SECTION 260000 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 -GENERAL

1.01 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. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

1.02 SUBMITTALS

A. None.

1.03 CLOSEOUT

A. None.

1.04 WARRANTIES

A. The Contractor shall warrant all materials, workmanship, and equipment against defects for a period of one year after the date of substantial completion. Certain equipment shall be warranted beginning at the time of final acceptance or for longer periods of time as specified in those divisions of the Project Manual. The Contractor shall repair or replace, at no additional cost to the Owner, any item which may become defective within the warrant period. Any manufacturers' warranties concerning any item installed will run to the benefit of the Owner. The Contractor agrees not to void or impair, or to allow Sub-Contractors to void or impair, any warranties regarding products or items installed as part of this project. The repair of faulty workmanship shall be considered to be included in the contract.

1.05 QUALITY ASSURANCE

A. Source Limitations: To fullest extent possible, provide products of same kind, from a single source.

1. When specified product is available only from sources that do not, or cannot, produce a quantity adequate to complete Project requirements in a timely manner, consult with Architect and Owner to determine most important product qualities before proceeding. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to fullest extent possible.

B. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.

2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect shall determine which products shall be used.

C. Contractor shall comply with all State, and local codes and ordinances.

D. Contractor shall make application for, obtain, and pay for all required permits and certificates of inspection of the work.

E. Required access for servicing and maintenance shall be provided for all equipment. Provide architectural access panels as required.

F. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment of types, materials, and sizes required for the project, whose products have been in satisfactory use in similar service for not less than five (5) years.

G. Installers Qualifications: Firm with at least three (3) years of successful installation experience on projects with equipment installation work similar to that required for project.

1.06 INTERPRETATION OF DOCUMENTS

A. All questions from contractors or subcontractors as it pertains to contract documents during the bidding phase or construction shall be submitted to the Engineer for clarification. Clarification will be issued through official written correspondence. Verbal interpretation or explanation not issued in the form of an addendum or supplemental instruction shall not be considered part of the bidding documents or contract. The Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

B. If any ambiguities should appear in the contract documents, the Contractor shall request clarification from the Engineer before proceeding with the work. Failure to obtain clarification may result in work not being accepted by the Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work.

1.07 PERMITS, FEES, AND NOTICES

A. Contractor shall secure and pay for permits and governmental fees, licenses, and inspections necessary for proper execution and completion of the Work, and for Owner to occupy space and operate systems.

B. Contractor shall comply with and file notices required by laws, ordinances, rules, regulations, and lawful orders of public authorities applicable.

1.08 CODES

A. The work shall be performed by persons skilled in the trade involved and shall be done in a manner consistent with normal industry standards. All work shall conform to all applicable sections of currently adopted editions of all applicable codes. The contractor is responsible for verifying the local codes in the jurisdiction with which the work is performed and installing the work as listed by said codes.

1.09 PROJECT COORDINATION AND LAYOUT

A. The contractor is responsible for laying out and coordinating all work prior to installation. The contractor shall produce coordination documents incorporating all mechanical and electrical trades in conjunction with the building structure and architectural features. The contractor shall coordinate all routing of systems prior to installation. Payment for changes due to pre-fabricating or moving of piping, ductwork, conduit, cable trays, equipment, or any other mechanical, electrical, plumbing, or technology system due to lack of coordination will not be approved.

B. Documents produced by Specialized Engineering Solutions are diagrammatical in nature. Not all system offsets are shown to accommodate final elevations and avoid interference with all other building structural, architectural, mechanical, electrical, fire protection, and technology systems. Contractor shall include in his base scope of work, offsets necessary to negotiate the building appropriately.

C. Contractor shall review and incorporate the following into the Project prior to bidding:

1. Obtain utility metering specification.

2. Review all associated project documents including but not limited to the following:

a. Mechanical plans and equipment connections.

b. Architectural drawings.

c. Vendor drawings for Owner-furnished equipment.

d. Door hardware schedule and shop drawings including fire alarm connections.

D. Contractor shall review approved mechanical shop drawings prior to rough-in to verify equipment connection requirements.

E. Provide all necessary components for a complete and functioning system.

F. Contractor shall submit a request for information for conflicts related to device locations, including items specified by other disciplines.

G. Contractor shall coordinate system outages with the Owner prior to outage in an effort to minimize disruption of services. Systems shall not be taken offline without Owner approval. Contractor shall be responsible for all schedule delays resulting from lack of coordination.

1.10 EQUIPMENT ELECTRICAL CONNECTIONS

A. Electrical connections identified are for the specific equipment manufacturer and model scheduled, and includes equipment furnished by this trade or furnished by other trades under these contract documents. If the Contractor chooses to provide equipment found acceptable from a different manufacturer or model than that scheduled but listed as equivalent in the specifications, or otherwise accepted by the Architect/Engineer, the Contractor shall include electrical connection revisions associated with that manufacturer’s electrical connection requirements in their bid. Upon approval of a manufacturer and model other than that specifically scheduled, the Contractor shall request clarification of the required electrical connection revision from the Engineer for incorporation into the electrical design and construction documents. If the necessary revision is found to require extensive design modification by the Engineer, the Contractor shall provide the Engineer reasonable compensation for incorporation of the selected manufacturer’s equipment into the project design.

1.11 BASIS OF DESIGN

A. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

1.12 OPERATION AND MAINTENANCE MANUALS

A. Manuals to be provided in pdf format and include:

1. Title page with project name and location and date of submittal.

2. Title, Name, address, and telephone number all contractors and suppliers.

3. Table of contents with corresponding tabs to mark sections.

B. Manual to contain the following:

1. Equipment record document submittal.

2. Warranty details, expiration dates, and contacts.

3. Licensing requirements including inspection and renewal dates.

4. Equipment location.

5. Operating manuals including wiring and control diagrams.

6. Operating procedures.

7. Precautions against improper use.

8. Startup shutdown and switchover procedures.

9. Emergency procedures.

10. Schedule for routine cleaning and maintenance.

C. Provide the Operation and Maintenance manuals as hardcopy and electronically on a disk. Provide a disk of the scanned as-built redlines, in addition to the hardcopy.

1.13 OPERATOR TRAINING

A. The contractor shall schedule complete owner training for every system and piece of equipment. Operating and maintenance manuals shall be complete and accepted by owner and engineer prior to training. The contractor shall coordinate a training session which will include the Owner/Owner's Representatives, Engineer, and all Subcontractors or equipment representatives needed to explain and train on the system. A training agenda shall be submitted prior to training. The agenda shall be reviewed and amended as necessary by the Engineer and Owner. The Contractor shall cover all information submitted in the operation and maintenance manual.

1.14 COORDINATION OF WORK

A. Refer to drawings for Coordination of Work matrix.

END OF SECTION 260000

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes:

1. Equipment coordination and installation.

2. Common electrical installation requirements.

B. Related Sections include the following:

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

2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. None.

1.04 EQUIPMENT CONNECTION

A. Incidental Equipment:

1. Contractor shall provide electrical connections and disconnects for incidental equipment. Connections include required line voltage branch circuits and fire alarm. “Incidental Equipment” shall mean equipment furnished by this trade, or furnished by other trades under these project documents, and that are not specifically identified or located on the plans. Examples include, but are not limited to, building management control panels, fire alarm remote power supplies, medical gas alarm panels, chemical treatment equipment, interconnections between packaged mechanical equipment with split interior/exterior equipment components. Each piece of equipment shall have a local disconnecting means, either by cord or plug or by disconnect switch. Where equipment is located in a public area, the disconnect switch shall be concealed from public access, shall be within sight of the equipment, and the location shall be identified within or on the equipment served. Coordinate requirements with equipment provided and other associated trades.

B. Scheduled Equipment:

1. Prior to ordering and installing material and electrical equipment, verify that scheduled connection requirements are consistent with equipment being provided. This shall include equipment furnished by this trade or furnished by other trades under these project documents. Verification is necessary due to the uncertainty of final equipment selection provided by other trades; including, but not limited to: Elevators, mechanical equipment, etc.

PART 2 -PRODUCTS (RESERVED)

PART 3 -EXECUTION

3.01 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.

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 Location: Install to facilitate service, maintenance, and repair or replacement of components associated with 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 piping systems installed at a required slope.

F. Equipment Dimensions: Equipment illustrated on drawings reflect equipment dimensions for one of the manufacturer's specified. These dimensions were utilized to coordinate a general mounting location that accommodates required clearances and available space for the equipment and in consideration of adjacent equipment/systems. Contractor shall provide equipment with similar dimensions. Where equipment is not provided with similar dimensions, Contractor shall provide necessary accommodations to maintain required clearances for the equipment and shall consider adjacent equipment/systems.

3.02 ELECTRICAL DEVICE MOUNTING HEIGHTS

A. Electrical devices' mounting heights specified on Architectural documents or specific mounting heights indicated on plans shall take precedence. See plans for typical electrical device mounting heights detail. Typical Mounting Heights (measured to the center of the device):

1. Wall Switches: 48 inches.

2. Wall Switches (Serving Undercabinet Task Lighting): Match receptacle outlet height above countertop/backsplash.

3. Receptacle Outlets (general): 18 inches.

4. Receptacle Outlets (above work surfaces): 4 inches above countertop/backsplash.

5. Special-Purpose Outlets: Within 72 inches of intended use.

6. Communications Outlets: 18 inches.

7. Fire Alarm Manual Station: 48 inches.

8. Fire Alarm Notification Appliance: 82 inches to center of strobe. If this height would result in being within 6 inches off the ceiling, coordinate height with authority having jurisdiction.

9. Push Buttons: 48 inches.

10. Exit Signs: 4 inches between top of door frame and bottom of exit sign where possible (when wall mounted).

11. Wall Phones: 48 inches.

12. Medical Gas Storage Room Devices: 66 inches (required to be above 60 inches).

13. Nurse Call:

    a. Wall Stations: 48 inches.

    b. Pull Cords:
        1) Toilets: Required between 36 inches to 48 inches and within 12 inches of the front of the toilet bowl. Coordinate exact location with Architect.

    c. Device at Patient Headwalls: Coordinate exact location with Architect.

    d. Dome Lights: Wall mounted with 4 inches between top of door frame and bottom of dome light where possible, or ceiling mounted. Coordinate exact location with Architect.

B. Coordination: Coordinate exact location of devices to serve equipment indicated and to accommodate architectural construction and finishes.

1. Devices shall not be located directly above or below alcohol antiseptic dispensers, and shall be a minimum 1 inch from the sides of alcohol antiseptic dispensers. Verify dispenser locations with Owner.

3.03 FIRESTOPPING

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

END OF SECTION 260500

SECTION 260519 - CONDUCTORS AND CABLES FOR ELECTRICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes:

1. Building wires and cables rated 600 V and less.

2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections include the following:

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

2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

3. Division 26 Section “Grounding and Bonding for Electrical” for grounding conductors, electrodes, and connectors.

4. Division 26 Section “Raceways and Boxes for Electrical” for raceway and metal-clad cable application.

5. Division 27 Section "Voice and Data Communication Cabling" for cabling used for voice and data circuits.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. None.

1.04 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 -PRODUCTS

2.01 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70 and UL rating.

B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

2.02 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 -EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper.

B. Branch Circuits: Copper. Solid for #10 AWG and smaller, stranded for #8 AWG and larger.

C. Solid for #10 AWG and smaller, stranded for #8 AWG and larger.

D. Fire Alarm Circuits: Power-limited, fire protective, signaling circuit cable or other cable as recommended by fire alarm manufacturer.

E. Hospital Isolation Power System Branch Circuits: Type XHHW single conductors in raceway.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.

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

D. Class 2 Control Circuits: Class 2 control cable suitable for the application.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated. Route cables in conduit when required by the applicable specification section.

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. Identify and color-code conductors and cables according to Division 26 Section "Electrical Identification."

F. Branch Circuit Size: #12 AWG unless noted otherwise.

1. Where 20A, 120V branch circuit conductor length from the overcurrent device to the furthest outlet exceeds 75’, all branch circuit conductors shall be #10 AWG.

2. Where 20A, 120V receptacle branch circuit conductor length from the overcurrent device to the furthest receptacle exceeds 150`, all branch circuit conductors shall be #8 AWG.

G. Provide dedicated neutrals for all branch circuits.

3.04 CONNECTIONS

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

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors. Existing aluminum conductors shall not be spliced or extended.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

B. Related Sections include the following:

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

2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. Field quality-control test reports.

1.04 QUALITY ASSURANCE

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 -PRODUCTS

2.01 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

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

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

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

C. Ground Bar: Rectangular bars of annealed copper, 1/4-by-4 inches in cross section, unless otherwise indicated; with insulators. Length as required to accommodate terminations.

2.02 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Connectors for Conductors: Mechanical crimp type, cast silicone bronze, long crimp barrel and two-bolt connection to ground bar.

C. Connectors for Pipes:

1. Pipe Connectors: Copper or copper alloy. Bolted, clamp type, sized for pipe.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

E. Aluminum bolted to cable type are not acceptable.

2.03 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet in length.

PART 3 -EXECUTION

3.01 APPLICATIONS

A. Ground Bar: Install in electrical and telecommunications rooms, housing service equipment, satellite telephone equipment rooms, and elsewhere as indicated.

1. Install bar on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.

2. Interconnect electrical and telecommunications ground bars per plans.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded or bolted connectors (listed for the application), except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Welded or bolted connectors.

