts shall be compatible and similar in design as specified camera enclosures.
 - 3. Coordinate with the Architect to establish the finish requirements for each Camera Enclosure on an individual basis. Some or all enclosure mounts may require painting to match the associated camera enclosure and surrounding surface finishes. All Camera Enclosure Mounts shall be finished as specified by the Architect.
 - 4. Each Camera Enclosure Mount shall be designed to adequately support each associated camera enclosure, which shall also include the weight of the camera, lens assembly, cable, and cable fittings.
 - 5. The Camera Enclosure Mount shall employ an adjustable swivel/tilt head to allow for enclosure rotation as necessary to obtain the correct camera field of view. Unless otherwise noted, all cabling between the conduit junction box and camera enclosure shall feed directly though the enclosure mounts. All accessible cabling shall be armored for protection. At no time shall the cabling bypass the Camera Enclosure Mount and feed directly into the camera enclosure.
 - 6. Provide all support structure as necessary to insure the Camera Enclosure Mount is securely fastened to the building structure.
 - 7. Camera mounts for each VSS camera shall be approved by the Architect prior to installation.
 - 8. Acceptable Manufacturers: As per the VSS manufacturer's recommendations.
- G. Interfaces
 - 1. Provide interfaces between VSS and other building systems.
- H. NETWORKING EQUIPMENT
 - 1. Access control panels, IPDC's and IP cameras shall communicate to the server via the Owner's network (provided by others).
 - 2. Provide all necessary equipment for the system to connect to the network switching equipment, provided by Owner, and communicate over the Owner's network.

2.6 ACCESS CONTROL AND ALARM MONITORING SYSTEM PRODUCTS

A. System Description

- 1. Provide ACAM System components (panels, readers, sensors, etc.) as indicated in the Drawings and as specified herein.
- 2. Provide file server to accommodate the future expansion of the system.
- 3. The network backbone shall be provided by the Telecommunications Design-Builder. The network switching equipment shall be provided by the Owner. Provide all equipment & materials required to connect the ACAM System to the IP network. Coordinate network requirements with the Telecommunications Design-Builder and Owner.
- B. Client/System Workstations
 - 1. Provide workstations as indicated on the Drawings.
 - 2. Design-Builder shall be responsible for sizing the client workstations to ensure it supports and provides a complete and functioning system as described herein.
 - 3. All workstations shall run on a Microsoft Windows operating system platform.
 - 4. All operator interfaces with the ACAMS shall be through workstations. Workstations shall display real-time system messages, data files and records, operator instructions, data programming information, and custom graphic illustrations.
 - 5. Workstations shall not be proprietary to the Design-Builder. The Owner shall be able to purchase additional workstations from computer vendors other than the Design-Builder.
 - 6. Minimum System Workstation Requirements:
 - 1. Processor: Pentium 4, 2 GHz minimum
 - **2**. RAM: 2GB
 - 3. Available HD Space: 1GB
 - 4. Network Card: 10/100 Mb
 - 5. CD-ROM Drive
 - 6. Display: 1024 x 768
 - 7. Acceptable Manufacturers: As per the ACAMS manufacturer's recommendations and/or specifications
- C. Data Gathering Panels
 - 1. The DGPs shall collect alarm input point status and access control data, multiplex the information, and transmit that data back to the file server/workstations. DGPs shall support a minimum of eight (8) card

readers through the use of plug-in or attached modules unless indicated otherwise.

- 2. The DGPs shall incorporate Flash ROM to allow for efficient firmware update downloads from the system software and/or remotely from the manufacturer.
- **3**. The DGPs shall receive and execute instructions issued automatically or manually from the file server/workstation.
- 4. The DGPs shall have memory and logic circuits as required to ensure continued operation of connected devices without degradation in system security in the event that communications with the file server is interrupted.
- 5. All DGPs shall communicate with the file server over a dedicated communications circuit. Provide all equipment necessary to facilitate communications, e.g. routers, terminal servers, short haul modems, etc. All communications shall be fully supervised
- 6. The DGPs shall provide:
 - 1. Supervised alarm inputs to monitor the status of alarm circuits and report the status information to the file server.
 - 2. Control relay outputs for controlling devices by remote command from the workstations, through time programming or on alarm point activation date on the file server. Control relay output contacts shall be rated for 2 A @ 24 VDC.
 - **3**. Flash ROM technology and shall provide for remote update of DGP firmware.
 - 4. Supervision of all wiring/circuits between the DGPs and monitored alarm devices, wire/device supervision shall meet UL 1076 guidelines.
 - 5. Sufficient RAM to maintain a minimum card database of 5,000 cards.
 - 6. Automatic disconnection from the communication circuit upon a communication failure within the DGPs.
 - 7. Enough RAM to operate normally upon loss of communication with the file server. In addition, the DGPs shall store up to 5,000 card transactions and up to 16 events per potential alarm input. Stored data shall be transmitted to the file server upon restoration of communications.
 - 8. Activation of a door control relay output and shunting of the intrusion alarm upon verification of a card authorization or request to exit.

- 9. Adjustable door control relay activation time through software from 1 to 30 seconds on an individual card reader basis. The door shall automatically relock upon closure.
- 10. An intrusion alarm indication on the ACAMS if the card reader controlled door is opened without an authorized card use or request to exit.
- 11. A door prop alarm indication if the card reader controlled door is held open past an adjustable time period after an authorized card use or request to exit. The door prop time delay shall be adjustable through software from 1 to 60 seconds on an individual card reader basis.
- 12. A wiring chart delineating wire routings, labeling, and all termination points. The chart shall be produced by the Design-Builder, laminated, and housed in a clear plastic sleeve affixed to the inside of the enclosure cover.
- 13. A tamper switch to sense the removal or opening of the enclosure cover.
- 7. Transaction time for authorized cards shall be less than 0.5 second from the time of card read until the door is unlocked.
- 8. Provide one (1) spare card reader input point and 20% spare input points and output points after all specified points are initially connected. Sufficient modules shall be provided to accommodate only the number of card readers initially installed, as well as one (1) spare input per DGP.
- 9. DGPs designated for elevator control shall support the following additional elevator functions.
- 10. Receiving and executing instructions issued automatically or manually through software.
- 11. Memory and logic circuits to ensure continued operation of connected devices without degradation in SMS security in the event that communications with the file server is interrupted.
- 12. Acceptable Manufacturers: As per the ACAMS manufacturer's recommendations and/or specifications.
- D. DGP Power Supply
 - 1. The DGP Power Supply shall be dedicated to the DGP and shall not provide power for locks or any other low voltage device.
 - 2. The Power Supply shall provide the following:
 - 1. 120 VAC 60 Hz input voltage and provide filtered and conditioned output voltage as required.

- 2. Four (4) hours of battery backup to provide continuous operation during power failure.
- 3. A battery charger to maintain the battery.
- 4. Low battery and power fail contacts to monitor the status of the input power and the battery.
- 3. Each Power Supply shall be housed in a locking steel enclosure designed for surface mounting. The housing shall include a tamper switch to sense the removal or opening of the enclosure cover. All power supplies, DGP's, and power distribution cabinets shall be keyed alike.
- 4. Acceptable Manufacturers: As per the SMS manufacturer's recommendations and/or Owner's standards.
- E. Card Reader Controlled Doors
 - 1. The SMS shall provide card reader, workstation, or time schedule control through file server programming of electric locking mechanisms as designated by the Owner.
 - 2. The SMS shall provide for monitoring of the open/closed status of card reader controlled doors through normally closed magnetic door position switches provided as part of the System. In addition, the ACAMS shall monitor the card reader for invalid card use. The ACAMS shall annunciate each condition individually.
 - 3. The SMS shall disarm the door position switch alarm monitoring for a predefined period of time upon the use of a valid request to exit device or a card reader provided as part of the card reader controlled door. This process shall be programmable and shall allow the door to be opened without generating a forced/intrusion alarm for the time period defined. The SMS shall generate a held open/door prop alarm if the door is still open once the predefined entry/exit time period has elapsed.
- F. Card Reader
 - 1. The Card Reader shall be a multi technology model with the capability to read multiple card formats, including smartcard, proximity, etc. It shall read encoded data from access cards and transmit the data to the DPGs. The operating frequency shall meet all local regulations.
 - 2. A two-color LED on the face of the Card Reader and an audible tone shall indicate authorized and unauthorized reader uses.
 - 3. No system compromise shall be possible from circuitry located in the reader unit.
 - 4. The Card Reader shall have provision to operate as specified in environments of electromagnetic and radio frequency interference as

well as spurious electrical line interference. When installed according to manufacturer's instructions the reader shall operate properly when mounted adjacent to or directly on any material including metal without the use of standoff or space.

- 5. The Card Reader and bit pattern shall not be proprietary to a single Design-Builder or manufacturer.
- 6. The Card Reader shall have a minimum read range of four (4) inches.
- 7. Provide manufacturer recommended power to each reader directly from the DGP or a secondary supply. The power supply shall be UL Class 2, power limited and shall provide necessary output voltage to allow the card reader to operate at its maximum specified read range.
- 8. Acceptable Manufacturers: HID iClass SE RP40 or approved equal or approved equal
- G. Integrated Wired Electrified Lock, Card Reader/Keypad
 - 1. Integrated electrified lock, card reader/keypads as indicated on the drawings shall be provided by Division 08. Coordinate with Division 08 Design-Builder for the installation and connection of the device to the system.
- H. Integrated Wireless Electrified Lock, Card Reader/Keypad (On-Line)
 - 1. Integrated wireless electrified lock, card reader/keypads as indicated on the drawings shall be provided by Division 08. Coordinate with Division 08 Design-Builder for the installation and connection of the device to the system.
- I. Integrated Wireless Electrified Lock, Card Reader/Keypad Panel Interface Module
 - 1. Provide Panel Interface Modules (PIM) as required to support the integrated wireless electrified lock card/reader keypads as indicated on the drawings.
 - 2. The PIM shall be powered by PoE.
 - 3. Acceptable Manufacturers: Schlage PIM400-1501, or approved equal.
- J. Integrated Wireless Cylindrical Lock
 - 1. Integrated wireless cylindrical lock, card reader as indicated on the drawings shall be provided by Division 08. Coordinate with Division 08 Design-Builder for the installation and connection of the device to the system.
- K. Integrated Wireless Cylindrical Lock, Card Reader Gateway