3.02 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. 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.

C. Water Heater, Heat-Tracing, and Antifrost 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.

D. Metal Poles Supporting Outdoor Lighting Fixtures: Bond equipment grounding conductor installed with branch-circuit conductors to pole.

3.03 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

2. For grounding electrode system, install one or more rods to meet NFPA 70 requirements, spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building`s main electrical service equipment, or Ground Bar, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Gas Piping: Bond each aboveground portion of gas piping system downstream from equipment shutoff valve. Where flexible gas piping is utilized, bond gas piping at building entrance to the building's main electrical service equipment utilizing an insulated #6 AWG copper grounding conductor in conduit.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

F. Ufer Ground (Concrete-Encased Grounding Electrode/Building Footing): Fabricate according to NFPA 70, by using a minimum of 20 feet of either bare copper conductor not smaller than No. 4 AWG for one or more bare or zinc galvanized or other electrically conductive coated steel reinforcing bars of not less than 1/2-inch diameter.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

G. Where structural metal of a building addition is isolated from the original facility's structural metal, provide a bonding jumper sized to match the grounding electrical conductor between the existing and new structural metal.

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. 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. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

3. Prepare dimensioned drawings locating each test well, 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.

B. Submit report for any instances where measured ground resistances exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.

3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

4. Patient Care Areas: Voltage and ground impedance measurements for the patient care vicinity as required by NFPA 99.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.

2. Construction requirements for concrete bases.

B. Related sections include the following:

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

2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

1.02 SUBMITTALS

A. None

1.03 CLOSE-OUTS

A. None

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. 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.

PART 2 -PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

2. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. 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.

D. 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.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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.

PART 3 -EXECUTION

3.01 APPLICATION

A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for conduit as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.02 SUPPORT INSTALLATION

A. Strength of Support Assemblies: 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.

B. 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. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or spring-tension clamps.

6. To Light Steel: Sheet metal screws.

7. 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.

C. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 CONCRETE BASES

A. Provide concrete bases for floor-mounted Division 26 equipment. Construct concrete bases 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base. Coordinate exact dimensions with equipment to provide support and accommodate required equipment access and operation.

B. Use 3000-psi, 28-day compressive-strength concrete.

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer`s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer`s written instructions.

4. Install base and equipment level.

3.04 PAINTING

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

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

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

2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. None.

1.04 QUALITY ASSURANCE

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

B. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the NFPA 70.

1.05 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. RMC: Rigid metallic conduit.

G. RNC: Rigid nonmetallic conduit.

1.06 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 -PRODUCTS

2.01 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B. IMC: ANSI C80.6.

C. EMT: ANSI C80.3.

D. FMC: Zinc-coated steel.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

2. Fittings for EMT: Steel or die-cast, compression type.

2.02 NONMETALLIC CONDUIT AND TUBING

A. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

B. HDPE: High density polyethylene.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.03 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

B. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.

C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

D. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer`s standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

2.04 SLEEVES

A. Wall Sleeves:

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

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

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

b. 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 inch.

2.05 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway.

1. Manufacturers: Subject to compliance with requirements.

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

3. Pressure Plates: Plastic. Include two for each sealing element.

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.

2.06 SLEEVE-SEAL FITTINGS

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

2.07 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, Grade B, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. Design mix: 5000-psi, 28-day compressive strength.

2.08 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multi-component, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.09 INFORMATION

A. All materials shall be approved and labeled by UL or approved equal.

PART 3 -EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors: Comply with the following applications. Conceal conduit within finished walls, ceilings, floors, and below exterior grades unless surface mounting is specifically indicated on plans.

1. Exposed Conduit: Rigid steel conduit.

2. Concealed Conduit, Aboveground: Rigid steel conduit.

3. Underground Conduit:

a. Direct Buried (by Excavation): RNC, Type EPC-40-PVC.

b. Direct Buried (by Directional Bore): Type HDPE.

c. Engine Generator Conduits (Direct Buried by Excavation): RNC, Type EPC-80-PVC.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoor: Comply with the following applications. Conceal conduit within finished walls, ceilings, floors, and below exterior grades unless surface mounting is specifically indicated on plans.

1. Exposed, Not Subject to Physical Damage: EMT.

2. Concealed in Ceilings and Interior Walls and Partitions: EMT.

3. Below Floor Conduit: RNC, Type EPC-40-PVC.

a. Only applicable to below-floor distribution feeders, equipment connections, site branch circuits, and floor boxes. General branch circuits shall not be routed within concrete slabs or below slab-on-grade surfaces.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Damp or Wet Locations: Rigid steel conduit.

6. Raceways for Optical Fiber or Communications Cable: EMT.

7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.

8. Surface Raceways: Only where specifically indicated on plans.

9. Connection to Undercabinet and Wall-Mounting Lighting Fixtures: Multi-conductor metal clad cable (Type HCF) may be used where installed concealed with lengths not exceeding 6 feet, if acceptable to Authority Having Jurisdiction for application and system branch. This wiring method only applies to this specific light fixture application.

10. Patient Care Areas: Branch circuits shall be installed in a metal raceway system (suitable as a ground path in addition to an insulated equipment grounding conductor) to comply with NFPA 70 and NFPA 99. Where branch circuits serving patient care areas are installed within concrete slabs or below slab-on-grade surfaces, threaded (thick wall), rigid metal conduit and metal floor boxes shall be used. Patient care areas shall be those areas defined by NFPA and shall include patient toilets.

C. Minimum Raceway Size:

1. All conduit systems: 3/4-inch trade size. 1/2" may be used for switches and receptacles located in the walls and for 120V lighting circuits.

2. Voice and Data Communications: 1-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

E. Conduit & Junction Box Color Code:

1. Provide conduits with the following manufacturer applied finishes by Branch/system. Paint junction boxes and box covers to match conduit.

a. Voice/Data/Video/Optical Fiber: Blue

b. Overhead Paging: Black

c. Nurse Call/Code

d. Fire Alarm: Red

e. Security Ssytems/Access Control/BAS Controls: Purple

f. Life Safety Branch: Yellow

g. Critical Branch: Orange

h. Equipment Branch: Green

i. Normal Branch: Gray (Standard Galvanized Finish)

F. Below Grade Elbows:

1. Stub-ups: Provide rigid steel conduit elbows for all below grade or below floor conduit stub-ups.

Extend elbows to above grade or above floor with rigid steel conduit stub-ups, conduits, and required fittings. Not required for concrete light pole bases.

2. Other Elbows: Provide sweeping bends of minimum 48 inch radius.

G. Exposed Raceway in Finished Spaces: Exposed raceway in finished spaces is only permitted where indicated on plans. Paint to match adjacent surface installed on. If plans indicate raceway is not to be painted, remove stickers from raceway before installation.

3.02 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

E. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

F. 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.

G. Raceways for Optical Fiber and Communications Cable: Install as follows:

1. Install raceways in maximum lengths of 100 feet.

2. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

H. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where otherwise required by NFPA 70.

I. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit from fixed junction box to recessed and semi-recessed lighting fixtures; equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

J. 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. Adjust mounting height to match coursing on exposed block or brick.

K. Set metal floor boxes level and flush with finished floor surface.

L. Adjacent boxes installed within common wall stud space shall not be installed back-to-back.

M. Maintain fire rating of wall, floor, and ceiling assemblies as required by UL and applicable building codes. Space boxes or provide putty backing as required.

N. Provide back supports on device boxes.

O. Coordinate device box and associated plaster ring selection to accommodate device/fixture served and to accommodate wall construction, wall finish, and casework/cabinets.

P. Coordinate device and junction box knockouts to accommodate conduits specified.

Q. Minimum two securing screws on stud mounted device boxes.

R. Cable Protection: Where conduits are utilized for routing of low voltage cables, provide plastic bushings as required to avoid bare conduit edges.

S. Building Expansion Joints: Provide conduit expansion fittings at building expansion joints.

3.03 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 for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified.

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified.

4. 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.

5. 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 of concrete.

   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

   c. Stub-ups at concrete pads shall extend vertically a minimum of 3” above top of concrete pad.

6. Refer to Specification Section “Earthwork” for additional requirements.

7. Warning Tape: Apply per Specification Section “Electrical Identification”.

8. Directional bore may be utilized in lieu of trenching.

3.04 SLEEVE INSTALLATION

A. Electrical penetrations occur when pathways, raceways, cables, wireways, or cable trays, or busways 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. 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.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 4 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway. Install sleeves and seal raceway sleeves with firestop materials. Comply with requirements in Section "Through-Penetration Firestop Systems."

K. Roof-Penetration Sleeves: Seal penetration of individual raceway with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.05 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.06 SLEEVE-SEAL FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.07 FIRESTOPPING

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

END OF SECTION 260533

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Identification for conductors.
2. Wiring device wall plate labels
3. Equipment identification labels.
4. Underground-line warning tape.
5. Fire/smoke barrier/penetration labeling.

B. Related Sections include the following:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.
3. Refer to Raceway and Boxes for Electrical Specification for conduit and box color code.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. None.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.05 COORDINATION

A. Coordinate identification names, colors, and other features with requirements in the Contract Documents, and with those required by codes. Use consistent designations throughout Project. Match existing Owner standards where applicable.

PART 2 -PRODUCTS

2.01 CONDUCTOR IDENTIFICATION MATERIALS

A. Colored Tape: Vinyl, self-adhesive type.

2.02 WIRING DEVICE WALL PLATE LABELS

A. Machine-printed, adhesive tape label, clear with black letters.

1. In lieu of machine printed, adhesive tape labels, provide engraved labels for device plates in the following rooms (black lettering for normal branch, red lettering for essential branches):

a. Surgery Department:
1) Operating rooms/procedure rooms.
2) Pre-op/post-op/recovery rooms and bed locations.
3) Sterile corridors, sterile supply rooms, and sub-sterilization rooms.

b. Sterile Processing Department: Clean processing/sterile supply rooms.

2.03 EQUIPMENT IDENTIFICATION LABELS

A. Engraved or Melamine Label: Adhesive backed, with white or black letters on a colored background. Minimum letter height shall be 3/8 inch.

1. Nameplate Color:

a. 208Y/120V Equipment: Blue with white core

b. 480Y/277V Equipment: Black with white core

c. Fire alarm: White with red core

d. Security: Dark red (burgundy) with white core

e. Essential Electrical System: Red with white core

f. Telephone Systems: Orange with white core

g. Data Systems: Brown with white core

h. Paging Systems: White with black core

B. Service Entrance: Adhesive label containing the following information:

1. Nominal system voltage.

2. Available fault current at the service overcurrent protective devices.

3. The clearing time of services overcurrent protective devices based on the available fault current at the service equipment.

4. The date the label was applied.

C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall indicate the arc hazard boundary (inches), working distance (inches), arc flash incident energy at the working distance (calories/cm2), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches), restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

2.04 UNDERGROUND-LINE WARNING TAPE

A. Permanent, bright-colored, continuous-printed, vinyl tape.

1. Compounded for permanent direct-burial service.

2. Embedded continuous metallic strip or core.

3. Printed legend indicating type of underground line.

2.05 FIRE/SMOKE BARRIER PENETRATION

A. Provide sticker complying with facility standard and penetration sealant product requirement listing product, date, company name, and initials of installer. Sticker to be minimum 3 by 5 and red in color.

PART 3 -EXECUTION

3.01 APPLICATION

A. Equipment Identification Labels:

1. On each unit of equipment, install unique designation label that is consistent with plans.

2. Labeling Instructions:

a. Indoor Equipment: Provide label per Part 2 requirements.

b. Outdoor Equipment: Provide label per Part 2 requirements, pre-drilled for screw attachment.

c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.

3. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.

b. Electrical switchgear and switchboards.

c. Transfer Switches.

d. Transformers.

e. Disconnect switches.

f. Enclosed circuit breakers.

g. Motor starters.

h. Push-button stations.

i. Power transfer equipment.

j. Lighting control panels.

k. Ground bars.

l. Control cabinets.

m. Power supplies.

n. Factory generated Mimic bus for multi-section switchboards.

o. Variable speed drives and other line-voltage motor controllers.

B. Wiring Device Wall Plate Labels:

1. On each wall plate, cover plate, and faceplate, install label per Part 2 requirements.

3.02 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. Receptacle Wall Plates: List panel and branch circuit number. Where served from a GFCI circuit breaker, indicate letter “G” at the end of the circuit number designation.

G. Conduits Out of Panels: Label conduits with marker indicating circuit number on conduits exiting switchboards, motor control centers, distribution panels, and lighting panels. Label at the source as they exit the enclosure.

H. Light Switch Wall Plates: Where two or more switches are ganged together, provide description of area or function for each switch.

I. Fire Alarm: Label control modules, monitoring modules, relays, and remote test/indicating devices to identify their associated function. Label addressable devices with their associated system address, visible without removal of the device. Coordinate exact label format with Owner.

J. Mechanical Equipment: Provide label indicating equipment name as well as panel name and circuit number feeding the equipment. For new fused disconnects and existing fused disconnects modified in the project include fuse size on equipment label. Locate on equipment disconnect. Locate label within sight of the equipment.

K. Conductor Color-Coding for Phase Identification:

1. Color shall be factory applied.

2. Colors for 208/120-V Circuits:

a. Phase A: Black.

b. Phase B: Red.

c. Phase C: Blue.

d. Neutral: White.

3. Colors for 480/277-V Circuits:

a. Phase A: Brown.

b. Phase B: Orange.

c. Phase C: Yellow.

d. Neutral: Gray.

4. Colors for Isolated Power Systems:

a. Phase A: Orange with black stripe.

b. Phase B: Brown with black stripe.

5. Neutral Identification:

a. Where individual (dedicated) neutral conductors are required for single-phase 120 volt and 277 volt branch circuits, neutral conductor shall have factory applied color stripe (tracer) along the length of the conductor, with tracer color to match associated phase conductor.

L. Junction Box Covers:

1. Label junction box covers located above accessible ceilings or in unfinished spaces with black permanent ink marker indicating panel and circuit number, or equivalent system information. Provide labeling of system name on covers for systems enclosed in conduit. For example, “Nurse Call” label cover Nurse Call. Where conduit is exposed and painted, provide label on inside of junction box cover.

2. In additional to labeling, paint junction box covers. Refer to Raceway and Boxes for Electrical Specification for color code.

M. Circuits More Than 600V: Identify raceway and boxes with “Danger-High Voltage” at 10 foot intervals.

N. Panelboards, Switchboards, Switchgear, Transfer Switches, Enclosed Circuit Breakers, and Motor Control Centers: Label shall identify equipment name, system branch, voltage, and source “fed from”.

O. Transformers: Label shall identify equipment name, system branch, and source “fed from”.

1. Distribution panels, switchboards, switchgear, and motor control centers shall include engraved labels at circuit breakers.

P. Path of Underground Electrical Lines:

1. During trench backfilling, for exterior underground power, control signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker.

Q. Ground Bars: Provide polyester write-on tag for each grounding conductor attached to ground bars external to equipment enclosures. Identify remote connection point of conductor on tag with permanent black ink marker and attach to conductor with nylon tie.

3.03 FIRE/SMOKE BARRIER PENETRATION LABELING

A. Affix label at every rated fire/smoke barrier penetrated with electrical systems, conduit, and systems pathways.

END OF SECTION 260553

SECTION 260573 - POWER SYSTEM STUDIES

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes computer-based, fault current, overcurrent protective device coordination, and arc flash studies. Protective devices shall be set based on results of the protective device coordination study.

1.02 SUBMITTALS

A. Other Action Submittals: The following submittals shall be made before the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.

2. Study and Equipment Evaluation Reports.

3. Coordination-Study Report.

4. Arc Flash Study Report.

1.03 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 fault current and coordination analysis.

D. Comply with IEEE 1584 for arc flash analysis.

E. Comply with IEEE 399 for general study procedures.

1.04 SCOPE OF ANALYSIS

A. The entire electrical distribution system, including all new and all existing equipment shall be included in the studies and data gathering.

PART 2 -PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, utilize products by one of the following:

1. CGI CYME.

2. EDSA Micro Corporation.

3. ESA Inc.

4. Operation Technology, Inc.

5. SKM Systems Analysis, Inc.

2.02 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-current-characteristic 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.

PART 3 -EXECUTION

3.01 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support studies:

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.

3.02 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker 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. Switchgear and switchboard bus.

2. Medium-voltage controller.

3. Motor-control center.

4. Distribution panelboard.

5. Branch circuit panelboard.

6. Automatic transfer switch.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. 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 C57.12.22.

b. IEEE C57.12.00.

c. 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.

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.

G. Provide equipment with interrupting duties required as a result of the study.

3.03 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) short-circuit currents.

3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

C. 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.

D. 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.

E. 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 fuses.

e. Cable damage curves.

f. Transformer inrush points.

g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.

3.04 ARC FLASH STUDY

A. Perform arc flash study for all equipment in the fault study and all transformers in scope using approved computer software program. Prepare a written report using results of the fault-current and coordination studies.

B. Comply with IEEE 1584.

C. Arc-Flash Study Report: Prepare a written report indicating the following results of the arc flash study:

1. Tabular Format of Arc Flash Warning/Danger Labels for Distribution Equipment

a. Arc hazard boundary (inches)

b. Working distance (inches)

c. Arc flash incident energy at working distance (calories/cm2)

d. PPE category and description including the glove rating

e. Voltage rating of the equipment

f. Limited approach distance (inches)

g. Restricted approach distance (inches)

h. Prohibited approach distance (inches)

i. Equipment/bus name

j. Date prepared

k. Supplier name and address

3.05 DISTRIBUTION EQUIPMENT SELECTION AND LABELING:

A. To accommodate required equipment selection as indicated below, studies required by this section shall be submitted and approved prior to submittal of equipment containing overcurrent protection devices.

B. Overcurrent protective device manufacturer shall provide equipment (switchboards, panelboards, motor control centers, transformers, enclosed switches/circuit breakers, etc.) with interrupting duties required as a result of the fault current study.

C. Manufacturer shall also provide overcurrent device types (circuit breaker frame size, plug rating, adjustability, fuse selection, etc.) required to achieve coordination to 0.1 seconds per NEC Article 517 as a result of the coordination study

D. Manufacturer shall provide arc flash warning/danger labels for each piece of distribution equipment, listing details derived from the arc flash analysis.

END OF SECTION 260573

SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes requirements for commissioning the HVAC system and its subsystems and equipment. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."

B. Related Sections include the following:

1. Division 01 1810 "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section.

2. Division 23 Section “Commissioning of HVAC Systems” for electrical systems commissioning requirements.

1.02 DEFINITIONS

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

C. BoD: Basis of Design.

D. CxA: Commissioning Authority.

E. OPR: Owner`s Project Requirements.

F. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

G. TAB: Testing, Adjusting, and Balancing.

1.03 CONTRACTOR`S RESPONSIBILITIES

A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Contractor:

1. Perform commissioning tests at the direction of the CxA as defined in the Commissioning Plan.

2. Attend Construction phase controls coordination meeting.

3. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

4. Provide information requested by the CxA for final commissioning documentation.

5. Provide training to Owner's personnel on system operations, preventive maintenance, sequence of operations, and function on systems.

6. Attend TAB review & coordination meeting for TAB Work.

C. Electrical Contractor:

1. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.

2. With the Mechanical Contractor & Subcontractors, coordinate installations and connections between and among electrical and HVAC systems, subsystems, and equipment.

1.04 COMMISSIONING DOCUMENTATION

A. The following are in addition to documentation specified in Division 01 Section "General Commissioning Requirements."

B. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.

2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Electrical systems, assemblies, equipment and components to be verified and tested.

4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.

5. Certificate of readiness certifying that Electrical systems, subsystems equipment and associated controls are ready for testing.

6. Test and inspection reports and certificates.

7. Corrective action documents.

C. Test Checklists: CxA, shall develop test checklists for Electrical systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Contractors shall complete test checklists. In addition to the requirements specified in Division 01 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:

1. Calibration of sensors and sensor function.

2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.

3. Expected performance of systems, subsystems, and equipment at each step of test.

4. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.

5. Interaction of auxiliary equipment.

6. Issues log.

1.05 SUBMITTALS

A. The following submittals are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.

C. Certificate of Readiness: CxA shall compile certificates of readiness from each Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

D. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed.

E. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates and shall include them in systems manual and commissioning report.

F. Corrective Action Documents: CxA shall submit corrective action documents.

PART 2 -PRODUCTS(NOT USED)

PART 3 -EXECUTION

3.01 TESTING PREPARATION

A. Prerequisites for Testing: (Completed by Contractor)

1. Certify that Electrical systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the OPR, BoD, and Contract Documents; and that Certificates of Readiness are signed and submitted.

2. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.

3. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power- if applicable, and alarm conditions).

4. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.

5. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable or failed. Repeat this test for each operating cycle that applies to system being tested.

6. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

7. Annotate checklist or data sheet when a deficiency is observed.

3.02 TESTING VERIFICATION

A. Prior to performance of testing, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Verification of Report:

1. Provide technicians, instrumentation, and tools to verify testing & balancing of HVAC and Plumbing systems at the direction of CxA.

2. CxA shall select up to 100 percent of report for field verification.

3. CxA shall notify Electrical Contractor 10 days in advance of the date of field verification; however, notice shall not include data points to be verified. The Electrical Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.

C. If deficiencies are identified during verification testing, CxA shall notify the Electrical Contractor, Construction Manager and Architect, and shall take action to remedy the deficiency. Architect shall review final tabulated checklists and data sheets to determine if verification is complete and that system is operating according to the Contract Documents.

D. CxA shall certify that Testing has been successfully completed.

3.03 GENERAL TESTING REQUIREMENTS

A. Scope of electrical testing shall include lighting system, motor controls and fire alarm system.

B. Test all operating modes, interlocks, control, responses, and responses to abnormal conditions, and verify proper response of building automation system controllers and sensors.

C. The CxA along with the electrical contractor shall prepare detailed testing plans, procedures, and checklists for the electrical systems, subsystems, and equipment.

D. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

E. Perform tests using design conditions whenever possible.

1. Simulate conditions by imposing an artificial condition when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

2. Alter set points when simulating conditions is not practical and when directed by CxA.

3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.

F. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.

2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented, and additional tests scheduled.

3.04 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Lighting Controls Testing and Acceptance Procedures: Testing requirements are specified in Division 26 lighting control sections. Provide Submittals and test data to the CxA.

B. Motor Controls Testing and Acceptance Procedures: Testing requirements are specified in Division 26 enclosed controllers sections. Provide submittals and test data to the CxA.

C. Fire Alarm Testing and Acceptance Procedures: Testing requirements are specified in Division 28 fire alarm sections. Provide submittals and test data to the CxA.

END OF SECTION 260800

SECTION 260943 - ADDRESSABLE NETWORK LIGHTING CONTROLS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes addressable networked digital lighting controls.

1.02 SUBMITTALS

A. Product Data: For each type of product (general device descriptions, dimensions, individual wiring details, nomenclature).

B. Bill of Materials: Complete list of all parts needed to fully install selected system components.

C. Shop Drawings:

1. Floor Plans: Location, orientation, and coverage area of each sensor; groups; zones; scenes, and other specific design symbols and designations as required to define the installation, location, and configuration of all control devices.

2. Point List and Data Bus Devices: Summary list of all control devices, sensors, and other devices connected to each data bus. Include remaining future device capacity of data bus.

3. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.

D. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

1. Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.

E. Room Interconnection Diagrams: Typical per room type (detailed drawings showing device interconnectivity of devices).

F. Example Contractor Startup/Commissioning Worksheet: Must be completed prior to factory start-up.

G. Field quality-control reports.

H. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On magnetic media or compact disk, complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

1.04 QUALITY ASSURANCE

A. All applicable products must be UL/CUL Listed or other acceptable national testing organization.

B. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, fixtures, and system controllers shall be resolved between the Contractor and the system provider, as required to ensure proper system operation and maintainability.

C. System startup shall be performed by manufacturer's authorized service representative.

1.05 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.

B. Coordinate lighting controls with BAS either through IP based intercommunication of system or hardwired auxiliary relay outputs.

C. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

D. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

E. Comply with protocol described in IEC 60929, Annexes E and G, for lighting control devices, wiring, and computer hardware and software.

F. Comply with UL 916.

1.06 WARRANTY

A. Manufacturer`s Warranty: Manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Software: Failure of input and output to execute switching or dimming commands.

b. Failure of modular relays to operate under manual or software commands.

c. Device failure.

d. Damage of electronic components due to transient voltage surges.

2. Warranty Periods:

a. Control Components: Three years from date of Substantial Completion.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

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

1. Digital Lighting Management (DLM) from WattStopper.

2. Encelium Energy Management System from Osram Sylvania.

3. nLight® Network Control System from Sensor Switch.

4. Quantum Total Light Management from Lutron.

5. Green Light from Crestron.

6. NX by Hubbell.

7. Approval prior to bid required for other manufacturers.

2.02 SYSTEM REQUIREMENTS

A. Operation: Input signal from digital signal sources, switches, sensors, or other devices associated with signal input.

1. Each input and control device is connected to a digital data bus.

2. Each device has a digital address and can be operated by a digital signal.

3. Each device can be assigned to any or all groups connected to a single data bus.

4. Each dimming device may have as many as 20 lighting levels in 5 percent increments.

5. Scenes can be programmed to devices and may be applied to groups.

B. System Requirements:

1. Components: Individually addressable control devices (such as relays, dimmers, and switches) that are operated from digital signals received through a data bus, from data-entry and -retrieval devices (such as PCs, hand-held infrared programming devices, and wired network connections). Devices also report status to data-entry and -retrieval devices though the bus.

2. Fixture Independence: Addressable control devices shall be mounted separately from the fixture and shall not be integrated into the fixture in manufacturing/assembly. Future removal of the addressable control device shall not require removal of the fixture, and future removal of the fixture shall not require removal of the addressable control device.

3. Digital Control: Use peer-to-peer communication and distributed logic, where the failure of any single component within a scope shall be automatically isolated and not affect function of other spaces.

C. System shall have an architecture that is based upon three main concepts:

1. Intelligent lighting control device.

2. Standalone lighting control zones.

3. Network backbone for remote or time based operation.

D. 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.

E. Each lighting control zone shall be capable of automatically configuring itself for default stand-alone operation without any start-up programming.

F. 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.

G. 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 or the occupancy sensor times out, 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.

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

H. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

I. System software interface shall have the ability to notify communication failures to system users via system and e-mail messages. E-mail messages shall be available in html and text formats.