- 1. Provide Gateway as required to support the integrated wireless cylindrical lock card reader as indicated on the drawings.
- 2. The Gateway shall be powered by 12 VDC.
- 3. The Gateway shall interface by RS-485 to the DGP.
- 4. Acceptable Manufacturers: Schlage GWE Gateway, or approved equal.
- L. Medical Cabinet Card Reader
 - 1. Provide medical cabinet card reader as indicated on the drawings, noted by AC-DR.
 - 2. Acceptable Manufacturer: HES K200 Series or approved equal.
- M. Access Control Card
 - 1. Access control cards are to be used.
- N. Electrified Locking Mechanisms
 - 1. Electrified locking mechanisms shall be provided by the door hardware Design-Builder as indicated on the Drawings.
 - 2. Assume electrified locking hardware is equipped with integral request to exit function. Wire the REX sensor to the REX input of the access control system.
 - 3. Interface with electrified locking mechanisms as indicated on the Drawings.
 - 4. Provide fail-safe operation of electrified locking mechanisms as required by local codes.
 - 5. Fail-secure locks shall remain operational during a fire alarm condition or power failure.
- O. Delayed Egress Locking Devices
 - 1. If required, the door hardware supplier shall provide delayed egress locking devices and compatible power supplies/controllers where indicated on the Drawings.
 - 2. Interface to delayed egress power supplies/controllers as necessary to facilitate required operation to include:
 - 1. Delayed egress locking devices shall unlock automatically for the following conditions:
 - (1) Any building fire alarm
 - (2) Loss of building power
 - (3) Failure of the power supply

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- 2. Provide monitoring of the normally closed alarm contact that shall open upon activation of the unlock timer.
- **3**. Provide lock control of delayed egress locking device through output contacts activated by file server/workstation, or time schedule.
- P. Electrified Locking Mechanism Power Supply
 - 1. Provide Power Supplies for all electric locking mechanisms as specified with the exception of those noted as having time-delay functions as defined by NFPA 101.
 - 2. Power Supplies for time-delay function locks shall be provided by others. The Design-Builder shall coordinate with others as necessary to ensure proper operation of all time-delay electric locking mechanisms to include the provision of, and final termination of, system control and monitoring wire and cable as necessary to facilitate desired operation and integration with the system.
 - 3. Provide Power Supplies for all electric locking mechanisms (with the exception of fire stair doors). Fail-safe locking devices shall unlock automatically under the following conditions:
 - 1. Any building fire alarm
 - 2. Loss of building power
 - **3**. Failure of the power supply
 - 4. Provide battery chargers and batteries sufficient for four (4) hours of backup power for the connected load for all power supplies except those for fail-safe locks.
 - 5. Monitor low battery and power fail alarms for each Power Supply.
 - 6. Minimum Specifications:
 - 1. Type: UL Listed Class II power limited
 - 2. Input Voltage: 120VAC 60 Hz
 - 3. Output Voltage: 24 VDC
 - 4. Output Connections: Individually fused outputs to each lock
 - 5. Output Rating: 150% of actual connected load
 - 6. Battery: Sealed gel type
 - 7. Alarm Outputs: Low battery and power fail
 - 8. Enclosure: Steel enclosure with integral lock and tamper switch

- 7. Acceptable Manufacturers: Altronix, Securitron, Alarm SAF or approved equal
- Q. Request-to-Exit Device
 - 1. Assume electrified locking hardware is equipped with integral request to exit function. Interface to request to exit switches integral to electrified locking hardware. Wire the REX sensor to the REX input of the access control system.
 - 2. Where external request to exit devices are necessary, provide infrared motion sensors for detecting authorized exits through card reader controlled doors. Wire the REX motion sensor to the REX input of the access control panel.
 - 3. For doors equipped with electromagnetic locks, activation of the REX motion sensor shall release the electric locking mechanism and shall shunt the intrusion alarm output.
 - 4. For doors equipped with electric locking mechanisms that are free exiting at all times (i.e. mortise electric locks, electric strikes, etc.), the REX motion sensor shall only shunt the intrusion alarm output and shall not unlock the lock.
 - 5. Minimum Specifications:
 - 1. Detection tech: Passive Infrared
 - 2. Detection pattern: Adjustable narrow 15° cone
 - 3. Output contact: Two (2) Form "C" relay contacts
 - 4. Power requirements: 24V DC
 - 5. Mounting: Door frame lintel mounted or ceiling mounted
 - 6. Provide UL Class 2, power limited power supply as specified herein and/or as recommended by the device manufacturer.
 - 7. Acceptable Manufacturers: Bosch, Honeywell, Securitron or approved equal
- R. Device Power Supply
 - 1. Provide Power Supplies for all ACAMS equipment as required.
 - 2. Monitor low battery and power fail alarms for each power supply.
 - 3. Minimum Specifications:
 - 1. Type: UL Listed Class II power limited
 - 2. Input: 120VAC 60 Hz hard wired
 - 3. Output: Regulated and filtered 24VDC

- 4. Output rating: 150% of the actual connected load
- 5. Battery backup: Four (4) hours of rechargeable backup
- 6. Battery: Sealed gel type
- 7. Alarm outputs: Low battery and power fail
- 8. Enclosure: Key lockable wall mount housing with tamper switch
- 4. Acceptable Manufacturers: Altronix, Alarm SAF, Honeywell or approved equal
- S. Door Position Switch
 - 1. Provide normally closed (N/C) magnetic door position switches to monitor the open/closed status of doors as specified herein and as indicated on the Drawings.
 - 2. Concealed Door Position Switch
 - 1. Minimum Specifications:
 - (1) Gap: $\frac{1}{2}$ " between the magnet and switch
 - (2) Configuration: N/C
 - (3) Mounting: 1" diameter hole in door and frame
 - 2. Acceptable Manufacturers: GE Interlogix, Bosch, Honeywell, or approved equal
 - 3. Surface Mount Door Position Switch
 - 1. Minimum Specifications:
 - (1) Gap: 3" between the magnet and switch
 - (2) Configuration: N/C
 - (3) Mounting: Surface mount to door and frame
 - 2. Provide armored cable from the switch location to the associated junction box in order to conceal the wire.
 - **3**. Acceptable Manufacturers: GE Interlogix, Bosch, Honeywell, or approved equal
- T. Tamper Switch
 - 1. Provide normally closed tamper switches to monitor the secure status of all panels, power supplies, and power distribution units.
 - 2. Include the number of tamper switches in the total alarm input figures.

- 3. Minimum Specifications:
 - 1. Type: Plunger
 - 2. Configuration: N/C
 - 3. Mounting: Within cabinet with no outside access to fasteners
- U. Duress Alarm
 - 1. Provide personnel duress alarms with normally closed alarm output contacts as indicated on the Drawings
 - 2. Upon activation, the duress alarm will remain active until which time it is reset by key. No other form of deactivation shall be provided.
 - 3. Locate desk mounted duress buttons below counter tops or in the knee space of desks in an accessible location. Verify the exact location with the Architect.
 - 4. Minimum Specifications:
 - 1. Activation: Push button
 - 2. Alarm output: DPDT contacts
 - 3. Reset method: Key-switch
 - 4. Mounting: Desk
 - 5. Acceptable Manufacturers: Honeywell, Bosch, Ademco or approved equal.
- V. Alarm Monitoring
 - 1. The ACAMS shall provide for alarm monitoring of intrusion and duress alarms.
 - 2. Alarms shall annunciate at the work stations as directed by the Owner.
 - 3. All alarms shall be programmable through the file server/workstations and shall report alarms based on user defined priority levels and schedules.
 - 4. The ACAMS shall be capable of grouping alarm device inputs according to area and shall allow for scheduled or manual control of those groups as defined by the user.
 - 5. The ACAMS shall provide for alarm messaging and response instruction by device, by area, or by schedule.
 - 6. The ACAMS shall also provide for command control or relay output actions through DGB components and software, which shall be selectable and programmable by device, by area, or by schedule.

- 7. Command control and relay output actions as defined by the ACAMS shall be selectable by device, by group, or by schedule across the entire system. These actions and controls shall not be limited by their location on an DGP.
- 8. For example: An alarm input on one DGP string shall be capable of executing a relay output command on another DGP string upon activation.

2.7 INTERCOM COMMUNICATIONS SYSTEM

- A. System Description
 - 1. Provide a complete and functional IP Intercom System consisting of master stations, video substations, etc., as indicated in the Drawings and as specified herein.
- B. Intercom Master Stations
 - 1. General
 - 1. Provide video intercom master stations as indicated on the Drawings in the new and existing Security Command Center.
 - 2. Minimum Specifications:
 - 1. Power Source: 802.3af PoE
 - 2. Communication: Handset Simultaneous Communication Handsfree Auto-voice actuation or PTT (push-to-talk)
 - 3. Monitor: 3.5-inch color LCD
 - 4. Paging capacity: Simultaneous to max. 5 zones and/or stations
 - 5. Mounting: Desktop w/ stand or wall mount
 - 6. Wiring: CAT-5e or CAT-6
 - 7. Wiring distance: 330'
 - 8. 802.3af PoE compliant
 - 3. Acceptable Manufacturers: Aiphone or approved equal
- C. Video Intercom Substations
 - 1. General
 - 1. Provide substations as indicated on the Drawings.
 - 2. Minimum Specifications:
 - 1. Power Source: 802.3af PoE compliant

- 2. Communication: Open voice hands-free
- 3. Wiring: CAT-5e or CAT-6 Wiring distance: 330'
- 4. Door release: 24V AC/DC, 500mA (N/O, COM, N/C)
- 5. Mounting: Mounts to single gang box
- 6. Weather resistant
- 3. Acceptable Manufacturers: Aiphone or approved equal
- D. Emergency Call Box Wall Mount
 - 1. Provide wall mount for emergency call box substations as indicated on the Drawings.
 - 2. Minimum Specifications:
 - 1. Dimensions (W x D x H): 12 x 7.88 x 32.2 in.
 - 2. Weight: 55 lbs.
 - **3**. Colors: Brushed stainless steel is standard. Available painted in custom colors.
 - 4. Signage: Confirm exact signage and working with Owner
 - 5. Lighting: Beacon/Strobe
 - 3. Acceptable Manufacturers: Code Blue CB 2-E, or approved equal
- E. Emergency Call Box Stanchion
 - 1. Provide wall mount for emergency call box substations as indicated on the Drawings.
 - 2. Minimum Specifications:
 - 1. Dimensions (W x D x H): 12 x 7.88 x 9.5'
 - 2. Weight: 220 lbs.
 - **3**. Colors: Safety Yellow.
 - 4. Signage: Confirm exact signage and working with Owner
 - 5. Lighting: Beacon/Strobe
 - 6. Options: Overhead Camera Mount
 - 3. Acceptable Manufacturers: Code Blue CB 5-S, or approved equal

2. NETWORKING EQUIPMENT

- A. Access control panels, DGP's and IP cameras shall communicate to the server via the Owner's network (provided by others).
- B. Provide all necessary equipment for the system to connect to the network switching equipment, provided by Owner, and communicate over the Owner's network.

PART 3 EXECUTION

3.1 LANGUAGE USAGE

A. English language shall be used throughout the security system, signage, labels, voice messages, instructions, manuals, software, and graphic displays.