J. Surge Suppression: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.

K. All system devices shall be capable of being given user defined names.

L. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

M. 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.

2.03 BUS POWER SUPPLY

A. Description: Supply power to data bus as an NFPA 70, Class 2 control circuit.

1. Primary Power: Field selectable, 120 and 277 V.

2. Power Supply: Regulated to maintain the operating voltage under full load, and rated for full capacity of connected devices.

3. Pilot Lights: Indicate data bus ground fault and data bus traffic.

2.04 CONTROLLER/GATEWAYS

A. Description: The controller/gateways link the distributed data buses to all other data buses with a dedicated lighting control network included with the system. A link is also provided for the Owner's Ethernet network to provide computer configuration, control, analysis, and maintenance. The controller/gateways operate independently and continue to process local inputs and schedules when disconnected from the dedicated lighting control network or Owner's Ethernet network. The controller/gateways shall provide local intelligence and features including the following:

1. Integrated real-time clock with automatic daylight savings adjustment and leap-year correction.

2. Integrated sunrise/sunset support based on the site location (latitude and longitude).

3. Automatic time schedules, to control groups for scheduled occupancy with support for holiday exceptions.

4. Digital outputs for additional control and interlocking with external equipment such as fans, valves, and security panels.

5. Support data bus(es).

6. Computer Monitoring and Configuration: The controller/gateway shall allow configuration, monitoring, and analysis from PCs on the Owner's Ethernet LAN.

B. Each data bus shall have the capacity to control connected addressable devices, using NFPA 70, Class 2 control circuit.

1. Each data bus shall have the capacity to control groups and scenes.

2. LED indicator lights for Ethernet status (link, send, and receive), power-on, and network failure.

3. Linking of switch and sensor inputs to control device outputs.

4. Viewing control device output status.

5. Controlling control device outputs.

6. Setting device addresses.

7. Assigning switch and sensor inputs and control device output modes.

C. Allow connection of the following addressable control devices:

1. Fluorescent fixture switching and dimming, for linear and compact lamps.

2. Incandescent fixture switching and dimming.

3. HID and HPS fixture switching and dimming.

4. LED fixture switching and dimming.

5. Occupancy and photoelectric sensors.

6. Emergency lighting interface complying with UL 924.

D. Stores system programming in nonvolatile memory.

1. Switch to enable or disable software programming.

2.05 USER INTERFACE

A. Workstation:

1. Lighting control system management software installed on Owner's PC, with Microsoft Windows operating system.

2. Include licenses, documentation, and storage media and licensing for a minimum of one user.

B. Infrared Programming Assistant: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier to program the manual switches.

2.06 LIGHTING CONTROL SYSTEM MANAGEMENT SOFTWARE

A. The software shall provide for programming, configuring, and monitoring all devices connected to all data buses of the lighting control system, using application-specific software with Microsoft Windows-based, user-friendly software with graphical user-interface designed screens.

1. The software shall be object oriented with pop-up menus and built-in help screens. All specified features of the data-bus-connected devices and those associated with controller/gateways shall be included in the software.

2.07 LED FIXTURE SWITCHING AND DIMMING

A. Each device or zone shall be addressable and shall include on/off, fade, dimming, scene settings, and other standard control functions as required to meet the Lighting Control Schedule functions. Control outlet and wiring shall be compatible with fixtures specified.

B. Drivers: Comply with requirements in Division 26 “Interior Lighting” for LED and the following:

1. Dimming Range: 100 to 5 percent of rated lumens, unless fixture specified is capable of lower outlet (match fixture).

2. Input Voltage Range: 108 to 305V.

2.08 SENSORS

A. Sensors may be powered directly from the lighting control network or with a standalone power supply. Units powered with a standalone power supply shall interface with the lighting control system through an electrically isolated digital input.

B. General Description: Ceiling-mounting, solid-state low voltage units.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes. Automatic sensitivity adjustment.

2. Sensor Type: Sensors shall be dual-technology type (unless noted otherwise).

a. Corridors and Vestibules: PIR type sensors are acceptable.

3. Sensor Output: Contacts rated to operate the connected power pack, complying with UL 773A. Sensor shall be powered from the power pack.

4. Mounting:

a. Sensor: Suitable for mounting on a standard outlet box.

b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind accessible cover.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

6. Bypass Switch: Override the on function in case of sensor failure.

C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic/microphonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches.

2.09 INDOOR PHOTOELECTRIC SENSORS

A. Photo sensor shall be sensitive to all waveforms within the visible light spectrum.

B. Spectral response of sensor shall match the sensitivity of the human eye.

C. Full Range Dimming: Photo sensor shall be capable of controlling associated luminaires over their full dimming range. Daylight harvesting shall be capable of turning associated luminaires off.

D. Daylight harvesting sequence shall include a minimum 2 minute time delay to avoid cycling from rapidly changing sky conditions.

E. Fade Rate: Fade rate from maximum to minimum light output shall be a minimum of 1 minute.

F. Closed Loop Photosensor: Setpoint adjustable from 20-60 foot candles.

G. Open Loop Photosensor: Minimum light sensor range of 20-700 foot candles.

H. Photosensor function may be integral to occupancy sensor.

2.10 RELAYS

A. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating shall be not less than 5 kA. With pilot light indicating when relay is closed and latched. Control shall be by digital data bus. Relay status shall be displayed when queried by lighting management software.

B. Relay Panel: A single enclosure with incoming lighting branch circuits, relays, and connection to the digital control network.

1. Enclosure: NEMA 250, Type 1, unless otherwise indicated.

2. Barriers to separate low-voltage and line-voltage components.

3. Directory: Cover mounted, identifying each relay with its device address and naming the load controlled.

C. Individually Mounted Relays:

1. Enclosure: Standard outlet box or NEMA 250, Type 1, unless otherwise indicated.

2. Directory: Cover mounted, identifying each relay with its device address.

2.11 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, operating over the digital data bus.

1. Each switch shall control the following functions, in coordination with lighting control schedule functions:

a. On.

b. Off.

c. Dimming, increase light level.

d. Dimming, decrease light level.

e. Return to preset light level.

2. On/off function may be combined into single button.

3. Where switch includes dimming functionality, distinct raise and lower buttons shall be provided. Dimming accomplished via holding down on/off button(s) or similar is not allowed.

4. Match color and style specified in Division 26 Section "Wiring Devices."

B. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."

2.12 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Conductors and Cables for Electrical."

B. Class 2 Control Cables: Multiconductor cable with copper conductors sized per manufacturer for circuit load and voltage conditions.

C. Class 1 Control Cables: Multiconductor cable with copper conductors sized per manufacturer for circuit load and voltage conditions.

D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, for horizontal copper cable. Manufacturer may select cable Category (5e, 6, etc.).

E. All cables shall be plenum rated.

F. Where composite cables require more than two conductors, provide manufacturer’s factory pre-terminated cable to connected lighting control devices. Cabling shall be plenum rated.

G. Cable Color Code: Coordinate cable color to be unique from other building systems and match existing when applicable.

H. Provide minimum 8 ft. slack in each cable segment for flexibility of device location adjustment.

2.13 EMERGENCY SHUNT RELAY

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

1. Lighting Control and Design, Inc.

2. Watt Stopper (The).

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: Coordinate coil voltage.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Engage manufacturer's representative to select devices, quantities, locations, and interconnecting cabling to achieve the control sequence specified in the lighting control schedule.

B. Wiring:

1. Comply with NECA 1.

2. Wiring Method: Install cables in raceways except where installed in accessible ceilings. Conceal raceway and cables except in unfinished spaces. Support cables at intervals not exceeding 60". Cable shall not be run in contact with structural members, pipes, ducts, or other potentially damaging items.

3. Route all low voltage cables separate from line-voltage conductors.

4. Conductor/Cable Coordination: Verify and coordinate quantity and configuration of line voltage conductors and/or low voltage cables needed to interconnect dimming control devices with associated lighting fixtures. Control method shall match. Note that dimming methods may require different conductor/cable configurations be used for different fixtures.

C. Wall Devices:

1. Provide junction box in wall with conduit stubbed up above nearest accessible ceiling space.

2. Where cabling is routed in inaccessible locations (above hard ceilings, within floors, within walls), provide conduit routed from device to nearest accessible ceiling space.

D. Sensors:

1. Select, install, and aim sensors to achieve not less than 90 percent coverage of installed areas. Do not exceed coverage limited specified in manufacturer's written instructions.

2. Adjust location of sensors to minimize activation of interior rooms from adjacent corridor activity per manufacturer's direction.

3. Arrange control zones per plans and details. Individual rooms (defined by full height wall partitions or doors) shall be controlled independent of adjacent rooms. Multiple occupancy sensors in the same room or zone shall control all lighting fixtures associated with that room or zone. Rooms or zones shown with multiple branch circuits shall be provided with multiple control devices to accommodate control sequence.

E. Emergency Lighting Interface:

1. Install emergency relay on life safety lighting circuits indicated with automatic controls. Relay shall bypass automatic controls and illuminate life safety lighting circuit upon loss of adjacent normal branch lighting circuit source voltage. Locate in associated source electrical room within NEMA-1 enclosure.

3.02 IDENTIFICATION

A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Division 26 Section "Electrical Identification."

B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Division 26 Section "Electrical Identification."

C. Identify all ceiling-mounted controls with data bus number and device address.

D. Label each device cable within 6 inches of connection to wiring terminals/ports.

3.03 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test continuity of each circuit.

B. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer`s written instructions.

2. Test each bus controller using a portable PC.

3. Activate light fixtures and verify that all fixtures are operating at 100 percent.

4. Confirm correct communications wiring, initiate communications between devices and controller/gateways, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

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

C. Field Test Reports:

1. Printed list of all points created from actual queries of all addressed control points to include ballasts, manual controls, and sensors.

2. Event log verifying the performance of all devices generating event messages to include occupancy sensors, control buttons, alarm messages, and any other change of value messages.

3. Trend data for all daylight zones covering a period of not less than one week and demonstrating performance consistent with the submitted computer models for those spaces.

D. Lighting controls will be considered defective if they do not pass tests and inspections.

E. Upon completion of initial programming, engage engineer, architect, and Owner while onsite to confirm time and scene controls/adjustments prior to final programming. Provide 2 weeks' notice. Time may be required outside of normal business hours to confirm lighting for those hours of operation.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions and to assist Owner's personnel in making program changes. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for three years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within three years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner`s maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 260943

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.02 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.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals. Provide transformer voltage test results and tap settings.

1.03 CLOSE-OUTS

A. Operation and maintenance data.

B. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from 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, "Test Code for Dry-Type Distribution and Power Transformers."

D. Ratings and Coordination: Withstand ratings and selective coordination shall meet the requirements of Division 26 Section “Power System Studies.”

1.05 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.

1.06 COORDINATION

A. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided. Installation shall be coordinated with the manufacturer and/or a structural engineer.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Products.

2. ABB/GE.

3. Siemens Energy & Automation, Inc.

4. Square D; Schneider Electric.

2.02 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.

2. Coil Material: Copper.

2.03 DISTRIBUTION TRANSFORMERS

A. Comply with 10 CFR 431, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Ratings required on transformer shall not be achieved through the addition of a secondary cooling fan.

E. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

F. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers:

1. Comply with DOE 2016 Efficiency.

2.04 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 "Electrical Identification."

2.05 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 -EXECUTION

3.01 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" 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.

3.02 INSTALLATION

A. Install transformers on concrete bases. Construct concrete bases according to Division 26 “Hangers and Supports for Electrical”.

B. Provide heat shielding where stacking or suspending transformers above one another.

C. Locate primary disconnection within sight of the transformer, unless the location of the disconnect is field-marked on the transformer and the disconnect is lockable (NEC 450.14).

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical."

B. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

3.04 FIELD QUALITY CONTROL

3.05 ADJUSTING

A. Record transformer secondary voltage at each transformer upon completion of project but before occupancy. Using recorded voltages, 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. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262413 - SWITCHBOARDS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes service and distribution switchboards rated 1000 V and less.

1. Coordination: Overcurrent protective device coordination (Reference Division 26 Section “Power System Studies”) shall be submitted and approved prior to submittal of switchboards in order to accommodate equipment selection required by that section.

1.02 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers` technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.

a. Mimic-bus diagram.

1.03 CLOSE-OUTS

A. Operation and maintenance data.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections or lengths that can be moved past obstructions in delivery path. Quantity and dimensions of shipping splits shall accommodate the final building path available for future removal and replacement.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.05 QUALITY ASSURANCE

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

B. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."

C. Comply with NFPA 70.

D. Ratings and Coordination: Withstand ratings and selective coordination shall meet the requirements of Division 26 Section “Power System Studies.”

PART 2 -PRODUCTS

2.01 MANUFACTURERS

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

2.02 MANUFACTURED UNITS

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. ABB/GE.
3. Siemens Energy & Automation, Inc.
4. Square D.

B. Front-Connected, Front-Accessible Switchboard: Panel-mounted main device, panel-mounted branches, front and rear sections align.

C. Main-Bus Continuous: As indicated on drawings.

D. Enclosure: Steel, NEMA 250, Type 1.

E. Enclosure Finish: Factory-applied finish in manufacturer`s standard gray finish over a rust-inhibiting primer on treated metal surface.

F. Barriers: Between adjacent switchboard sections.

G. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

H. Buses and Connections: Three phase, four wire, unless otherwise indicated. Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.

1. Ground Bus: 1/4-by-2-inch- minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure 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.
2. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard`s main and distribution sections. Provide for future extensions from both ends.
3. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
4. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

I. Surge Protective Devices (SPD): On all Emergency and Life Safety Switchboards, provide SPD, meeting the requirements of Division 26 Section “Surge Protection for Low Voltage Electrical Power Circuits”.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

1. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, 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.

2. 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.

3. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

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

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground fault and short time protection function.

C. GFP: Provide ground fault protection per NEC.

D. Coordination: Electronic trip circuit breakers may be required in lieu of thermal magnetic to achieve overcurrent protective device coordination (Reference Division 26 Section “Power System Studies”). Manufacturer to provide devices accordingly.

2.04 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

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: Ratios shall be as required with accuracy class and burden suitable for connected relays, meters, and instruments.

3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.

b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

d. Kilowatts: Plus or minus 2 percent.

e. Kilovars: Plus or minus 2 percent.

f. Power Factor: Plus or minus 2 percent.

g. Frequency: Plus or minus 0.5 percent.

h. Kilowatt Demand (Instantaneous and Recorded Maximum): Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.

i. Accumulated Energy, Kilowatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.05 ACCESSORY COMPONENTS AND FEATURES

A. Furnish tools required to adjust settings of solid-state trip devices.

2.06 OVERCURRENT PROTECTIVE DEVICE COORDINATION

A. Overcurrent protective device manufacturer shall provide overcurrent device types (circuit breaker frame size, plug rating, adjustability, fuse selection, etc.) required to achieve coordination to 0.1 seconds per NEC Article 517.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.

B. Install floor-mounted switchboards on concrete bases. Construct concrete bases according to Division 26 Section “Hangers and Supports for Electrical”.

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 overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable circuit-breaker trip ranges.

3.02 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide labels as specified in Division 26 Section "Common Work Results for Electrical". Provide warning signs required by NEC.

B. Switchboard Nameplates: Label each switchboard compartment. Use engraved nameplates as specified in Division 26 Section "Electrical Identification."

C. Branch Device Nameplates: Provide identification for each branch device. Use engraved nameplates as specified in Division 26 Section "Electrical Identification."

3.03 FIELD QUALITY CONTROL

A. Perform acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. 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, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. 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.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Distribution panelboards.

2. Lighting and appliance branch-circuit panelboards.

1.02 SUBMITTALS

A. Coordination: Overcurrent protective device coordination (Reference Division 26 Section “Power System Studies”) shall be submitted and approved prior to submittal of panelboards in order to accommodate equipment selection required by that section.

B. Product Data: For each type of panelboard, overcurrent protective device, surge protection device, accessory, and component indicated. Include dimensions and manufacturers` technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.

4. Short-circuit current rating of panelboards and overcurrent protective devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.03 CLOSE-OUTS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer`s written instructions for testing and adjusting overcurrent protective devices.

B. Panelboard Schedules: For installation in panelboards.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings represent maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Coordinate and comply with required 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 NEMA PB 1 and NECA 407.

E. Comply with NFPA 70.

F. Ratings and Coordination: Withstand ratings and selective coordinatino shall meet the requirements of Division 26 Section “Power System Studies.”

1.05 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; store in a dry environment or install temporary electric heating (250 W per panelboard) as required to prevent condensation.

1.06 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.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

1.07 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, dedicated electrical space, and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.08 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 spares for each type of panelboard cabinet lock.

PART 2 -PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB/GE.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Enclosures:

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Hinged Front Cover (Door-in-Door or Hinged Trim Construction): Entire front trim hinged to box and with standard door within hinged trim cover.

3. Door:

a. Distribution panelboards.
1) Secured with vault-type latch with tumbler lock; keyed alike.
(a) For doors more than 36 inches high, provide two latches, keyed alike.

b. Lighting and appliance branch circuit panelboards.
1) Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

4. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer`s standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, with transparent protective cover.

6. Mounting Configuration: Coordinate flush and surface mounting types as scheduled or as required to accommodate construction.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

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

3. Neutral Bus: Adequate for dedicated branch circuit neutrals.

D. 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.

E. Surge Protective Devices (SPD) On all Life Safety and other indicated panelboards, provide SPD, meeting the requirements of Division 26 Section "Surge Protective Devices for Low Voltage Electrical Power Circuits".

2.02 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals. Coordinate with drawings and Overcurrent Protective Device Coordination study.

2.03 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

1. Lighting and appliance branch panelboards with sub-feed breakers are not acceptable as a substitute to distribution panelboards.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

1. Load centers will not be accepted for lighting and appliance branch circuit panelboards.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.05 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; and the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

4. GFCI Circuit Breakers: Class A ground-fault protection (6-mA trip).

5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.

b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

c. Provide the following features where indicated on drawings or panel schedules.
1) Ground-Fault Protection: Integrally mounted relay and trip unit with push-to-test feature, and ground-fault indicator.
2) Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
3) Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. Coordination: Electronic trip circuit breakers may be required in lieu of thermal magnetic to achieve overcurrent protective device coordination (Division 26 Section “Power System Studies”). Manufacturer to provide devices accordingly.

2.06 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.

2.07 OVERCURRENT PROTECTIVE DEVICE COORDINATION

A. Overcurrent protective device manufacturer shall provide overcurrent device types (circuit breaker frame size, plug rating, adjustability, fuse selection, etc.) required to achieve “coordinated short-circuit protection” per NEC Articles 240.12 and 700.27.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

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.

3.02 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Equipment Mounting: Install full-height, floor-mounted distribution panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to panelboards.

5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 74 inches above finished floor unless panel height exceeds this. Maintain NEC accessibility requirements for highest mounted device.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Recessed Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Provide with pull strings.

I. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide labels complying with Division 26 Section "Electrical Identification." Provide warning signs required by NEC.

B. Create a directory to indicate installed circuit loads; incorporate Owner`s final room designations. Obtain approval before installing. Use a computer to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Electrical Identification."

D. Branch Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Electrical Identification."

3.04 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. 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.

E. Test and Inspection Report:

1. Perform test/inspections and submit report prior to Engineer’s final punch inspection.

2. Report shall consist of any developed test result data and shall, at minimum, include a copy of this “Field Quality Control” Section of the specification to illustrate Contractor acknowledgement of tests and inspections.

a. Contractor shall indicate successful completion by initialing individual test and inspection requirements listed above on the copy. Initialing indicates that tests and inspections were performed for specified work with a successful outcome. Work not found to be in compliance was corrected and retested/reinspected successfully or has been specifically clarified and noted above by the Contractor.

3.05 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 "Power System Studies".

END OF SECTION 262416

SECTION 262421 - HOSPITAL ISOLATION POWER PANELBOARDS

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Operating rooms ungrounded panelboards including shielded isolation transformer, line isolation monitor, and load circuit breakers.

1.02 DEFINITION

A. Basis of Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named.

1.03 REFERENCES

A. NFPA 70 – National Electrical Code, Article 517.

B. NFPA 99 – Health Care Facilities.

C. UL 1022 – Line Isolation Monitors.

D. UL 1047 – Isolated Power System Distribution Equipment.

1.04 SUBMITTALS

A. Product Data: Provide dimensions, knockout sizes and locations, materials, fabrication details, finishes, and accessories. Provide manufacturer’s technical data on features, performance, electrical characteristics, wiring diagrams, and ratings.

B. Manufacturer’s Instructions: Indicate application, conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

C. Test results that comply with requirements.

D. Operation and Maintenance Data:

1. Manufacturer’s written instructions for testing.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with NECA Standard of Installation.

1.06 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified as shown.

1.07 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.

PART 2 -PRODUCTS

2.01 MANUFACTURERS – UNGROUNDED PANELBOARDS

A. Basis of Design Product: Square D products are used as the basis of design. Subject to compliance with requirements, provide comparable product by one of the following:

1. Square D; A Brand of Schneider Electric.

2. Post Glover.

3. Isoltrol.

B. Manufacturers: Approved manufacturer for the various components of a complete isolated power distribution system shall be as listed herein.

1. Transformer shall be a shielded low leakage isolating transformer, specifically manufactured for the use in hospital isolated systems, Class 7450 Isolating Transformer manufactured by the Square D Company.

C. The ungrounded panels shall be located as indicated on the drawings. The LIM used in these units shall indicate alarm when the total hazard current exceeds 5 mA. The remote indicator alarm unit shall be located in the operating room and connected to the panel supplying power to the circuits in that room.

2.02 COMPONENTS

A. The following components shall be provided by the manufacturer of the ungrounded panels as one integral unit.

B. Isolation Transformer:

1. The isolation transformer shall be wound with an electrostatic shield between the primary and secondary windings which shall be grounded to the enclosure. The electrostatic shield will be of such design that it will prevent direct shorting of the primary winding to the secondary winding and reduce the coupling of harmonic distortions between the primary circuit and secondary circuits.

2. The total leakage current to ground from the transformer secondary winding shall not exceed values shown in Table 29.2 of UL 1047.

3. Regulation to be certified not to exceed 2.6% at 0.8 PF at 20 deg C above the full load continuous operating temperature in accordance with NEMA-ANSI Standards.

4. The transformer is to be single phase, 60 Hz, with primary and secondary voltages as listed in the drawings and/or schedule.

5. Class H rated insulation shall be used in the manufacture of the transformer and the temperature rise will be limited to 55 deg C above ambient under full load conditions when tested in accordance with NEMA-ANSI Standards.

6. Transformers must have a 220 deg C, UL recognized insulation system. The core and coil shall be vacuum impregnated and shall have a final wrap of insulating materials so as not to expose any bare conductor.

7. The core shall be of stacked design and securely clamped and bolted. The core and coils shall be internally isolated from the enclosure by means of a suitable vibration dampening system. The design sound level of the completed units shall not be in excess of 27 dB. Certified sound level reports shall be furnished for each individual unit upon the request of the Consulting Engineer.

C. Circuit Breakers:

1. The panel shall be equipped with a 2-pole circuit breaker to protect the primary windings of the isolation transformer.

2. The rating of the primary circuit breaker shall be in accordance with Article 450-3 (b) (1) of the National Electrical Code (NFPA 70).

3. The panel shall have at least eight factory installed secondary branch circuit breakers rated at 20 amperes. All secondary branch breakers are to be 2-pole and shall utilize a combination thermal and magnetic trip mechanism.

4. The panel shall be designed to allow field conversion for up to 16 2-pole branch circuit breakers. The conversion shall not require the use of any special tools or punches.

5. Refer to the panelboard schedule for quantity and sizes of secondary branch circuit breakers.

6. Square D Type QO, QOB, Q1, FAL, ORKAL.

D. Line Isolation Monitor (LIM):

1. The LIM shall be the Square D ISO-GARD® Series D.

2. The LIM shall use microprocessor-based digital signal processing to continually monitor the impedance from all secondary conductors of the isolated power systems to ground.

3. The LIM shall be capable of measuring all combinations of capacitive and resistive faults including balanced, unbalanced, and hybrid faults.

4. LIMs which internally switch between either line and ground will not be accepted.

5. The LIM shall not contribute more than 15 uA to the total hazard current of the system being monitored.

6. The LIM shall have the following specifications:

a. Operating Voltage: 85 to 265 VAC.

b. Accuracy: 5% or better.

c. Alarm Level: 2 or 5 mA (selectable).

d. Alarm Bandwidth: Zero (0).

e. Alarm Hysteresis (On/Off): 50 xA.

f. Mode: Single- or three-phase.

g. Monitor Hazard Current: 50 xA.

h. Operating Frequency: 50 or 60 Hz.

7. All of the listed specifications shall be contained within one unit and be user selectable thus allowing the LIM to be interchanged from system to system.

8. The LIM shall incorporate a momentary test switch. When pressed, it shall check and recalibrate the unit. Additionally, the test switch shall perform a complete test of all indicating lamps and meters on the face of the LIM and at any remote indicating stations.

9. The LIM shall use digital signal processing to determine the hazard current of the system being monitored. The microprocessor within the LIM shall be #MC68HC16Z1 as manufactured by Motorola. The algorithms used to determine the system hazard current shall be preprogrammed into the LIM's microprocessor. At least every 65 minutes, the unit shall recheck its calibration and recalibrate the system to original performance specifications. Additionally, by pressing the LIM's momentary test switch, an immediate check and recalibration of the LIM shall be performed.

10. If internal components are more than 30% out of original specifications because of aging or failure, the LIM shall notify the user by displaying a unique error code thus eliminating the need for periodic manual testing to determine the unit's integrity. LIMs which use analog signal processing technology and/or require manual testing or recalibration will not be accepted.

11. The LIM shall provide both analog and digital indication of the isolated power system's hazard current. Digital indication shall be provided by a digital meter and analog indication shall be provided by an LED bar graph type meter calibrated from 0 (zero) to 160% of the alarm setting of the LIM.

12. The LIM shall have a green safe light and red hazard light on the front panel. The red hazard light shall remain illuminated for the duration when the isolated power system hazard current is above the selected alarm level of the LIM. An audible alarm shall be incorporated into the unit and shall activate in conjunction with the red hazard light. The audible alarm shall have high, low, and off settings. A silence button shall be provided on the face of the unit to silence the audible alarm during fault conditions. Upon silencing the audible alarm, a yellow indicating light shall illuminate to indicate the audible alarm has been silenced. The red hazard light and yellow silence light shall automatically reset when the fault condition is eliminated. During fault conditions, the red hazard light and all red segments to the LED bar graph shall blink at a constant rate. All lamps shall be long life LED type.