3.2 EXAMINATION OF CONDITIONS

- A. Prior to the start of work, carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.
- B. Install equipment in accordance with applicable codes and regulations, the original design intent, and the referenced standards.
- C. In the event of a discrepancy, immediately provide notification notify the Project Manager.
- D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.3 PROTECTION OF SYSTEMS AND EQUIPMENT

- A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature, and rain.
- B. Damage from rain, dirt, sun, and ground water shall be prevented by storing the equipment on elevated supports and covering the sides with securely fastened protective rigid or flexible waterproof coverings.
- C. During installation, equipment shall be protected against entry of foreign matter on the inside and be cleaned both inside and outside before testing, operating, or painting.
- D. As determined by the Project Manager, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the contract documents. The decision of the Project Manager shall be final.
- E. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with the same quality of paint and workmanship as used by the manufacturer.

3.4 ACCESS TO EQUIPMENT

- A. Equipment shall be installed in location and manner that will allow convenient access for maintenance and inspection.
- B. Working spaces shall be not less than specified in the National Electrical Code (NEC) for voltages specified.
- C. Where the Project Manager determines that the installed equipment is not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one

time only, as directed by the Project Manager, at no additional cost. "Conveniently accessible" is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and duct work, except where required by design or intent.

3.5 INSTALLATION

- A. The Design-Builder shall carefully follow the instructions in the manufacturers' Installation Manual to insure all steps have been taken to provide a reliable, easy to operate system.
- B. The Administrator Terminal shall be connected to the remote terminals before connecting to any card reader processors.
- C. Perform all Work as indicated in the Drawings and Specifications.
- D. The Design-Builder shall install the appropriate cable from the CPU to readers, door contacts, request-to-exit devices, and electric locks at each door and/or gate.
- E. All communications cables shall be kept away from power circuits.
- F. The Design-Builder shall install the power supply(s) for electric locks in locations where they won't interfere with other operations.
- G. The Design-Builder shall also execute adequate testing of the system to insure proper operation.
- H. The Design-Builder shall provide adequate training of the system users to insure adequate understanding to prevent operating errors.

3.6 WORKMANSHIP

- A. Comply with highest industry standards, except when specified requirements indicate more rigid standards or more precise workmanship.
- B. Perform Work with persons experienced and qualified to produce workmanship specified.
- C. Maintain quality control over suppliers and SubDesign-Builders.
- D. Quality of workmanship is considered important. Project Manager will have the authority to reject Work which does not conform to the Drawings and Specifications.

3.7 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested as per manufacturer's instructions prior to delivery to job site and prior to installation.

3.8 WIRE AND CABLE

A. Design, layout, size, and plan new wire and cable runs as required.

- B. All wire and cable from the processors to all devices at each door shall be "home-run" unless otherwise specified.
- C. All wire and cable, including any wire and cable that is existing and will be reused in the Work, shall be installed in conduit or surface metal raceway, except as follows:
 - 1. Wire or cable, in lengths of less than ten (10) feet, that is "fished" within walls, ceilings, and doorframes.
- D. All wire and cable passing thru metalwork shall be sleeved by an approved grommet or bushing.
- E. Avoid splicing conductors. All splices shall be made in junction boxes (except at equipment). Splices shall be made with an approved crimp connection. Wire nuts shall not be used on any low-voltage wiring. Where necessary, provide heat-shrink to insulate all wire splices and connections. The use of electrical tape for splices and connections shall not be acceptable.
- F. Identify all wire and cable at terminations and at every junction box. Identification shall be made with an approved permanent label, or equal.
- G. Furnish and install all SMS wire and cable with the exception of traveling cable for elevator control and monitoring.
- H. Coordinate the protection and routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc. with the Architect.
- I. Run all wire and cable continuous from device location to the final point of termination. No mid-run cable splices shall be allowed.
- J. Wire and cable within ICs, power distribution cabinets and other security enclosures shall be neatly installed, completely terminated, pulled tight with slack removed and routed in such a way as to allow direct, unimpeded access to the equipment within the enclosure. All wire and cable shall be bundled and tied.
- K. Provide heat-shrink to insulate all wire splices and connections. The use of electrical tape for splices and connections shall not be acceptable.
- L. Visually inspect all wire and cable for faulty insulation prior to installation.
- M. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on Wire and Cable.
- N. Make connections with solder-less devices, mechanically and electrically secured in accordance with the manufacturers' recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.
- O. Neatly bundle and wrap all horizontally run (above accessible ceilings and not within conduit) wire and cable at three-meter intervals. Provide supports as required. All supports shall be UL listed for the application.

P. All System wiring within vertical riser shafts (as required) shall be bundled, wrapped and tied to the structure at three-meter intervals in order to isolate it from other wire and cable within the shaft. Additionally, all wire and cable within the shaft shall be supported at least every two floors. Provide all personnel and equipment necessary to install and support the cable. All equipment shall be UL listed for the application.

3.9 CONDUIT AND RACEWAY INSTALLATION

- A. Design, lay-out, size and plan new conduit and raceway systems as required.
- B. Cabling shall be installed in conduit under any of the following conditions:
 - 1. Where required by code
 - 2. Where cabling traverses unsecure, public space
 - 3. Where cabling would otherwise be exposed to tampering or vandalism
- C. No exposed conduit shall be installed within public areas unless approved by Architect.
- D. Indoor Requirements:
 - 1. Route exposed conduit and raceway parallel and perpendicular to walls and adjacent piping.
 - 2. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps.
 - 3. Use conduit bodies to make sharp changes in direction, as around beams. Fasten conduits and raceways to structural steel using approved spring clips or clamps.
 - 4. Where conduit penetrates fire-rated walls and floors, seal opening with UL listed fire rated sealer or other methods as approved by codes.
 - 5. No exposed conduit, raceway, or junction box shall be installed within any office area.
 - 6. Install all boxes straight and plumb.
 - 7. Do not support conduit from mechanical, plumbing, or fire sprinkler systems.
 - 8. Drill or core drill all holes in walls, ceilings, or floors where required for new conduits. Do not cause damage to any structural steel or other structural support member by drilling or cutting.
 - 9. Do not use flexible conduit in lengths longer than six (6) feet.
- E. Outdoor Requirements:
 - 1. In locations where conduit penetrates exterior walls, seal opening around conduit in an approved manner to make watertight.

- 2. Use galvanized straps and fasteners on all exterior conduit.
- 3. All exterior boxes will only be used to aid in pulling the cable between points.

3.10 PENETRATIONS

- A. Do not penetrate any roof, flashing, exterior wall, or parapet without prior approval from designated Construction Project representative.
- B. When penetrating a fire wall for passage of cables and/or conduit, always provide a firestop system that complies with code and the local authority having jurisdiction.

3.11 FIRE RATED DOORS AND FRAMES

A. Do nothing to modify a UL-rated door or frame that would void the UL-label or fire rating.

3.12 GROUNDING

A. Provide earth-grounding of equipment as required by equipment manufacturer. Earth ground shall be connected to ground rod or approved cold water pipe. Electrical or telephone ground connections shall not be used as earth grounds. Connections to mounting posts or building structural steel shall not be used as earth grounds.

3.13 POWER TO SECURITY EQUIPMENT

- A. Power all equipment from circuits dedicated for security use, except as noted. Mark all panel circuit breakers with labels worded "Security Equipment Do Not Operate", or equivalent.
- B. All plug-in transformers shall be located at the security control panels. Secure all low-voltage plug-in transformers to outlet with screw or strap. Clearly label all transformers to identify purpose and use.
- C. AC power dedicated to security and on generator backup shall be provided for the Security System as indicated on the Documents. Coordinate with the Architect to establish locations of dedicated AC circuits.
- D. Connect to the AC power and provide UL listed power supplies and transformers to distribute low voltage power to the System components as required.
- E. Provide hinged cover terminal cabinets with tamper switches for all power supplies, transformers, and power distribution terminal strips. Provide all conduit and wiring from the AC power facilities to the terminal cabinets.
- F. Surge Protection
 - 1. Provide protection against spikes, surges, noise, and other line problems for all System equipment and components.
 - 2. Protect all exterior video, control, power, signal cables, and conductors against power surges. Video surge protectors shall not attenuate or reduce video and sync signals under normal conditions. Each surge protector shall be UL Listed.

3.14 CUTTING AND PATCHING

A. The Design-Builder shall be responsible for all cutting, fitting, or patching that may be required to complete the Work.

3.15 PAINTING

A. All surface raceway systems shall be painted to match the surfaces they are attached to.

3.16 PLYWOOD BACKING

- A. Install the processor(s), power supplies, and all other related equipment on a plywood backboard for testing in the shop. The mounted assembly will then be transported "as is" to the job site for mounting in the Communication Room.
- B. Fasten the plywood backing to the wall using a hanger bolt at the four corners which align with pre-drilled holes in the plywood. Secure with flat washers and a nut.

3.17 CLEANING

- A. During construction, and prior to acceptance of the building, remove from the premises and dispose of packing material and debris caused by electronic security work.
- B. Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.18 MANUFACTURER PROFESSIONAL SERVICES

- A. Design-Builder shall coordinate with the manufacturer to provide the manufacturer's professional services team to assist in coordinating the interfaces between the security management system and other on-site systems as necessary.
- B. Professional Services personnel shall be employed by the manufacturer of the security management system and shall be thoroughly knowledgeable of the security management system applications.
- C. Professional Services personnel shall be on-site and available to meet for a period of not less than two consecutive days.

3.19 SYSTEM START-UP

- A. The Work shall be complete and ready to operate prior to final acceptance.
- B. Load the entire initial user database into all programmable systems up to the day of beneficial use of the system. The Architect shall assist in establishing procedural guidelines and in defining terminology and conditions unique to the Owner's operation.

3.20 SYSTEM ACCEPTANCE

- A. Final acceptance testing of the Work will be conducted by the Architect, Consultant, and/or Owner.
- B. Prior to any final acceptance testing, the Design-Builder shall submit two (2) sets of preliminary Record Drawings to the Architect. The preliminary Record Drawings are to be used by the Architect to conduct the system final test.
- C. The Design-Builder shall submit a report matrix indicating completion or delinquency for each item included in the Specification and all subsequent addenda and bulletins as part of the Work. Should work on any item be under way, but not yet fully complete, indicate the extent (or lack thereof) of completion to date, and the proposed date of completion.
- D. Conduct a complete test of the entire system and provide the Architect with a written report on the results of that test. During the course of this test, place the integrated system in service and calibrate and test all equipment.
- E. Fully complete a Security Systems Readiness Checklist prior to the test of the system. The checklist shall accompany the written certification to the Architect that the installed complete system has been calibrated, tested, and is fully functional as specified herein.
- F. Following completion of the initial testing and correction of any noted deficiencies, conduct a five (5) day burn-in test. The intent of the burn-in test shall be to prove the system by placing it in near real operating conditions. During this period the system shall be fully functional and programmed such that all points, interfaces, controls, reports, messages, prompts, etc. can be exercised and validated. Record and correct any system anomaly, deficiency, or failure noted during this period. Scheduling of the final acceptance test shall be based on a review of the results of this burn-in test.
- G. Deliver a report describing the results of functional tests, burn-in tests, diagnostics, calibrations, corrections, and repairs including written certification to the Architect that the installed complete system has been calibrated, tested, and are fully functional as specified herein.
- H. Prior to the final acceptance test, coordinate with the Architect for security related construction clean-up requirements. Security equipment closets and similar areas should be free of accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work, remove all waste materials, rubbish, the Design-Builder's and it's sub-Design-Builders' tools, construction equipment, machinery, and all surplus materials.
- I. Upon written notification from the Design-Builder that the system is completely installed, integrated, and operational, and the burn-in testing completed, the Consultant will conduct a final acceptance test of the entire system.
- J. During the course of the final acceptance test by the Consultant, the Design-Builder shall be responsible for demonstrating that, without exception, the completed and integrated system complies with the contract requirements. All physical and functional requirements of the project shall be demonstrated and shown. This demonstration will begin by comparing "as built" conditions of the system to requirements outlined in the Specification, item by item. Following the Specification compliance review, all system head-end equipment will be evaluated.