13. A set of normally open and normally closed contacts, rated 3 amperes at 120 VAC shall be provided on the LIM for use with external alarm systems. The LIM shall also provide a 12 VAC output signal rated at 10 VA to power remote indicator alarm units. This 12 VAC output signal shall not increase the hazard current of the system being monitored. Provisions for connection of the remote metering shall also be provided as part of the LIM. These connections shall have the ability to operate either an analog or digital type remote meter.

14. The LIM shall incorporate a loss-of-ground feature which will activate the audible and visual alarms when connection is lost with the reference ground of the isolated power system being monitored. In addition to activating the alarm, the unit shall display an error code in the digital display of the LIM.

15. All switches, meters, and indicating lamps shall be flush with the face of the LIM. The entire front face of the unit shall have a polymer overlay that protects the unit from the intrusion of housekeeping cleaning agents.

16. The design of the LIM shall consist of two circuit boards interconnected by a ribbon connector. The two boards shall contain all of the unit's electrical components and be mounted in the rear housing of the LIM. A phenolic cover shall complete the assembly. The unit shall not contain any components, such as circuit breakers, meter, switches, or indicating lamps, which are mounted on or attached to the front cover of the LIM. Access to the inside of the LIM shall be through the front of the unit thus eliminating the need to remove the unit from its mounting position to change any of the settings. Unique fasteners shall attach to the front cover of the unit to prevent unauthorized access to the interior of the LIM.

17. The LIM shall be manufactured by Square D Company, UL component recognized under UL 1022 Standard for Line Isolation Monitors, and UL recognized as meeting CSA 22.2 the Canadian Standard for Line Isolation Monitors.

E. Ground Bus Bar:

1. The ungrounded panel shall contain a ground bus to which the ground bar from the ground wire from all receptacles and the ground wire from the LIM are connected. The ground bus bar is to serve as the reference ground point for the operating room. The ground bus bar shall contain a sufficient number of points to allow termination of all internal ground wires and the termination of all ground leads from permanently installed metal objects in the surgery area.

2.03 CONSTRUCTION

A. Enclosure:

1. The enclosure shall be 12 gauge steel which is degreased, phosphatized, primed, and finish painted with a coat of baked enamel, except for the front trim which is to be of type 304 stainless steel with a No. 4 brushed finish. The enclosure will be flush mounting unless otherwise stated on the plans; units shall have a maximum depth of 8 in (12 in for 7.5 kVA and 10 kVA panels). The front trim shall be mounted on a continuous length piano-type hinge for access to field wiring compartments.

2. The front panel shall not contain any type of grille or louver for the purpose of Isolation Transformer ventilation. The panel and transformer shall be so designed that the heat generated by the transformers under full load conditions shall not affect the normal operation of the circuit breakers and ground detector. The maximum front panel temperature shall not exceed 30 deg C rise under full load continuous operation.

3. Panelboard typed directories.

B. Wiring:

1. Wiring within all panels shall be in accordance with applicable NEC Code Standards. Low leakage insulation shall be used on all wire. The total panel leakage for a 3 or 5 kVA panel shall not exceed 30 microamperes when energized and assembled. The manufacturer of the panel shall provide certified test data on each individual panel as to maximum leakage of each complete assembly.

2. The contractor shall wire all external receptacles to the panels using copper stranded conductor having a cross-linked polyethylene insulation or equivalent with a dielectric constant of 3.5 or less. Minimum insulation wall thickness shall be 3/64 in for #10 and #12 AWG and 5/64 in for #8 AWG and larger conductor. Under no circumstances shall wire pulling compound be used when pulling the wire for isolated circuits. All wiring shall be color-coded in accordance with NEC and appropriate NFPA standards.

3. The shortest possible routing to the isolated circuits shall be used to minimize total wire length. Run these conduits as far as possible from metal structures or pipes and minimize wherever possible, parallel runs to metal pipes.

2.04 OVERCURRENT PROTECTIVE DEVICE COORDINATION

A. Overcurrent protective device manufacturer shall provide overcurrent device types (circuit breaker frame size, plug rating, adjustability, fuse selection, etc.) required to achieve “coordinated short-circuit protection” per NEC Articles 240.12 and 700.27.

PART 3 -EXECUTION

3.01 INSTALLATION

A. The contractor shall furnish and install ungrounded isolated distribution system panels for operating rooms as indicated on the drawings. In addition, portable laser outlets within these locations shall be powered from separate isolated distribution panels as shown on the drawings. Locations of panels are indicated on the drawings and cannot be changed without written permission from the consulting electrical engineer and architect.

B. The panel(s) shall be factory wired and tested and include a shielded low leakage isolation transformer, primary and secondary circuit breakers, and LIM.

3.02 TESTING BY THE MANUFACTURER

A. The contractor shall include the cost of, and make all arrangements for, testing all ungrounded isolated systems in the hospital by a qualified factory technician provided by the manufacturer of the isolation systems. The testing shall include a complete inspection of all connections and materials used. The contractor shall be prepared to demonstrate to the factory technician that proper polarity was observed, and installation practices were in accordance with the drawings and specifications for these systems.

B. The factory technician shall check and record system current leakages. The factory technician shall further simulate faults on the isolated system of a magnitude high enough to bring the total system leakage, which the LIM detects, above the calibrated point, thus verifying correct operation of the LIM. The faults simulated shall be combinations of resistive and capacitive faults.

C. The factory technician shall check the resistance between the ground point of each receptacle and the reference point, and it shall be less than 0.1 ohms. The voltage potential difference between any exposed conductive surfaces in the patient vicinity shall be checked, the difference to be no more than 40 millivolts. These tests are required by NFPA No. 99 for new construction areas.

D. The factory technician shall instruct the hospital maintenance staff in the use of the following:

1. The panel and LIM as a leakage measuring device.

2. How instrument leakage areas can be measured and labeled.

3. How to perform leakage tests.

E. The technician shall also test the system impedance of the entire isolated power system to ensure compliance with the applicable sections of NFPA No. 99, Chapter 3. The measured system impedance shall become part of the permanent logged records of each panel.

F. After all tests are complete, a letter shall be given to the hospital and the consulting engineer. The letter shall state that the system conforms with all codes, good installation practices, and the specifications.

G. Upon completion of all tests, the factory technician shall meet with hospital medical and maintenance staff to thoroughly explain the operation of the equipment installed, and the need and procedure for periodically testing and logging test results. The technician shall furnish log books to the maintenance department, enter the first readings of all panels in these log books, and clearly instruct the hospital maintenance staff how to enter future readings.

END OF SECTION 262421

SECTION 262726 - WIRING DEVICES

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, receptacles with integral USB chargers, and associated device plates.

2. Snap switches.

B. See Division 26 Section "Conductors and Cables for Electrical " for workstation outlets.

C. See Division 26 Section "Electrical Identification" for device labeling requirements.

1.02 SUBMITTALS

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

1.03 CLOSE-OUTS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers` packing label warnings and instruction manuals that include labeling conditions.

B. Test reports.

1.04 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers` Names: Shortened versions (shown in parentheses) of the following manufacturers` names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).

2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).

4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.02 STRAIGHT BLADE RECEPTACLES

A. Hospital Grade:

1. Receptacles shall be Hospital grade at the following locations:

a. Throughout (all receptacle locations).

2. Hospital grade receptacles shall be the hospital-grade equivalent to straight blade receptacles listed below.

B. Tamper Resistant

1. Receptacles shall be tamper resistant at the following locations:

a. Throughout (all receptacle locations).

2. Tamper resistant receptacles shall be the tamper resistant equivalent to straight blade receptacles listed below.

C. Weather Resistant

1. Receptacles shall be weather resistant at all wet locations.

2. Weather resistant receptacles shall be the weather resistant equivalent to straight blade receptacles listed below.

D. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5351 (single), 5352 (duplex).

b. Hubbell; HBL5351 (single), CR5352 (duplex).

c. Leviton; 5891 (single), 5352 (duplex).

d. Pass & Seymour; 5381 (single), 5362 (duplex).

2. GFCI RECEPTACLES

a. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

b. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1) Products: Subject to compliance with requirements. Provide GFCI equivalent to Straight Blade Receptacles indicated above.
(a) Cooper; GF20.
(b) Hubbell; GFRST20.
(c) Leviton; G5362.
(d) Pass & Seymour; 2095.

3. USB CHARGING RECEPTACLES

a. Duplex Convenience Receptacles, 125V, 20A, with two USB charging ports, USB Type A, 5 V dc, and minimum 2.1 A per receptacle.
1) Subject to compliance with requirements. Provide one of the following:
(a) Cooper TR7756
(b) Hubbell USB20X
(c) Leviton T5832

2.03 TWIST-LOCKING RECEPTACLES

A. Single Receptacles: Comply with NEMA WD 1, NEMA WD 6 configuration as indicated, and UL 498.

2.04 SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper/Eaton/Arrowhart; CSB120 (single pole), CSB220 (two pole), CSB320 (three way), CSB420 (four way).

b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).

c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).

d. Pass & Seymour/Legrand; CS20AC1 (single pole), CS20AC2 (two pole), CS20AC3 (three way), CS20AC4 (four way).

2.05 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: 0.035-inch-thick, satin-finished stainless steel.

3. Material for Unfinished Spaces: Galvanized steel.

4. Material for Damp Locations: Cast aluminum enclosure with spring-loaded lift cover, and listed and labeled for use in "wet locations."

5. Material for Wet-Location, Weatherproof Cover Plates: NEMA 250 enclosure, complying with Type 3R weather-resistant, die-cast aluminum with lockable, in-use style cover.

B. FINISHES

1. Color: Wiring device catalog numbers in Section Text do not designate device color.

a. Wiring Devices Connected to Normal Power System: Ivory device, unless otherwise indicated.

b. Wiring Devices Connected to Generator-Supplied Power System: Red device.

PART 3 -EXECUTION

3.01 COORDINATION

A. Coordinate receptacles for Owner-furnished equipment. Match equipment requirements.

3.02 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. 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 the 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 wall or 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 just 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.

5. Receptacles shall be grounded with an equipment grounding conductor, sized per NEC, but not smaller than #12, routed with the branch circuit and connected to the equipment ground bus in the branch circuit panelboard. The equipment ground conductor shall also be bonded to the outlet box in which the receptacle is mounted.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they 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, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

10. GFCI devices shall not protect downstream devices. Individual GFCI devices shall be installed.

11. Do not connect under cabinet lighting downstream of a GFCI device.

12. Provide physical barrier between adjacent 120 and 277 volt circuit conductors in ganged wall switch installations.

13. Provide separate device boxes for normal power system and emergency power system devices to maintain proper system wiring separation.

E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Dimmers:

1. Install dimmers within terms of their listing.

2. Verify that dimmers used for fan speed control are listed for that application.

3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers` device listing conditions in the written instructions.

4. Install dimmers in individual device box to avoid derating requirements.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

3.03 IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles (comply with testing requirements of NFPA 99):

1. Physical Integrity: Visually inspect.

2. Retention Force: Not less than 115 g (4 oz.)

3. Line Voltage: Acceptable range is 105 to 132 V. Verify polarity.

4. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.

5. Ground Impedance: Values of up to 2 ohms are acceptable.

6. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

7. Using the test plug, verify that the device and its outlet box are securely mounted.

8. The 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, and retest as specified above.

C. Test and Inspection Report:

1. Perform test/inspections and submit report prior to Engineer's final punch inspection.

2. Report shall consist of any developed test result data and shall, at minimum, include a copy of this "Field Quality Control" Section of the specification to illustrate Contractor acknowledgement of tests and inspections.

a. Contractor to indicate successful completion by initialing individual test and inspection requirements listed above on the copy. Initialing indicates that tests and inspections were performed for specified work with a successful outcome. Work not found to be in compliance was corrected and retested/reinspected successfully or has been specifically clarified and noted above by the Contractor.

b. Acknowledgement of Tests and Inspections:

"Tests and inspections have been successfully completed as specified, or have been clarified/noted above.
1) Representative Company Name: _____
2) Representative Personnel Name: _____

3) Representative Personnel Signature: _____
4) Date of Report: _____"

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.
4. Molded-case circuit breakers (MCCBs).

1.02 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.03 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers` technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer`s written instructions for testing and adjusting enclosed switches and circuit breakers.

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

C. Comply with NFPA 70.

D. Ratings and Coordination: Withstand ratings and selective coordination shall meet the requirements of Division 26 section “Power System Studies.”

1.05 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.

1.06 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.

1.07 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. Fuses: 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

2.01 FUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate required fuses, lockable handle with capability to accept three padlocks, lockable cover latch, and interlocked with cover in closed position.

C. 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.

3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open, when used as a motor disconnect on motors served from a VFD.

4. Hookstick Handle: Allows use of a hookstick to operate the handle.

5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.02 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, lockable cover latch, and interlocked with cover in closed position.

C. 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.

3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open, when switch is used as a motor disconnect on motors served from VFD.

4. Hookstick Handle: Allows use of a hookstick to operate the handle.

5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.03 MOLDED-CASE CIRCUIT BREAKERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 150 A and larger.

D. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

2.04 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. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

2.05 OVERCURRENT PROTECTIVE DEVICE COORDINATION

A. Overcurrent protective device manufacturer shall provide overcurrent device types (circuit breaker frame size, plug rating, adjustability, fuse selection, etc.) required to achieve “coordinated short-circuit protection” per NEC Article s 240.12 and 700.27.

PART 3 -EXECUTION

3.01 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.

3.02 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install fuses in fusible devices.

C. Comply with NECA 1.

D. Where enclosed switches are installed as a motor disconnect on motors served from a VFD, provide connection between switch auxiliary contacts and VFD. Coordinate to disable VFD when disconnect is open.

3.03 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Electrical Identification."

1. Identify field-installed conductors, interconnecting wiring, and components.

2. Label each enclosure with laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

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

2. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.05 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.

END OF SECTION 262816

SECTION 263213 - ENGINE GENERATORS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes packaged engine-generator sets with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Outdoor enclosure.

B. See Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.02 SUBMITTALS

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

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Source quality-control test reports.

1.03 CLOSE-OUTS

A. Field quality-control test reports.

B. Operation and maintenance data.

1.04 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 qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

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

D. Comply with ASME B15.1.

E. Comply with NFPA 37.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

I. Comply with UL 2200, all components as assembled.

J. Engine Exhaust Emissions: Comply with applicable state and local government requirements. Packaged unit shall be EPA emissions certified prior to shipment.

K. 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.

1.05 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 15 to plus 40 deg C.

2. Relative Humidity: 0 to 95 percent.

3. Altitude: Sea level to 1000 feet.

1.06 PERMITS, FEES, AND NOTICES

A. Contractor shall secure and pay for permits and governmental fees, licenses, and inspections necessary for proper execution and completion of the Work, and for Owner to occupy and operate.

B. Contractor shall comply with and file notices required by laws, ordinances, rules, regulations, and lawful orders of public authorities applicable.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

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

1. Caterpillar; Engine Div.

2. MTU Onsite Energy

3. Onan/Cummins Power Generation; Industrial Business Group.

2.02 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

C. Communication: Integrate generator status, alarms, and control into the Novant Health BAS system via BACnet MS/TP. Provide all necessary cards and cabling to integrate with BAS system. Confirm exact parameters to integrate with Novant Health.

D. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated.

2. Rated Operating Condition: Standby.

3. Output Connections: Three-phase, four wire.

4. Nameplates: For each major system component to identify manufacturer`s name and address, and model and serial number of components.

E. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. Start Time: Comply with NFPA 110, Type 10, system requirements. From the moment of normal source failure, the transfer switch(es) and generator(s) shall restore suitable power source to the load within 10 seconds per NFPA 110 (and NFPA 99 as applicable). Coordinate with and accommodate transfer switch performance.

2.03 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

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.

1. Provide branch circuit from generator enclosure panelboard.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer`s engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.

2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 24-V 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 twice without recharging.

5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

   a. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.
      1) Provide branch circuit from generator enclosure panel.

2.04 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.

2. Capacity: Fuel for 12 hours` continuous operation at 100 percent rated power output, plus 33% reserve.

3. Vandal-resistant fill cap.

4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.05 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter.

2. AC ammeter.

3. AC frequency meter.

4. DC voltmeter (alternator battery charging).

5. Engine-coolant temperature gage.

6. Engine lubricating-oil pressure gage.

7. Running-time meter.

8. Ammeter-voltmeter, phase-selector switch(es).

9. Generator-voltage adjusting rheostat.

10. Fuel tank derangement alarm.

11. Fuel tank high-level shutdown of fuel supply alarm.

12. Generator overload.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.

2. Coolant low-temperature alarm.

3. Control switch not in auto position.

4. Battery-charger malfunction alarm.

5. Battery low-voltage alarm.

G. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Location:

a. Nurse Station

b. Emergency Electrical Room

H. Independent Monitoring: Include alarm contacts to report alarm conditions for independent monitoring.

1. Fire Alarm:

a. Generator not in “Auto”.

b. Generator low fuel.

c. Generator general alarm.

2.06 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic or electronic LSI type; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.

2. Trip Rating: Matched to generator rating.

3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

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.

2.07 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. Maximum Temperature Rise: 105 deg C.

E. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

F. 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.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

1. Provide branch circuit from generator enclosure panelboard.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.08 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Custom, sound-attenuated reach-in style enclosure. Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

1. Attenuation: Max 85 dBA at 50 feet from enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

3. Ducting: Turning vanes and associated duct to direct discharge air up and out to top of enclosure. Storm-proof and drainable.

C. Unit Heater: Maintain minimum 40 deg F ambient temperature within enclosure when generator is not running.

1. Provide branch circuit from generator enclosure panel.

D. Silencer: Located within enclosure.

E. Panelboard: Line-voltage panelboard mounted within enclosure and factory wired with generator accessory branch circuits and enclosure accessory branch circuits. Arrange for feeder source connection from building electrical power system.

F. Fuel Fill: Fuel tank fill station accessible from exterior of enclosure.

2.09 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer`s standard finish over corrosion-resistant pretreatment and compatible primer.

2.10 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.

PART 3 -EXECUTION

3.01 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 Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

1. For outdoor enclosures furnished with factory wired accessory panelboard, provide feeder source connection from building electrical system.

E. Piping installation requirements are specified in Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

F. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

G. Connect engine exhaust pipe to engine with flexible connector.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical."

I. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

J. Identify system components according to Division 23 Section "HVAC Identification" and Division 26 Section "Electrical Identification."

K. Remote Annunciator: Provide cable in conduit to remote annunciator location.

L. Start Signal: Provide cable in conduit from automatic transfer switches to generator.

M. Fire Alarm Monitoring: Provide cable in conduit and fire alarm modules for monitoring of generator alarm conditions.

N. Remote Shutdown Switch: Provide remote shutdown switch with tamper-resistant weather-proof cover. Provide with engraved label stating “Generator Shutdown”. Coordinate exact location with Engineer. Provide conductors in conduit and connect to shutdown generator.

1. Location:

a. Emergency Electrical Room

O. Battery Charger: Provide conductors in conduit from batteries to local or remote battery charger.

3.02 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer`s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. 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.

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 full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.

c. Verify acceptance of charge for each element of the battery after discharge.

d. Verify that measurements are within manufacturer`s specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging 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. 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.

7. 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.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.03 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner`s maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

3.04 IDENTIFICATION

A. Identify system components according to Division 23 Section "HVAC Identification" and Division 26 Section "Electrical Identification.

B. Emergency Sources: A sign shall be placed at the service-entrance equipment, indicating type and location of on-site emergency power sources.

END OF SECTION 263213

SECTION 263600 - TRANSFER SWITCHES

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.

1.02 SUBMITTALS

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

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1.03 CLOSE-OUTS

A. Field quality-control test reports.

B. 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.

1.04 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 and engine-generator set through one source from a single manufacturer.

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

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are more stringent.

I. Ratings and Coordination: Withstand ratings and selective coordination shall meet the requirements of Division 26 section “Overcurrent Protective Device Coordination.”

PART 2 -PRODUCTS

2.01 MANUFACTURERS

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

1. Contactor Transfer Switches:

a. Caterpillar; Engine Div.

b. Emerson; ASCO Power Technologies, LP.

c. GE Zenith Controls.

d. Onan/Cummins Power Generation; Industrial Business Group.

e. Russelectric, Inc.

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Communication: Integrate transfer switch status, metering, and control into the Novant Health BAS system via BACnet MS/TP. Provide all necessary cards and cabling to integrate with BAS system. Confirm exact parameters to integrate with Novant Health.

B. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, unless otherwise indicated.

C. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

D. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.

2. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

H. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Electrical Identification."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

K. Digital Power Meter:

1. Display indicating volts, amps, and frequency.

L. In-Phase Monitor (Life Safety and Critical Branch Transfer Switches): Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage. From the moment of normal-source failure, the transfer switch(es) and generator(s) shall restore suitable power source to the load within 10 seconds per NFPA 110 (and NFPA 99 as applicable). Coordinate with and accommodate generator performance.

M. Programmed Neutral Switch Position (Equipment Branch Transfer Switches): Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

2.03 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110, for healthcare occupancy.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

E. Automatic Transfer-Switch Features:

1. Under voltage/over voltage Sensing and under/over frequency sensing for each phase of normal source and emergency sources: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from 0 to 120 seconds, and factory set for one second.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time delay for transfer to emergency source field adjustable 0 to 120 seconds and factory set at 3 seconds.

5. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

6. Time Delay Stop: A time delay provided to allow generator set to operate unloaded for an adjustable period of 0 to 30 minimum and factory set at 5 minutes.

7. Test Switch: Simulate normal-source failure. Selector shall be provided for testing either with or without load.

8. Switch-Position Pilot Lights: Indicate source to which load is connected.

9. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

10. Unassigned Auxiliary Contacts: One normally open and one normally closed, single-pole double throw contacts for each switch position, rated 10 A at 240-V ac.

11. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

12. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

13. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at engine-generator controls after retransfer of load to normal source.

14. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

    b. Push-button programming control with digital LED display of all calibrations, settings, and date time stamp event log of the last 50 events. Voltage and frequency metering of each phase normal and emergency loads.

    c. Integral battery operation of time switch when normal control power is not available.

15. Manual operating handle permanently mounted on transfer switches through 1000 ampere and removable on switches 1200 amps through 4000 amps.

2.04 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

3.01 INSTALLATION

A. Floor-Mounting Switch: Install floor-mounted transfer switches on concrete bases. Construct concrete bases according to Division 26 “Electrical Supports”.

B. Identify components according to Division 26 Section "Electrical Identification."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.02 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 Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical."

C. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

D. Start Signal: Provide cable in conduit from transfer switches to generator.

3.03 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 insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer`s specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.

b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

c. Verify that manual transfer warnings are properly placed.

d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

b. Simulate loss of phase-to-ground voltage for each phase of normal source.

c. Verify time-delay settings.

d. Verify pickup and dropout voltages by data readout or inspection of control settings.

e. Test automatic transfer-switch operations.

f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Test and Inspection Report:

1. Perform test/inspections and submit report prior to Engineer’s final punch inspection.

2. Report shall consist of any developed test result data and shall, at minimum, include a copy of this “Field Quality Control” Section of the specification to illustrate Contractor acknowledgement of tests and inspections.

a. Contractor shall indicate successful completion by initialing individual test and inspection requirements listed above on the copy. Initialing indicates that tests and inspections were performed for specified work with a successful outcome. Work not found to be in compliance was corrected and retested/reinspected successfully or has been specifically clarified and noted above by the Contractor.

b. Acknowledgement of Tests and Inspections:

c. “Tests and inspections have been successfully completed as specified or have been clarified/noted above.
1) Representative Company Name: _____
2) Representative Personnel Name: _____
3) Representative Personnel Signature: _____
4) Date of Report: _____”

D. Coordinate tests with tests of generator and run them concurrently.

E. 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.

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

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner`s maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes lightning protection for structures.

1.02 SUBMITTALS

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

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.

a. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.03 CLOSE-OUTS

A. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label.

2. LPI System Certificate.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

PART 2 -PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum.

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. VFC Group

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. Roof and Cross-Run Conductors: Aluminum.

D. Down Conductors: Copper

E. Ground Loop Conductor: Tinned copper.

F. Ground Rods: Copper-clad steel, sectional type; 3/4 inch in diameter by 10 feet long.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Conceal the following conductors:

1. System conductors.

2. Down conductors (conceal with building interior).

3. Interior conductors.

4. Conductors within normal view of exterior locations at grade within 200 feet of building.

C. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

D. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer`s written instructions.

E. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

F. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter structure.

1. Bury ground ring not less than 24 inches from building foundation.

2. Bond ground terminals to the ground loop.

3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.

G. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.02 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.

3.03 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. System Inspection: Meet requirements to obtain an LPI System Certificate or UL Master Label.

END OF SECTION 264113

SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes integral SPD for low-voltage (120 to 600 V) power distribution and control equipment. These specifications describe the electrical and mechanical requirements for a high-energy surge protective device (SPD). The specified system shall provide effective, high-energy surge current diversion and be suitable for use as Type 1 or Type 2, 20kA device per ANSI/UL 1449 Fourth Edition.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

1. Manufacturer and model numbers.
2. Short Circuit Current Rating (SCCR).
3. I nominal rating (In).
4. Maximum Continuous Operating Voltage (MCOV).
5. Voltage Protection Ratings (VPRs) for all modes.
6. Type 1 or Type 2 device listing.

1.03 CLOSE-OUTS

A. Operation and maintenance manual.

1. The manufacturer shall furnish an installation manual with installation, startup, and operating instructions for the specified system.

1.04 STANDARDS

A. The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

B. Underwriters Laboratories; ANSI/UL 1449 4th Edition 2014 Revision

C. Underwriters Laboratories; UL 1283 5th Edition 2015 (complimentary listing for Type 2 locations)

D. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.34, C62.41, C62.45, C62.62, C62.72)

E. Institute of Electrical and Electronic Engineers 1100 Emerald Book

F. Federal Information Processing Standards Publication 94 (FIPS PUB 94)

G. National Fire Protection Association (NFPA 20, 70, 75 and 780)

H. International Standards Organization (ISO) Company certified ISO 9001 for manufacturing, design and service

I. The system shall be UL listed and labeled under ANSI/UL 1449 Fourth Edition and the voltage protection ratings (VPRs) shall be permanently affixed to the SPD. Type 2 units of the product family shall be listed and labeled to UL1283 Standard for Electromagnetic Interference Filters.