- K. In order to sufficiently demonstrate the system's functionality, the console operator on duty and his/her superior may be requested to perform certain daily operations inherent to the system.
 - 1. As all of these operations depend heavily on the training outlined within the Specification, the Design-Builder shall have completed all of the required training prior to initiation of the final acceptance test.
- L. The functionality of all interfaces between systems will be tested.
- M. Following the system head-end equipment and console review, the installation of all field devices will be inspected. Areas examined will include general neatness and quality of installations, complete functionality of each individual device, and mounting, back box and conduit requirements compliance.
- N. All equipment shall be fully operational during testing procedures. The Design-Builder shall provide all personnel, equipment, and supplies necessary to perform all site testing. A minimum of two (2) employees familiar with the system for the final acceptance test shall be present during the testing. One employee shall be responsible for monitoring and verifying alarms while the other will be required to demonstrate the function of each device. Supply at least two (2) two-way radios for use during the test. A manufacturer's representative may be present on site to answer any questions that may be beyond the technical capability of the Design-Builder's employees, if the Design-Builder so elects or by specific request of the Architect or Owner, at no charge to the Architect or Owner.
- O. Upon successful completion of the final acceptance test (or subsequent punch list retest) the Consultant will issue a letter of final acceptance.
- P. The Consultant retains the right to suspend and/or terminate testing at any time when the system fails to perform as specified. In the event that it becomes necessary to suspend the test, all of the Owner's/Architect's fees and expenses related to the suspended test will be deducted from the Design-Builder's retainage. Furthermore, in the event it becomes necessary to suspend the test, the Design-Builder shall work diligently to complete/repair all outstanding items to the condition specified in Documents. The Design-Builder shall supply the Consultant with a detailed completion schedule outlining phase-by-phase completion dates and a tentative date for a subsequent punch list retest. During the final acceptance test, no adjustments, repairs, or modifications to the system will be conducted without the permission of the Consultant.

3.21 RECORD DOCUMENTATION

- A. Record Documentation shall include all information required in the Pre-fabrication Submittals but revised to reflect "as installed" conditions.
- B. General Description and Requirements
 - 1. Submit Record Documentation in accordance with the Architect's construction schedule.

- 2. Record Documentation shall consist of Record Drawings and Operation and Maintenance Manuals.
- 3. Provide a letter of transmittal with Record Documentation identifying the name of the Project, Design-Builder's name, date submitted for review, and a list of items transmitted.
- 4. Prior to the final acceptance of the Work, submit two draft sets of the Record Drawings portion of Record Documentation to the Architect. The draft copy shall be used during the final acceptance testing by the Architect.
- 5. Update all record documentation to reflect changes or modifications made during final acceptance testing as required and submit three blue/black lines and one reproducible set.
- C. Record Drawings
 - 1. Produce all Record Drawings using the latest version of AutoCAD. Record Drawings shall, at a minimum, include the following:
 - 2. Floor plan drawings indicating device locations, with device legends indicating manufacturers and model numbers for each device
 - 3. Floor plan drawings indicating wire routing, wire routing shall be delineated in straight line runs and be tagged with cable identification and terminal strip numbers to coincide with the installation
 - 4. Mounting details for all equipment and hardware
 - 5. Functional block diagrams for each subsystem
 - 6. Wiring details showing rack elevations, equipment wiring and terminations, and interrack wiring
 - 7. Wiring diagrams for all custom circuitry including interfaces to various control output controlled devices.
 - 8. Typical point-to-point wiring diagrams for each piece of equipment and groups of equipment within the system
 - 9. Layout details for each riser location, including security panels, power supplies, junction boxes, conduit, and any other security related equipment
- D. Operation and Maintenance Manuals
 - 1. Operation and Maintenance Manuals shall apply to all security related devices, equipment and software modules.
 - 2. Operation and Maintenance Manuals shall be formatted as follows:

- A. Identify each manual's contents on the cover.
- B. Provide a table of contents and tabulated sheets for each manual. Place tab sheets at the beginning of each chapter or section and at the beginning of each appendix if applicable.
- C. Any hardware manual demonstrating more than one model number of device on any one page shall be clearly marked as to delineate which model has been implemented in the Work.
- 3. Operation and Maintenance Manuals shall include, at a minimum, the following:
 - A. Operational description of each subsystem
 - B. Detailed programming descriptions for each subsystem
 - C. Explanations of subsystem interrelationships
 - D. Electrical schematics for each piece of equipment specified
 - E. Power-up and power-down procedures for each subsystem
 - F. Description of all diagnostic procedures
 - G. A menu tree for each subsystem
 - H. Setup procedures for each component of the subsystems
 - I. A list of manufacturers, their local representatives, and subDesign-Builders that have performed Work on the Project
 - J. Installation and service manuals for each piece of equipment
 - K. Maintenance schedules for all installed components
- 4. Operation and Maintenance Manuals shall include a separate section for each software program incorporated into the Project. The software section shall include, at a minimum, the following information:
 - A. Definitions of all software related terms and functions
 - B. Description of required sequences
 - C. Directory of all disk files
 - D. Description of all communications protocols, including data formats, command characters, and a sample of each type of data transfer
 - E. Instructions for manufacturer supplied report generation
 - F. Instructions for custom report generation

- G. Database format and data entry requirements
- E. Procedure for Resubmitting
 - 1. Make corrections or changes as required by the Architect and resubmit when the Architect's stamp requires re-submittal.
 - 2. Clearly identify changes made other than those specifically requested by the Architect when resubmitting Record Drawings. Changes shall be clouded or similarly highlighted as coordinated with the Architect. Only changes that have been specifically requested by the Architect or have been clouded by the Design-Builder will be reviewed on resubmittals.
 - 3. Any drawing sheets added to the resubmittal shall be clearly identified and clouded, and shall not change the sheet numbering scheme for previously issued Record Drawings.
 - 4. The Design-Builder shall be responsible for any delays caused by the re-submittal process.
 - 5. Re-submittal Review Fees
 - A. If the Architect rejects the Design-Builder's Record Submittal (Rejected, Revise, and Resubmit) more than two times, the Architect will be compensated for all subsequent reviews, whether partial or comprehensive. The amount of such compensation will be incorporated by Change Order and withheld from the Design-Builder's Application for Payment.

3.22 TRAINING

- A. Design-Builder shall provide complete operator training on the security system. Training shall consist of 16 of classroom instruction for 8 people, plus two (2) hours of individual hands-on training for each of 8 people. Hands-on training shall include the opportunity for each person to operate the system, and to practice each operation that an operator would be expected to perform.
- B. Training shall cover all operating features of the system.
- C. Design-Builder shall provide written training materials for each of 8 people.
- D. Training sessions shall include the opportunity for each person to operate the system, and to practice each operation that an operator would be expected to perform.

3.23 VSS INSTALLATION

- A. Coordination
 - 1. At a minimum, coordinate the following with the Architect:
- 2. Coordinate with the Architect to ensure that adequate conduit is provided, and equipment back-boxes are adequate for System installation.
- 3. Coordinate with the Architect to ensure that adequate power has been provided and properly located for the security System equipment.
- 4. Coordinate locations of all devices with the Architect prior to installation.
- 5. Coordinate final camera locations, desired views, and camera housing and mount requirements with the Architect prior to installation.
- 6. Coordinate camera housing and mount finishes with the Architect prior to installation.
- 7. Coordinate finishes and colors of all equipment with the Architect. Submit all finish and graphics for all equipment in public areas to the Architect for approval prior to installation.
- B. At a minimum, coordinate the following with the Owner:
 - 1. Coordinate programming information.
 - 2. Coordinate final device locations and installation and operational requirements.
 - 1. Coordinate equipment labeling.
 - 2. Coordinate cable jacket colors. Refer to Telecommunications specification 27 1000 for assigned cabling color.
 - **3**. The location and orientation of each piece of rack mounted equipment.
 - 4. Initial database partitioning and setup prior to initial programming and cardholder data entry.
 - 5. Coordinate training curriculum, syllabus, and schedule.
 - 2. At a minimum, coordinate with the following other trades:
 - 1. Communications.
 - 2. Electrical.
 - **3**. Fire/Life Safety System
 - 4. Door Hardware
 - 5. Elevator
 - 6. Verify that adequate power has been provided and properly located for the security system equipment. Coordinate circuit, breaker, and panel locations and identify locations in record documents.
 - B. General

- 1. Design-Builder or equipment manufacturer logos or names shall not be visible on equipment in public areas.
- 2. Provide tamper proof fasteners for all equipment in public areas. Fastener finish shall match equipment finish.
- C. Equipment: Provide equipment as indicated on the Drawings and specified herein. Additional specific installation requirements are as follows:
 - 1. VSS Cameras
 - 1. Field verify the exact location and positioning of all cameras with the Architect prior to installation.
 - 2. Power all cameras from centrally located POE switches or low voltage power supplies in the security riser locations.
 - **3**. Field verify and confirm views with the Owner prior to final installation and adjust camera positions and lens sizes as required.
- D. System Programming and Data Entry
 - 1. Provide all initial System programming and setup of the VSS including, but not limited to the following:
 - 1. Initial setup for the interface with the SMS. The interface shall provide for automatic VSS Camera selection upon alarms within the SMS as defined in the Specification. Coordinate automatic VSS Camera selection and NVR record status alarm annunciation requirements with the Owner prior to programming.
 - 2. Graphical Maps and Icons: Coordinate with the Architect to obtain AutoCAD architectural backgrounds for implementation as graphical maps. Import all AutoCAD background information provided by the Architect and produce a complete set of graphical maps depicting all VSS points.
 - **3**. On-screen alphanumeric identification of each VSS Camera, on each Monitor and Video Multiplexer. Coordinate descriptors with the Owner prior to programming.
 - 4. Automatic selection of a VSS Camera adjacent to a Card Reader upon an invalid card use. Coordinate automatic camera selection requirements with the Owner prior to System programming.
- 5. Automatic camera display upon selection of IC System Substations shall not cause the NVR to switch into real time recording mode unless requested by the Owner.
 - 2. Enter all data needed to make the Security System operational. Deliver the data to the Owner on data entry forms, utilizing data from the

Contract Documents, Design-Builder's field surveys and all other pertinent information in the Design-Builder's possession required for complete installation of the database. Identify and request from the Architect any additional data needed to make the Security System fully operational and integrated. The completed forms shall be delivered to the Owner for review and approval at least 90 days prior to the Design-Builder's scheduled date.

3.24 ACS COORDINATION

- A. At a minimum, coordinate the following with the Owner:
 - 1. Coordinate programming information.
 - 2. Coordinate final device locations and installation and operational requirements.
 - **3**. Custom report requirements. Submit report templates to the Owner for review and acceptance.
 - 4. Coordinate equipment labeling.
 - 5. Coordinate cable jacket colors.
 - 6. The location and orientation of each piece of rack mounted equipment.
 - 7. Initial database partitioning and setup prior to initial programming and cardholder data entry.
 - 8. Coordinate training curriculum, syllabus, and schedule.
- B. At a minimum, coordinate with the following other trades:
 - 1. Communications.
 - 2. Electrical.
 - **3**. Fire/Life Safety System
 - 4. Door Hardware
 - 5. Elevator
 - 6. Verify that adequate power has been provided and properly located for the security system equipment. Coordinate circuit, breaker, and panel locations and identify locations in record documents.

3.25 ACS INSTALLATION

- C. General
 - 1. Coordinate equipment installation requirements with other trades prior to installation.
 - 2. After installation, protect equipment to prevent damage during the construction period. Close openings in conduits and boxes to prevent the entrance of foreign materials.
 - 3. Make equipment connections in accordance with the approved submittal drawings and manufacturer specifications.
 - 4. Seal exterior devices to protect against weather conditions including heat, cold, moisture, dust, and sand.
- D. Equipment Provide equipment as specified herein. Additional specific installation requirements are as follows:

- 1. Security Equipment Room and Riser Locations
 - 1. Configure security equipment as indicated in the Drawings.
 - 2. Wire all power supply power fail alarm contacts in each equipment room as a single alarm input to the SMS.
 - 3. Wire each power supply low battery alarm contact as individual alarm inputs to the SMS.
- 2. Card Readers
 - 1. Wire card reader LEDs to indicate valid and invalid card reads, and door locked and unlocked conditions. All card reader LED indicators shall operate identically.
- 3. Electric Locking Mechanisms
 - 1. Interface with electric locking mechanisms provided by the door hardware supplier.
 - 2. Wire electric locking mechanisms as indicated on the Drawings.
 - **3**. Wire fail-safe electric locking mechanisms in accordance with local codes.
 - 4. Wire fail-secure electric locking mechanisms and power supplies such that a fire alarm condition or building power failure shall not affect operation of the lock.
- E. Interfaces
 - 1. Provide interfaces between ACAMS and other building systems, Wonder Management and Nurse Call integration.
- F. System Programming and Data Entry
 - 1. All programming shall be performed by the Design-Builder with the Owner's supervision. The Design-Builder shall be responsible for loading all software. Coordinate and provide all system programming and setup of the System including, but not limited to the following:
 - 1. Graphical Maps and Icons: Coordinate with the Designer to obtain AutoCAD backgrounds for implementation as graphical maps. Import AutoCAD background information provided by the Designer and produce a complete set of graphical maps.
 - 2. Card Reader Information
 - 3. Coordinate all card reader values and text, including descriptors, alarm messages, VSS camera call up, map call up and identification with the Owner.
 - 2. Enter all data needed to make the Security System operational. Deliver the data to the Owner on data entry forms, utilizing data from the Contract Documents, Design-Builder's field surveys and all other pertinent information in the Design-Builder's possession required for complete installation of the database. Identify and request from the Owner any additional data needed to make the Security System fully operational and integrated. The completed forms shall be delivered to

the Owner for review and approval at least 90 days prior to the Design-Builder's scheduled need date.

3.26 LABELED FRAMES AND DOORS

- A. In no instance shall any UL labeled door or frame be drilled, cut, penetrated, or modified in any way.
- B. The Design-Builder shall be responsible for replacing any labeled door or frame that is modified without written approval from the Owner.

3.27 SURGE PROTECTION

- A. Provide protection against spikes, surges, noise, and other line problems for all system equipment and components.
- B. Provide surge protection for all power circuits, telephone, network, and other communication circuits, and electronic modules.
- C. Provide equipment submittals for all proposed surge protection for review prior to ordering or installing.
 - 1. Submit in accordance with Division 1 and Section 280500

3.28 POWER REQUIREMENTS

- A. Electrical Design-Builder to provide 120 VAC power requirements dedicated to security as indicated on the drawings.
- B. Connect to the AC power and provide duplex receptacles within locked power supply cabinets. Provide UL listed power supplies and transformers with plug type connectors to distribute low voltage power to the system components as required. Plug transformers into duplex receptacles within locked cabinets only. Plug transformers shall be fastened to the duplex receptacle to prevent disconnection.

3.29 CONDUIT AND JUNCITON BOXES

A. Electrical Design-Builder to provide conduit and junction boxes.

3.30 PROJECT COMPLETION PROCESS

- A. System Programming
 - 1. Submit system-programming forms to the Owner. Include dates that the Owner must have the forms completed in order to maintain the construction schedules.
 - 2. Program the security systems as necessary.
- B. Final Testing Scripts

- 1. Provide proposed testing scripts and written methods and procedures at least 3 weeks prior to final testing.
- 2. Testing scripts shall include a written description for each piece of equipment in the system that describes the effect to the system if that piece of equipment fails.
- 3. Coordinate with the Owner to determine exact formats for testing scripts.

SECTION 28 31 00 - FIRE ALARM AND SMOKE DETECTION SYSTEMS

PART 1 – GENERAL

1.1. SUMMARY

- A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.
- B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.
- C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
 - 1. Fire alarm system detection and notification operations.
 - 2. Control and monitoring of elevators, door hold-open devices, and other equipment as indicated in the drawings and specifications.

1.2. SCOPE OF WORK

A. Provide new Simplex 4100ES voice evacuation panel including both addressable initiating and notification devices as shown on drawings. This system shall connect to existing campus 4120 network reporting point-level detail to owners existing graphic computer.

1.3. ACCEPTABLE EQUIPMENT AND SERVICE PROVIDERS

- A. Manufacturers: The equipment and service described in this specification are those supplied and supported by Johnson controls fire protection and represent the base bid for the equipment.
 - 1. Subject to compliance with the requirements of this specification, provide alternate products by one of the following:
 - a) Simplex
- B. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.
- C. Alternate products must be submitted to the Engineer two weeks prior to bid for approval. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
- D. The equipment and service provider shall be a nationally recognized company specializing in fire alarm and detection systems. This provider shall employ factory trained and NICET Level II certified technicians, and shall maintain a service organization within 100 miles of this project location. The equipment and service provider shall have a minimum of 10 years experience in the fire protective signaling systems industry.

1.4. RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this section.
- B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:

- 1. Division 16: "Basic Electrical Materials and Methods."
- 2. Division 16: "Wiring Methods."
- 3. Division 13: "Fire Suppression".
- 4. Division 15: "Fire Protection".
- 5. Division 15: "HVAC Systems".
- 6. Division 13: "Building Automation and Control".
- 7. Section 019113 "General Commissioning Requirements" for commissioning requirements.
- C. The system and all associated operations shall be in accordance with all latest locally adopted versions of the following codes, standards and ordinances including but not limited to:
 - 1. Requirements of the following Model Building Code: IBC/IFS 2015 Edition.
 - 2. Requirements of the following: BOCA, SBCCI, UFC, IFC, ANSI and NFPA 1.
 - NFPA 70 National Electrical Code, 71 Central Station Signaling Systems, 72 National Fire Alarm Code, 90A - Standard for the Installation of Air Conditioning and Ventilating Systems and 101 - Life Safety Code.
 - 4. UL 864 Fire Alarm and UL 1076 Security.
 - 5. ADA, Americans with Disabilities Act accessibility guidelines.
 - 6. ANSI/ASME A17.1 / CSA B44, Safety Code for Elevators and Escalators.
 - 7. ICC/ANSI A117.1 Accessible and Useable Buildings and Facilities.

1.5. SYSTEM DESCRIPTION

- A. General: Provide a complete, non-coded addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.
- B. Power Requirements
 - 1. The control unit shall receive AC power via a dedicated fused disconnect circuit.
 - 2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
 - 3. All circuits requiring system-operating power shall be 24 VDC nominal voltage and shall be individually fused at the control unit.
 - 4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
 - 5. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
 - 6. The system shall support NAC Lockout feature to prevent subsequent activation of

Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control.

- 7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
- 8. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.
- C. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary.
 - 1. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation.
 - 2. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.
 - 3. Panels shall be capable of full system operation during new site specific configuration download, master exec downloads, and slave exec downloads.
 - 4. Remote panel site-specific software and executive firmware downloads shall be capable of being performed over proprietary fire alarm network communications and via TCP/IP Ethernet network communications. Ethernet access to any fire alarm panel shall be capable of providing access only to authenticated users through a cryptographically authenticated and secure SSL tunnel.
 - 5. Panels shall automatically store all program changes to the panel's non-volatile memory each time a new program is downloaded. Panels shall be capable of storing the active site-specific configuration program and no less than 9 previous revisions in reserve. A compare utility program shall also be available to authorized users to compare any two of the saved programs. The compare utility shall provide a deviation report highlighting the changes between the two compared programs.
 - 6. Panels shall provide electronic file storage with a means to retrieve a record copy of the site-specific software and up to 9 previous revisions. Sufficient file storage shall be provided for other related system documentation such as record drawings, record of completion, owner's manuals, testing and maintenance records, etc.
 - 7. The media used to store the record copy of site-specific software and other related system documentation shall be electrically supervised. If the media is removed a trouble shall be reported on the fire alarm control panel.
- D. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- E. Recording of Events: The system shall be capable of recording all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout shall differentiate alarm signals from all other printed indications.
- F. Wiring/Signal Transmission:
 - 1. Transmission shall be hard-wired using separate individual circuits for each zone of alarm

operation, as required or addressable signal transmission, dedicated to fire alarm service only.