J. International Electrotechnical Commission (IEC)

1.05 SYSTEM DESCRIPTION

A. The system shall be constructed using single or multiple surge current diversion modules utilizing thermally protected metal oxide varistors (TPMOV). The surge current circuit shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.

B. Maximum Continuous Operating Voltage (MCOV): The SPD and all components in the suppression path (including all current diversion components) maximum continuous operating voltage (MCOV) shall be greater than 115% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS over-voltage (swell conditions).

C. Operating Frequency: The operating frequency range of the system shall be at least 47 - 63 Hz.

1.06 QUALITY ASSURANCE

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

B. Comply with IEEE C62.41.1 – 2002, C62.41.2 – 2002, and comply and test devices according to IEEE C62.45 – 2002, C62.62-2010, C62.72-2016.

1. Component Testing and Monitoring: The proposed product shall be single pulsed surge current tested in all modes at the rated surge currents by an industry recognized independent test laboratory. The test shall include a surge impulse (6kV 1.2x50µs, 500 amp 8x20µs waveform) to benchmark the unit’s suppression voltage. The applied impulse is followed by a single pulse surge of the maximum rated surge current magnitude, followed by a second 6kV 1.2x50µs, 500 amp 8x20µs impulse as a means of measuring clamping deviation (component degradation). Compliance is achieved if the two measured suppression voltage do not vary by more than 5%.

C. Comply with UL 1283 and UL 1449, Fourth Edition or most recent edition.

D. Comply with NFPA 70.

E. Ratings and Coordination: Withstand ratings and selective coordination shall meet the requirements of Division 26 section “Power System Studies.”

1.07 WARRANTY

A. The manufacturer shall provide a full ten year warranty from date of shipment against any part failure when installed in compliance with manufacturer`s written instructions, UL listing requirements, and any applicable national or local electrical codes. Manufacturer shall make available (local, national) field engineering service support. Where direct factory employed service engineers are not locally available, travel time from the factory or nearest dispatch center shall be stated.

PART 2 -PRODUCTS

2.01 SERVICE ENTRANCE SUPPRESSORS

A. Manufacturers: Provide integral surge suppressor where indicated in drawings by same manufacturer as service entrance equipment.

B. Surge Protection Devices:

1. Non-modular.

2. SPD shall have an integral status circuit that monitors the operational status of all modes of protection, including Line to Neutral, Line to Ground and Neutral to Ground. No manual testing shall be required to confirm the integrity of the suppression system. SPD shall be equipped with at minimum a red and green solid-state indicators mounted within the enclosure and be externally visible.

3. SPD shall be UL labeled with Type 1, 200kA Short Circuit Current Rating (SCCR) and 20kA I nominal. Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD.

4. Redundant suppression circuits.

5. Arrangement with bus connections or wire connections to phase buses, neutral bus, and ground bus.

6. SPD shall be UL labeled as Type 1, intended for use without need for external or supplemental overcurrent controls. The SPD shall provide protection as follows: All modes, L-N or L-L, L-G and N-G (where applicable). Note: L = Line, G = Ground, N = Neutral. All suppression components shall be thermally protected and rated to allow maximum specified surge current capacity. Devices that utilize a single fuse to protect two or more suppression paths are not accepted. Individual surge components shall be UL listed to be capable of interrupting up to 200 kA symmetrical fault current with 480 VAC applied. Replaceable fusing is unacceptable. Overcurrent protection that limits specified surge currents is not acceptable.

C. Peak Single-Impulse Surge Current Rating: 150kA per mode/300kA per phase.

2.02 PANELBOARD SUPPRESSORS

A. Manufacturers: Provide integral surge suppressor where indicated in drawings by same manufacturer as panelboards.

B. Surge Protection Devices:

1. Non-modular.

2. LED indicator lights for power and protection status.

3. SPD shall be UL labeled with Type 2, 200kA Short Circuit Current Rating (SCCR) and 20kA I nominal. Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD.

4. Redundant suppression circuits.

5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

C. Peak Single-Impulse Surge Current Rating: 50kA per mode/100kA per phase.

D. Protection modes and UL 1449, Fourth Edition, or most recent edition, VPRs for grounded wye circuits with 480Y/277 V, 208Y/120 V, and 600Y/347 V, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.

2. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.

3. Neutral to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install SPD at service entrance on load side, with ground lead bonded to service entrance ground.

1. Provide multi-pole, circuit breaker (sized per manufacturer’s recommendations) as a dedicated disconnecting means for SPD unless otherwise indicated.

B. Install SPD for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer`s recommended lead length. Do not bond neutral and ground. Install the parallel SPD with short and straight conductors as practically possible. Twist the SPD input conductors together to reduce input conductor inductance. Follow the SPD manufacturer’s recommended installation practices as found in the installation, operation and maintenance manual and comply with all applicable codes.

3.02 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section "Surge Arresters, Low-Voltage Surge Protection Devices". Certify compliance with test parameters.

2. After installing SPD but before electrical circuitry has been energized, test for compliance with requirements.

3. Complete startup checks according to manufacturer`s written instructions.

C. The SPD will be considered defective if it does not pass tests and inspections.

D. Test and Inspection Report:

1. Perform test/inspections and submit report prior to Engineer's final punch inspection.

2. Report shall consist of any developed test result data and shall, at minimum, include a copy of this "Field Quality Control" Section of the specification to illustrate Contractor acknowledgement of tests and inspections.

a. Indicate successful completion by initialing individual test and inspection requirements listed above on the copy. Initialing indicates that tests and inspections were performed for specified work with a successful outcome. Work not found to be in compliance was corrected and retested/reinspected successfully or has been specifically clarified and noted above by the Contractor.

b. Acknowledgement of Tests and Inspections:

"Tests and inspections have been successfully completed as specified, or have been clarified/noted above.
1) Representative Company Name: _____
2) Representative Personnel Name: _____
3) Representative Personnel Signature: _____
4) Date of Report: _____"

3.03 STARTUP SERVICE

A. Do not energize or connect service entrance equipment or panelboards to their sources until SPD are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests and reconnect immediately after the testing is over.

3.04 DEMONSTRATION

A. Train Owner`s maintenance personnel to maintain SPD.

END OF SECTION 264313

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior solid-state luminaires that use LED technology.

2. Lighting fixture supports.

B. Related Sections:

1. Division 26 Section "Wiring Devices" for manual wall-box dimmers.

2. Division 26 Section “Addressable Network Lighting Controls” for automatic control of lighting.

1.02 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. LED: Light-emitting diode.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.03 SUBMITTALS

A. Product Data: For each type of product, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.

2. Projected lifetime (L70), output (lumens, CCT, and CRI), wattage, and efficacy.

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. Use same designations indicated on Drawings.

1.04 CLOSE-OUTS

A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

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

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.06 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.07 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. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.08 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: Five year(s) from date of Substantial Completion.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Lighting Fixtures: Subject to compliance with requirements, provide lighting fixture product indicated on Drawings. Substitutions will only be allowed where specifically indicated on drawings.

2.02 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. LED luminaires shall be Reduction of Hazardous Substances (RoHS) compliant.

C. Recessed Fixtures: Comply with NEMA LE 4.

D. Dimmable from 100 percent to 10 percent of maximum light output unless otherwise indicated.

E. Internal driver unless otherwise indicated.

F. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

G. Comply with UL 1598 and UL 8750.

H. Each luminaire shall be rated for a minimum operational life (L70) of 50,000 hours as defined by IES LM-80 and TM-21.

I. Absolute photometrics shall be available for each luminaire based on IES LM-79.

J. Individual LEDs within the luminaire shall be connected such that loss or failure of a single LED will not result in the loss of the entire array.

K. LEDs shall have a minimum CRI of 90 unless otherwise indicated.

L. Each LED luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

M. Luminaire Power Factor: 0.90 or higher.

N. Total Harmonic Distortion Rating: Less than 20 percent.

2.03 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: 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.

C. Diffusers, and Globes:

1. Acrylic: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2. Glass: Annealed crystal glass unless otherwise indicated.

3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.04 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. LEDs: 50,000 hours minimum rated life.

2.05 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.06 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical " for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports: Sized and rated for luminaire weight.

D. Wall-mounted Fixtures: Attach to studs or backing in the walls. Lighting fixtures shall not be attached directly to gypsum board.

E. Comply with requirements in Division 26 Section "Conductors and Cables for Electrical" for wiring connections.

F. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

G. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.

H. Two by Two Lighting Fixtures:

1. Unless otherwise indicated, install fixtures such that linear components are perpendicular to the long dimension of the room.

I. Remote Mounting of Driver: Distance between the driver and fixture shall not exceed that recommended by driver manufacturer. Verify, with driver manufacturers, maximum distance between driver and luminaire. Remote mount only where indicated on plans. Remote mount location shall be concealed from view and accessible without the need for architectural access panel unless specifically noted.

1. Where not indicated on plans, locate concealed within nearest accessible indoor ceiling space.

J. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.

1. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on architectural reflected ceiling plans, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

K. Suspended Lighting Fixture Support:

1. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

L. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

M. Fixture Whip Conductor Coordination:

1. Coordinate conductor quantity within fixture whips with fixture selection and lighting control requirements.

a. 0-10 V dimming fixtures require additional conductors for lighting control.

3.02 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation.

1. Local Battery Lighting or Central Battery Inverter Supply: Verify transfer from normal power to battery and retransfer to normal. Test shall be 90 minutes on battery source only and shall maintain illumination. Replace units/batteries that fail testing.

B. 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.

C. Luminaire will be considered defective if it does not pass operation tests and inspections.

3.03 ADJUSTING

A. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265119

SECTION 265619 - LED EXTERIOR LIGHTING

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED technology.

2. Poles and accessories.

B. Related Sections:

1. Division 26 Section "Interior LED Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.02 SUBMITTALS

A. Product Data: For each type of luminaire, pole, and support component, arranged in order of lighting unit designation Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

2. Luminaire materials.

3. Projected lifetime (L70), output (lumens, CCT, and CRI), and efficacy.

4. Materials, dimensions, and finishes of poles.

B. 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.

1.03 CLOSE-OUTS

A. Operation and maintenance data.

1.04 QUALITY ASSURANCE

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

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.05 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Immediately remove all packing and shipping materials to prevent accelerated finish deterioration.

D. Handle poles with web fabric straps.

1.07 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 lbf, 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 for calculating wind load for poles 50 feet high or less is 100 mph.

a. Wind Importance Factor: 1.3.

b. Minimum Design Life: 25 years.

c. Velocity Conversion Factors: 1.0.

1.08 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. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.09 FIELD CONDITIONS

A. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

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.

1. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.02 LED 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. UL Compliance: Comply with UL 1598 and listed for wet location.

C. In-line Fusing: Separate in-line fuse for each luminaire.

D. Fixture Rating: Fixture marked for outdoor use and in enclosed locations.

E. Comply with UL 1598 and UL 8750.

F. Each luminaire shall be rated for a minimum operational life (L70) of 70,000 hours as defined by IES LM-80 and TM-21.

G. Absolute photometrics shall be available for each luminaire based on IES LM-79.

H. Individual LEDS within the luminaire shall be connected such that loss or failure of a single LED will not result in the loss of the entire array.

I. LEDs shall have a minimum CRI of 70.

J. Luminaire Power Factor: 0.90 or higher.

K. Total Harmonic Distortion Rating: Less than 20 percent.

2.03 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

C. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2. Glass: Annealed crystal glass unless otherwise indicated.

3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

E. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

F. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.

2. Provide filter/breather for enclosed luminaires.

2.04 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. 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.

B. 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.

C. Comply with NAAMM`s "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.05 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical" for channel and angle iron supports and nonmetallic channel and angle supports.

2.06 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 wind speeds of 110 mph.

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. Provide on all, except wood poles.

E. Finish: Manufacturer's standard paint applied over primer or over galvanization before shipping.

F. Vibration Damper: Provide manufacturer's vibration damper on all square poles unless otherwise indicated.

G. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

2.07 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.

1. Recessed, verify mounting height above finished grade.

2. Cast metal, weatherproof in use, cover, Insert color to match pole that when mounted results in NEMA 250, Type 3R enclosure.

3. With cord opening.

4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Base Covers: Manufacturers` standard metal units, arranged to cover pole`s mounting bolts and nuts. Finish same as pole.

PART 3 -EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Fasten luminaire to structural support.

D. Supports:

1. Sized and rated for luminaire weight.

2. Able to maintain luminaire position after cleaning and re-lamping.

3. Support luminaires without causing deflection of finished surface.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wiring Method: Install cables in raceways. Conceal raceways and cables.

F. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

G. Coordinate layout and installation of luminaires with other construction.

H. Adjust luminaires that require field adjustment or aiming.

I. Comply with requirements in Division 26 Sections "Conductors and Cables for Electrical" and "Raceways and Boxes for Electrical" for wiring connections and wiring methods.

3.02 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.03 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 Division 03 Section "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. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.

2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.

3. Install base covers unless otherwise indicated.

4. 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).

3.04 BOLLARD LUMINAIRE INSTALLATION

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.

3.05 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes for Electrical." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.06 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical."

1. Install grounding electrode for each pole unless otherwise indicated.

2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.07 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

3.08 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. 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.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

END OF SECTION 265619