- 2. System connections for initiating device circuits shall be Class B, Style D, signaling line circuits shall be Class B, Style 4 and notification appliance circuits shall be Class B, Style Y.
- 3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.
- G. Remote Services Access:
 - 1. Fire Alarm Control Panel (FACP) shall provide the necessary hardware to provide a remote service access feature using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3. The Remote Access feature shall provide automatic notification of system faults and remote diagnostics of system status for responding technicians prior to arrival on site.
 - 2. A standard RJ-45 Ethernet connection shall connect to the owners Ethernet network. Provisions for that connection must be provided at each fire alarm control panel as part of the contract.
 - 3. The Ethernet access feature shall be agency listed for specific interfaces and for the purpose described in this section. The use of non-listed external third party interfaces is not acceptable.
 - 4. The internet remote access service function shall provide automated real time off-site reporting of discrete system events to a remote service support center with details of internal FACP fault conditions allowing a pre-site visit analysis of repair requirements.
 - 5. Existing FACP controls shall be capable of retrofitting the Remote Service module as a plug-in upgrade feature.
 - 6. The remote service network shall work on the customers Ethernet infrastructure and be Fire-Wall friendly for two-way communications for off-site reporting. The feature shall be compatible with existing proxy servers and firewalls shall not require any special changes or modifications.
 - 7. The remote service system shall be able to connect to the remote service center without the need for a VPN account or similar tunnel.
 - 8. The remote service system shall be a non Windows based application to protect against conventional virus attacks.
 - 9. The remote service system shall support a secure connection with strong encryption, 128 bit or better, and an optional secondary encryption method if required.
 - 10. The remote service system shall be compatible with virtual LANS (VLAN).
 - 11. The remote service system shall work on an outbound communication premise (panel calls home) in order to eliminate the possibility of any inbound connection into the network (from trusted or non trusted sites).
 - 12. The remote service system shall provide an audit trail of all events and service connections.
 - 13. The Remote Service connection will provide access for panel software downloads and

uploads for archiving job specific programs back at the enterprise server.

- 14. The supplier shall provide a service contract for the Remote Service program that provides the following requirements:
 - a) 24/7 recording of FACP service activity.
 - b) Off-site diagnostics by a technical specialist to provide repair and parts guidance to the service technician prior to a site visit.
- H. Required Functions: The following are required system functions and operating features:
 - 1. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority, respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
 - 2. Noninterfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.
 - 3. Transmission to an approved Supervising Station: Automatically route alarm, supervisory, and trouble signals to an approved supervising station service provider, under another contract.
 - 4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the type of device, the operational state of the device (i.e alarm, trouble or supervisory) and shall display the custom label associated with the device.
 - 5. Selective Alarm: A system alarm shall include:
 - a) Indication of alarm condition at the FACP and the annunciator(s).
 - b) Identification of the device /zone that is the source of the alarm at the FACP and the annunciator(s).
 - c) Operation of audible and visible notification appliances until silenced at FACP.
 - d) Selectively closing doors normally held open by magnetic door holders on the fire floor, floor above and floor below.
 - e) Unlocking designated doors.
 - f) Shutting down supply and return fans serving zone where alarm is initiated.
 - g) Closing smoke dampers on system serving zone where alarm is initiated.
 - h) Initiation of smoke control sequence.
 - i) Transmission of signal to the supervising station.
 - j) Initiation of elevator Phase I functions (recall, shunt trip, illumination of indicator in cab, etc.) in accordance with ANSI/ASME A17.1 / CSA

B44, Safety Code for Elevators and Escalators, when specified detectors or sensors are activated, as appropriate.

- 6. Supervisory Operations: Upon activation of a supervisory device such as a fire pump power failure, low air pressure switch, and tamper switch, the system shall operate as follows:
 - a) Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.
 - b) Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
 - c) Record the event in the FACP historical log.
 - d) Transmission of supervisory signal to the supervising station.
 - e) Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
- 7. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation.
- 8. Priority Two Operations: Upon activation of a priority two condition such as intrusion alert, weather alert, the system shall operate as follows:
 - a) Activate the system priority two audible signal and illuminate the LED at the control unit and the remote annunciator.
 - b) Pressing the Priority 2 Acknowledge Key will silence the audible signal while maintaining the Priority 2 LED "on" indicating off-normal condition.
 - c) Record the event in the FACP historical log.
 - d) Transmission of priority two signal to the supervising station.
 - e) Restoring the condition shall cause the Priority 2 LED to clear and restore the system to normal.
- 9. System Reset
 - a) The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-alarming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
 - b) Should an alarm condition continue, the system will remain in an alarmed state.
- 10. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
- 11. WALKTEST: The system shall have the capacity of 8 programmable passcode protected

one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:

- a) The city circuit connection and any suppression release circuits shall be bypassed for the testing group.
- b) Control relay functions associated with one of the 8 testing groups shall be bypassed.
- c) The control unit shall indicate a trouble condition.
- d) The alarm activation of any initiating device in the testing group shall cause the audible notification appliances assigned only to that group to sound a code to identify the device or zone.
- e) The unit shall automatically reset itself after signaling is complete.
- f) Any opening of an initiating device or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.
- 12. Install Mode: The system shall provide the capability to group all non-commissioned points and devices into a single "Install Mode" trouble condition allowing an operator to clearly identify event activations from commissioned points and devices in occupied areas.
 - a) It shall be possible to individually remove points from Install Mode as required for phased system commissioning.
 - b) It shall be possible to retrieve an Install Mode report listing that includes a list of all points assigned to the Install Mode. Panels not having an install mode shall be reprogrammed to remove any non-commissioned points and devices.

13. Module Distribution:

- a) The fire alarm control panel shall be capable of allowing remote location of the following modules; interface of such modules shall be through a (Class B) supervised serial communications channel (SLC):
 - (a) Initiating Device Circuits
 - (b) Notification Appliance Circuits
 - (c) Auxiliary Control Circuits
 - (d) Graphic Annunciator LED/Switch Control Modules

(i) In systems with two or more Annunciators and/or Command Centers, each Annunciator/Command Center shall be programmable to allow multiple Annunciators/Command Centers to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciator/Command Center locations.

- 14. Service Gateway: A Service Gateway software application shall be provided that allows an authorized service person to remotely query panel status during testing, commissioning, and service without the need to return to the panel using standard email or instant messaging tools. For systems without a service gateway application the service provider shall provide a minimum of two technicians for any system testing or commissioning.
- I. Analog Smoke Sensors:
 - 1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
 - 2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
 - 3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 selectable sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
 - 4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements.
 - a) Reports shall be capable of being printed for annual recording and logging of the calibration maintenance schedule.
 - 5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to automatically indicate when a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate if a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a sensor approaching dirty without creating a trouble in the system. If this indicator is ignored and the second level is reached, a "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported [to the Supervising Station][none]. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.
 - 6. The FACP shall continuously perform an automatic self-test on each sensor that will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
 - 7. Multi-Sensors shall combine photoelectric smoke sensing and heat sensing technologies. An alarm shall be determined by either smoke detection, with selectable sensitivity from 0.2 to 3.7 %/ft obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity.
 - 8. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.
 - 9. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.

- J. Addressable Notification Appliances:
 - 1. Monitoring: The FACP shall monitor individual addressable notification appliances for status, condition, type of appliance, and configured appliance settings. A fault in any individual appliance shall automatically report a trouble condition on the FACP.
 - 2. Individual Appliance Custom Label: Each addressable appliance shall have its own 40 character custom label to identify the location of the appliance and to aid in troubleshooting fault conditions.
 - 3. Individual Appliance Information Display:
 - a) The FACP shall be capable of calling up detailed information for each addressable appliance including the appliance location, status, condition, type of appliance, and configured appliance settings.
 - b) [Notification appliances that are not capable of communicating and reporting their individual location, status, condition, type of appliance, and configured appliance settings to the FACP shall not be accepted.]
 - 4. Programmable Appliance Settings:
 - a) The selectable operation of each addressable notification appliance shall be capable of being configured by the FACP without having to replace or remove the appliance from the wall or ceiling.

(a) Programmable appliance settings for applicable addressable notification appliances shall include:

- (i) Operation:
 - (a) General Evac
 - (b) Alert
 - (c) User Defined
- (ii) Style:
 - (a) Indoor
 - (b) UL Weatherproof
 - (c) ULC Weatherproof
- (iii) Candela Selections:
 - (a) Indoor: 15, 30, 75, 110, 135, or 185 cd (per UL1971)
 - (b) UL Weatherproof: 15 or 75 cd (per
 - UL1971), and 75 or 185 cd (per UL1638)
 - (c) ULC Weatherproof: 20, 30 or 75 cd (per ULCS526)
- b) Systems that require replacement or removal of the appliances from the wall or ceiling to change their applicable operation or settings shall not be accepted.
- 5. Programmable Notification Zones:
 - a) Changing the notification zone assigned to a notification appliance shall be configurable by the FACP and shall not require additional circuits or wiring.
- K. Manual Voice Paging

- 1. The system shall be configured to allow voice paging. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.
- 2. The control panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.
- 3. Total building paging shall be accomplished by the means of an "All Call" switch. Separate microphone on plate with LOC required at alternate entrance to building.
- L. Constant Supervision of Non-Alarm Audio Functions Connection to customer's A/V paging system:
 - 1. When required, the system shall be configured to allow Non-Alarm Audio (NAA) functions such as background music or general/public address paging.
 - 2. During NAA operation, the speaker circuit shall be electrically supervised to provide continuous monitoring of the speaker circuit.
 - 3. During an alarm condition, supervision shall be disabled and alarm signals delivered to speakers.
 - 4. Other Emergency and Non Emergency Notification:
 - a) Where required, notification appliances for purposes not related to fire alarm shall be capable of:
 - (a) being connected to the same circuit as the fire alarm appliances, and
 - (b) being individually configured for their intended use without requiring additional circuits or wiring.
 - b) Systems that require separate circuits and wiring for other Emergency and Non Emergency notification shall not be accepted.
 - 5. Addressable Appliance Reports: The FACP shall maintain reports that include the Status and Candela for each applicable addressable notification appliance.
 - a) Reports shall be capable of being printed for viewing and record keeping.
 - b) Where required, reports shall be accessible remotely through:

(a) A Fire Panel Internet Interface using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3. The Fire Panel Internet Interface shall be capable of automatically scheduling email reports to individual user accounts on a weekly, bi-weekly, or monthly schedule.

(b) A PC Annunciator using an RS232-C connection to the FACP or a PC Annunciator Client using a TCP/IP communications protocol connection to the PC Annunciator server compatible with IEEE Standard 802.3.

6. Magnet test: When the control panel is in diagnostic mode, the appliances shall be capable of being tested with a magnet. The magnet diagnostics shall:

- a) Pulse the appliance LED to indicate appliance address and
- b) briefly flash the individual strobe to confirm visible appliance operation
- M. Fire Suppression Monitoring:
 - 1. Water flow: Activation of a water flow switch shall initiate general alarm operations.
 - 2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
 - 3. WSO: Water flow switch and sprinkler valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device is in alarm on the initiating zone.
- N. Audible Alarm Notification: By audible devices in areas as indicated on drawings.
- O. Audible Alarm Notification: By voice evacuation and tone signals on loudspeakers in areas as indicated on drawings.
 - 1. Automatic Voice Evacuation Sequence:
 - a) The audio alarm signal shall consist of an alarm tone for a maximum of five seconds followed by an automatic digital voice message. At the end of the voice message, the alarm tone shall resume. This sequence shall sound continuously until the "Alarm Silence" switch is activated.
 - b) All audio operations shall be activated by the system software so that any required future changes can be facilitated by authorized personnel without any component rewiring or hardware additions.
- P. Speaker: Speaker notification appliances shall be listed to ULC-S525.
 - 1. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted/shielded wire.
 - 2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum ULC rated sound pressure level of 83dBA at 3 meters.
 - 3. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.

1.6. SUBMITTALS

- A. General: Submit the following according to Conditions of Contract.
 - 1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
 - 2. Wiring diagrams from manufacturer.
 - 3. Shop drawings showing system details including location of FACP, all devices, circuiting and details of graphic annunciator.
 - 4. System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate in accordance with the prescribed backup time periods

and under all voltage conditions per UL and NFPA standards.

- 5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.
- 6. Operating instructions for FACP.
- 7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
- 8. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
- 9. Record of field tests of system.
- B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions, if required, to make clarifications or revisions to obtain approval.

1.7. QUALITY ASSURANCE

- A. Installer Qualifications: A factory authorized installer is to perform the work of this section.
- B. Each and every item of the Fire Alarm System shall be listed under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

1.8. MAINTENANCE SERVICE

- A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives.
- B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
- C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.
- D. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

1.9. EXTRA MATERIALS

A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:

- 1. Break Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
- 2. Notification Appliances: Furnish quantity equal to 10 percent of each type and number of units installed, but not less than one of each type.
- 3. Smoke Detectors or Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of each type and number of units installed but not less than one of each type.
- 4. Detector or Sensor Bases: Furnish quantity equal to 2 percent of each type and number of units installed but not less than one of each type.

PART 2 – PRODUCTS

- 2.1. FIRE ALARM CONTROL PANEL
 - A. General: Comply with UL 864, "Control Units and Accessories for Fire Alarm Systems".
 - B. The following FACP hardware shall be provided:
 - 1. Power Limited base panel with platinum cabinet and door, 120 VAC input power.
 - 2. 2,500 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
 - 3. 2000 points of annunciation where one (1) point of annunciation equals:
 - a) 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
 - b) 1 LED on panel or 1 switch on panel.
 - 4. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FACP LCD Display.
 - 5. One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
 - 6. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
 - 7. Three (3) Class B Addressable Notification Appliance Signaling Line Circuits (SLCs).
 - a) Each Addressable Notification Appliance SLC shall be rated at 3A and capable of supporting up to 63 Notification Appliances per channel.
 - b) Wiring shall be 18 AWG to 12 AWG unshielded twisted pair wire. Systems that require shielded wire for Notification Appliances shall not be accepted.
 - c) A constant voltage under both primary and secondary power conditions shall be maintained at the notification appliance field wiring terminal connections in the FACP to ensure the voltage drop on the circuit is consistent under both primary and secondary power conditions.
 - d) For systems that do not provide a constant voltage source at the FACP notification appliance field wiring terminal connections, the fire alarm contractor shall:

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(a) Provide separate point-to-point voltage drop calculations for all notification appliances under worst case secondary power specifications, and

(b) Perform a complete functional test of all notification appliances under worst case secondary power conditions.

- 8. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
- 9. Power Supplies with three (3) Class B integral Intelligent Addressable Notification Appliance Signaling Line Circuits (SLCs) for system expansion.
 - a) Each Addressable Notification Appliance SLC shall be rated at 3A and capable of supporting up to 63 Notification Appliances per channel.
 - b) Wiring shall be 18 AWG to 12 AWG unshielded twisted pair wire. Systems that require shielded wire for Notification Appliances shall not be accepted.
 - c) A constant voltage under both primary and secondary power conditions shall be maintained at the notification appliance field wiring terminal connections in the FACP to ensure the voltage drop on the circuit is consistent under both primary and secondary power conditions.
 - d) For systems that do not provide a constant voltage source at the FACP notification appliance field wiring terminal connections, the fire alarm contractor shall:

(a) Provide separate point-to-point voltage drop calculations for all notification appliances under worst case secondary power specifications, and

(b) Perform a complete functional test of all notification appliances under worst case secondary power conditions.

- 10. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
- 11. The FACP shall support up to (5) RS-232-C ports and one service port. All (5) RS-232 Ports shall be capable of two-way communications.
- 12. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
- 13. Programmable DACT for either Common Event Reporting or per Point Reporting.
- C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.
- D. Alphanumeric Display and System Controls: Panel shall include an 80 character, LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in

entering and executing control commands.

- E. Distributed Module Operation: FACP shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Class B supervised serial communications channel (SLC):
 - 1. Addressable Signaling Line Circuits
 - 2. Initiating Device Circuits
 - 3. Notification Appliance Circuits
 - 4. Auxiliary Control Circuits
 - 5. Graphic Annunciator LED/Switch Control Modules
 - a) In systems with two or more Annunciators and/or Command Centers, each Annunciator/Command Center shall be programmable to allow multiple Annunciators/Command Centers to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciator/Command Center locations.
- F. Voice Alarm: Provide an emergency communication system, integral with the FACP, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:
 - 1. Amplifiers comply with CAN/ULC-S527 Amplifiers shall provide an onboard local mode temporal coded tone as a default backup tone. Test switches on the amplifier shall be provided to test and observe amplifier backup switchover. Each amplifier shall communicate to the host panel amplifier and NAC circuit voltage and current levels for display on the user interface. Each amplifier shall be capable of performing constant supervision for non-alarm audio functions such as background music and general paging.
 - 2. All announcements are made over dedicated, supervised communication lines. All risers shall support Class B wiring for each audio channel.
 - 3. Emergency voice communication audio controller module shall provide up to 32 minutes of message memory for digitally stored messages.
 - 4. When required, Redundant Voice Command Centers shall be capable of generating voice paging from more than one node in a network audio system.

2.2. REMOTE LCD ANNUNCIATOR

- A. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.
- B. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.
- C. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
- D. The LCD shall display the following information relative to the abnormal condition of a point in the system:
 - 1. 40 character custom location label.

- 2. Type of device (e.g., smoke, pull station, waterflow).
- 3. Point status (e.g., alarm, trouble).
- E. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.
- 2.3. EMERGENCY POWER SUPPLY
 - A. General: Components include battery, charger, and an automatic transfer switch.
- 2.4. ADDRESSABLE INITIATING

A. ADDRESSABLE MANUAL PULL STATIONS

- 1. Description: Addressable single- or double-action type, red LEXAN, with molded, raisedletter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
- 2. Protective Shield: Where required, as indicated on the drawings, provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning shall be activated. The warning shall be silenced by lowering and realigning the shield. The audible device shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

B. SMOKE SENSORS

- 1. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
 - a) Factory Nameplate: Serial number and type identification.
 - b) Operating Voltage: 24 VDC, nominal.
 - c) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 - d) Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
 - e) Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 - f) Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
 - g) The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI.
 - h) Sensors include a communication transmitter and receiver in the

mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.

- i) Removal of the sensor head for cleaning shall not require the setting of addresses.
- j) Separate remote red LED alarm indicator shall connect to addressable base.
- 2. Type: Smoke sensors shall be of the photoelectric or combination photoelectric / heat type.
- 3. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.
- 4. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.
 - a) Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACP.
 - b) The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
 - c) Duct Housing shall provide a relay control trouble indicator Yellow LED.
 - d) Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
 - e) Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
 - f) Duct Housing shall provide a magnetic test area and Red sensor status LED.
 - g) For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
 - h) Each duct smoke sensor shall have a Remote Test Station with an alarm LED and test switch.
 - i) Where indicated provide a NEMA 4X weatherproof duct housing enclosure that shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.
 - j) The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single Form C contact rated at 7A@

28VDC and 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit

- k) Duct Housing shall provide a magnetic test area and Red sensor status LED.
- 1) Each duct smoke sensor shall have a Remote Test Station with an alarm LED and test switch.
- m) Each duct housing shall have remote functional smoke testing capability.
- n) Each duct housing shall be supplied with a replacement air inlet filter.
- o) Each duct housing shall have an optional water trap with a ball valve for draining to eliminate moisture buildup.
- p) The Air Aspirating Detection system shall have an operating air velocity range of 0 to 4000 linear ft/minute) 0 to 1220 meters/minute.
- q) The Addressable Air Aspirating Detection system shall be capable of use in other areas where point type detectors are not practical, such as; prison cells in correctional facilities, transformer vaults, cable tunnels and MRI rooms.

C. HEAT SENSORS

- 1. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
- 2. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
- 3. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.
- 4. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.
- D. Addressable CO Sensor
 - The CO Sensor shall be an addressable carbon monoxide (CO) sensing module providing both CO toxic gas detection and enhanced fire detection, and shall be listed to UL 268, Smoke Detectors for Fire Alarm Signaling Systems and UL 2075, Gas and Vapor Detectors and Sensors; allowing systems to be listed to Standard 2034, Single and Multiple Station Carbon Monoxide Alarms.
 - a) The CO Sensor shall include CO sensor element mounted in the sensor base which can be easily replaced without replacing the complete sensor base assembly.
 - b) The CO Sensor base shall provide address selection in the base allowing the address to remain with its location when the sensor is removed for service or type change.
 - c) The CO Sensor base shall include an integral red LED to indicate the

power-on, trouble, test mode or alarm status.

- d) CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.
- e) The CO Sensor base shall report the following CO Sensor troubles: Communication loss, Disabled, Almost Expired 12 Months, Almost Expired 6 Months, Expired (End of Life), and Sensor Missing/Failed.
- E. Addressable CO Base
 - 1. The CO Sensor shall be an addressable carbon monoxide (CO) sensing module providing both CO toxic gas detection and enhanced fire detection, and shall be listed to UL 268, Smoke Detectors for Fire Alarm Signaling Systems and UL 2075, Gas and Vapor Detectors and Sensors; allowing systems to be listed to Standard 2034, Single and Multiple Station Carbon Monoxide Alarms.
 - a) The CO Sensing element shall support operation with base.
 - b) CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.
 - c) The CO Base shall include CO sensor element mounted in the addressable base which can be easily replaced without replacing the complete sensor base assembly.
 - d) The CO base shall provide address selection in the base allowing the address to remain with its location when the sensor is removed for service or type change.
 - e) The CO Sensor base shall include an integral red LED to indicate the power-on, trouble, test mode or alarm status.
 - f) The CO Sensor base shall report the following CO Sensor troubles: Communication loss, Disabled, Almost Expired 12 Months, Almost Expired 6 Months, Expired (End of Life), and Sensor Missing/Failed.

F. ADDRESSABLE CIRCUIT INTERFACE MODULES

- 1. Addressable Circuit Interface Modules: Arrange to monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of AHU systems.
- Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.
- 3. There shall be the following types of modules:
 - a) Type 1: Monitor Circuit Interface Module:

(a) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision.

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The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.

(b) For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.

Type 2: Line Powered Monitor Circuit Interface Module

(a) This type of module is an individually addressable module that has both its power and its communications supplied by the two wire signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.

(b) This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.

Type 3: Single Address Multi-Point Interface Modules

(a) This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.

(b) This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.

(c) This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.

Type 4: Line Powered Control Circuit Interface Module

b)

c)

d)

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(a) This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module. This module may connect to customers auxiliary devices in patient room such as bed shakers etc.

e) Type 5: 4-20 mA Analog Monitor Circuit Interface Module

(a) This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.

4. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.5. ADDRESSABLE NOTIFICATION

A. ADDRESSABLE ALARM NOTIFICATION APPLIANCES

- 1. Addressable Notification Appliances: The Contractor shall furnish and install Addressable Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).
 - a) Addressable Notification appliance operation shall provide power, supervision and separate control of audible / visual devices notification devices over a single pair of wires. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.
 - b) All Notification Appliances shall operate as a completely independent device allowing for specific location alerting of both fire alarm and Mass Notification functions. Each visible device (both clear fire alarm and amber mass notification) shall be capable of operating on multiple notification zones or completely separate from all other notification devices, this allows "On the fly" program operation changes for Mass Notification alerting and fire alarm notification.
 - c) All Notification Appliances shall operate as a completely independent device allowing for appliances in handicap accessible rooms and other locations to operate on the same SLC and to activate individually based on an alarm condition in a room or as part of a general alarm condition where all appliances activate together.
 - d) Individual Notification Appliances shall be able to be grouped into zones (or operational groups) by central programming at the main fire alarm

control panel.

- e) Notification Appliances shall provide for "unobtrusive" testing. Each Notification Appliance shall be tested for audible and visible operation on an individual basis at the device or from the main fire alarm control panel, allowing for minimal invasive impact.
- f) Class B (Style 4) notification appliances shall be wired without requiring traditional in/out wiring methods; addressable "T" Tapping shall be permitted. Up to 63 addresses can be supported on a single channel.
- g) Each Addressable notification appliance shall contain an electronic module and a selectable address setting to allow it to occupy a unique location on the channel. This on-board module shall also allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications and shall flash with the appliances address setting when locally requested using a magnetic test tool.
- h) Each addressable notification appliance shall have electrical test point access without removing the device cover.
- 2. Visible/Only: Addressable strobe shall be listed to UL 1971. The V/O device shall consist of a xenon flash tube and associated lens/reflector system, cover and mounting plate. For ease of installation the mounting plate shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. When the appliance is connected to an active circuit, the front cover of the appliance shall be removable without causing a trouble indication on the fire alarm control panel. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The V/O appliance shall be provided with multiple minimum flash intensities of 15cd, 75cd, 110cd, 135cd and 185cd. The Candela levels shall be settable from the fire alarm control panel or by using a hardware selector on the appliance.
- 3. Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480. Addressable functionality controls visible operation, while the speaker operates on a 25VRMS or 70.7VRMS NAC.
 - a) Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.
 - b) The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 82 dBA at 10 feet.
 - c) The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.
 - d) The S/V installs directly to a 4" square, $1\frac{1}{2}$ " deep electrical box with 1 $\frac{1}{2}$ " extension.
- 4. Isolator Module: Isolator module provides short circuit isolation for addressable notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall

mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Addressable Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:

- a) Report faults to the host FACP.
- b) On-board Yellow LED provides module status.
- c) After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.

B. ADRESSABLE APPLIANCE SLC REPEATER

- 1. Addressable Repeater shall supervise channel (SLC) wiring and communicate with and control addressable notification appliances. The Repeater shall be a stand-alone panel capable of powering one (1) NAC SLC. The channel (SLC) shall be rated for 3 amps and support up to 63 addresses. Power and communication for the notification appliances shall be provided on the same pair of wires. It shall be possible to program the setting of the audible appliances by channel from the addressable controller.
 - a) The Repeater shall provide a constant voltage output to ensure NAC current and voltage do not vary whether the panel is operating on AC or battery. The output voltage during alarm conditions shall be 29 VRMS.
 - b) For Class B circuits, the Repeater shall support up to 4 Class B branches directly at its output terminals for one SLC.
 - c) The internal power supply and battery charger shall be capable of charging up two 12.7 Ah batteries internally mounted or 25Ah batteries mounted in an external cabinet.
 - d) The Repeater panel can be mounted close to the host fire alarm control panel or remotely.
 - e) The Repeater status shall be communicated to the host fire alarm control panel and locally indicated.
 - f) A 200mA auxiliary output shall be available
 - g) The Repeater shall be listed to UL 864

2.6. EMERGENCY CONTROL DEVICES

A. MAGNETIC DOOR HOLDERS

- 1. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develop a minimum of 25 lbs. holding force.
- 2. Material and Finish: Match door hardware.

PART 3 – EXECUTION

- 3.1. INSTALLATION, GENERAL
 - A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

- B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
 - 1. Factory trained and certified personnel.
 - 2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
 - 3. Personnel licensed or certified by state or local authority.
- 3.2. EQUIPMENT INSTALLATION
 - A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, ethernet drops, and all other necessary material for a complete operating system.
 - B. Existing Fire Alarm Equipment shall be maintained fully operational until the new equipment has been tested and accepted.
 - C. Equipment Removal: After acceptance of the new fire alarm system, disconnect and remove the existing fire alarm equipment and restore damaged surfaces. Package operational fire alarm and detection equipment that has been removed and deliver to the Owner. Remove from the site and legally dispose of the remainder of the existing material.
 - D. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.
 - E. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.
 - F. Install manual station with operating handle 48 inches (1.22 m) above floor. Install wall mounted audible and visual notification appliances not less than 80 inches (2.03 m) above floor to bottom of lens and not greater than 96 inches (2.44 m) above floor to bottom of lens.
 - G. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
 - H. Automatic Detector Installation: Conform to NFPA 72.
 - I. Ethernet Drop: A standard RJ-45 Ethernet connection to the owner's Ethernet network shall be provided at each fire alarm control panel as part of the contract.
- 3.3. PREPARATION
- 3.4. WIRING INSTALLATION
 - A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
 - B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
 - C. Color Coding: Color-code fire alarm conductors differently from the normal building power

wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

- 3.5. FIELD QUALITY CONTROL
 - A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
 - B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
 - 1. Factory trained and certified.
 - 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 - 3. International Municipal Signal Association (IMSA) fire alarm certified.
 - 4. Certified by a state or local authority.
 - 5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
 - C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
 - D. Inspection:
 - 1. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
 - 2. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.
 - E. Acceptance Operational Tests:
 - 1. Perform operational system tests to verify conformance with specifications:
 - a) Each alarm initiating device installed shall be operationally tested. Each device shall be tested for alarm and trouble conditions. Contractor shall submit a written certification that the Fire Alarm System installation is complete including all punch-list items. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified. Test Supervising Station Signal Transmitter. Coordinate testing with Supervising Station monitoring firm/entity.
 - b) Test each Notification Appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.
 - c) Test Fire Alarm Control Panel and Remote Annunciator.
 - 2. Provide minimum 10 days notice of acceptance test performance schedule to Owner, and local Authority Having Jurisdiction.

- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Use NFPA 72 Forms for documentation.
- H. Final Test, Record of Completion, and Certificate of Occupancy:
 - 1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Owner and AHJ.
- 3.6. CLEANING AND ADJUSTING
 - A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
 - B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.
- 3.7. TRAINING
 - A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.
 - 1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.
 - 2. Schedule training with the Owner at least seven days in advance.

END OF SECTION 28 31 00

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes temporary excavation support and protection systems.
- B. Related Requirements:
 - 1. Section 013233 "Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
 - 2. Section 312000 "Earth Moving" for excavating and backfilling, for controlling surfacewater runoff and ponding, and for dewatering excavations.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project Site.
 - 1. Review geotechnical report.
 - 2. Review existing utilities and subsurface conditions.
 - 3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
 - 4. Review proposed excavations.
 - 5. Review proposed equipment.
 - 6. Review monitoring of excavation support and protection system.
 - 7. Review coordination with waterproofing.
 - 8. Review abandonment or removal of excavation support and protection system.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.
- B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.
 - 1. Include plans, elevations, sections, and details.

- 2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
- 3. Indicate type and location of waterproofing.
- 4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.
- C. Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For the following:
 - 1. Land surveyor.
 - 2. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the state in which Project is located.
- B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.6 CLOSEOUT SUBMITTALS

A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of utility.
 - 2. Do not proceed with interruption of utility without Construction Manager's written permission.
- B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design excavation support and protection systems to resist all lateral loading and surcharge, including but not limited to, retained soil, groundwater pressure, adjacent building loads, adjacent traffic loads, construction traffic loads, material stockpile loads, and seismic loads, based on the following:
 - 1. Compliance with OSHA Standards and interpretations, 29 CFR 1926, Subpart P.
 - 2. Compliance with AASHTO Standard Specification for Highway Bridges or AASHTO LRFD Bridge Design Specification, Customary U.S. Units.
 - 3. Compliance with requirements of authorities having jurisdiction.
 - 4. Compliance with utility company requirements.
 - 5. Compliance with railroad requirements.

2.2 MATERIALS

- A. Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A36/A36M, ASTM A690/A690M, or ASTM A992/A992M.
- C. Steel Sheet Piling: ASTM A328/A328M, ASTM A572/A572M, or ASTM A690/A690M; with continuous interlocks.
 - 1. Corners: Roll-formed corner shape with continuous interlock.
- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 3 inches (75 mm).
- E. Shotcrete: Comply with Section 033713 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.
- F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- G. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed.
- H. Tiebacks: Steel bars, ASTM A722/A722M.
- I. Tiebacks: Steel strand, ASTM A416/A416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

3.2 INSTALLATION - GENERAL

- A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.3 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation.
 - 1. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement.
 - 2. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging.
 - 3. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.
- B. Install wood lagging within flanges of soldier piles as excavation proceeds.
 - 1. Trim excavation as required to install lagging.
 - 2. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.4 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.
- B. Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.
 - 1. Limit vertical offset of adjacent sheet piling to 60 inches (1500 mm).
 - 2. Accurately align exposed faces of sheet piling to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.
- C. Cut tops of sheet piling to uniform elevation at top of excavation.
3.5 TIEBACKS

- A. Drill, install, grout, and tension tiebacks.
- B. Test load-carrying capacity of each tieback, and replace and retest deficient tiebacks.
 - 1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.
- C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 BRACING

- A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
 - 2. Install internal bracing if required to prevent spreading or distortion of braced frames.
 - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.7 MAINTENANCE

- A. Monitor and maintain excavation support and protection system.
- B. Prevent surface water from entering excavations by grading, dikes, or other means.
- C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.8 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.
 - 1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
 - 2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
- B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.
- C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.9 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.
 - 1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
 - 2. Remove excavation support and protection systems to a minimum depth of 48 inches (1200 mm) below overlying construction, and abandon remainder.
 - 3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
 - 4. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.
- B. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000