SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Furnish and install electrical systems, materials, equipment, and accessories in accordance with this specifications and drawings.

1.02 SUBMITTALS

A. The Engineer's approval shall be obtained for all equipment and materials before delivery to the job site. Delivery, storage or installation of equipment and materials which has not had prior approval will not be permitted.

B. All submittals shall include 2 copies of adequate descriptive literature, catalog, shop drawings, test reports, certifications, samples, and other data necessary to ascertain that the proposed equipment and materials comply with drawings and specifications requirements.

C. Submittals for individuals systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
   1. Mark the submittals, "SUBMITTED UNDER SECTION "_____".
   2. Submit each section separately.

D. Electrical equipment submittals will be rejected without dimensioned equipment room or equipment location layouts..

1.03 REFERENCE STANDARDS

A. Perform Work specified in Division 26 in accordance with standards listed below of the latest applicable edition adopted by the authority having jurisdiction. The Drawings and Specifications shall take precedent in those instances where requirements are greater than those stated in the below codes and standards. In case of conflict, obtain a decision from the Engineer of Record.

B. Florida Building Code (2014)

C. NFPA 1: Fire Code (2012)

D. NFPA 30: Flammable and Combustible Liquids Code (2012)

E. NFPA 37: Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2010.

F. NFPA 70: National Electrical Code (2011)

G. NFPA 101: Life Safety Code (2012)

H. NFPA 110: Standard for Emergency and Standby Power Systems (2010)

I. NFPA 780: Installation of Lightning Protection Systems (2011)

J. City of Dunedin Electrical Code

K. Other standards:
   1. ANSI
   2. ASME
   3. ASTM
   4. IEEE
   5. ISO
   6. NECA
   7. NEMA
   8. OSHA
   9. UL

1.04 QUALITY ASSURANCE

A. Comply with applicable local, state, and federal codes.

B. Warrant electrical Work against faulty material or Workmanship in accordance with Division 01. If the Project is occupied or the systems placed in operation in several phases at the request of the Owner's Representative, then the warranty of each system or piece of equipment used, shall begin on the date each system or piece of equipment was placed in satisfactory operation and accepted as such, in writing, by the Owner's Representative. The use of building equipment for temporary service and testing does not constitute the beginning of the warranty.

C. Upon completion of contract and progressively as work proceeds, clean-up and remove dirt, debris and scrap materials. Maintain premises neat and clean. Protect and preserve access to energized equipment at all times. Clean items with factory finishes. Touch-up minor damage to surfaces; refinish entire piece of equipment when sustained major damage. Use only factory supplied paints of matching color and formula. Schedule an off-hour shutdown of all electrical equipment during the 2-week period preceding substantial completion. During this shut down, clean all buses and insulators inside all switchgear, switchboards, bus ducts, collector buses and panelboards located inside or adjacent to the project limits.

1.05 QUALIFICATIONS (PRODUCT AND SERVICES)

A. Manufacture's Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the equipment and materials specified for this project, and shall have manufactured the equipment and materials for at least three years.

B. Product Qualification:
   1. Manufactured equipment and materials shall have been in satisfactory operation, on three installation of similar size and type as this project at least for three years.
   2. The Engineer reserves the right to require the Contractor to submit a list of installations where the equipment and materials have been in operation before approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment and materials in manufacturer's original unopened packaging. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fume, moisture, cold, and rain. Evidence of damage from water or other contaminants will be cause of rejection.
   1. Store equipment and materials indoors in clean dry space with uniform temperature to prevent condensation.
   2. During installation, equipment shall be protected against entry of instances matter, and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
   3. Damaged equipment shall be repaired or replaced, as determined by the Engineer.
   4. Painted surfaces shall be protected with factory installed removable heavy craft paper, sheet vinyl or equal.
   5. Damaged paint on equipment shall be refinished with the same quality of paint as used by manufacturer so repaired areas are not obvious.

1.07 OPERATING AND MAINTENANCE MANUALS

A. Provide three hard copies in binders and one electronic copy in a thumb drive.

B. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover or an approved equivalent.
   1. Inscribe the following identification "MAINTENANCE AND OPERATION MANUAL", the name and location of the system, equipment, building, name of Contractor, and contract name and number.

2. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. the instruction shall be legible and easily to read, with large sheets of drawings folded in.
3. The manuals shall include:
   a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
   b. A control sequence describing start-up, operation, and shutdown.
   c. Installation instructions
   d. Safety precautions for operation and maintenance.
   e. Periodic maintenance and testing procedures.
   f. Performance data.
   g. Pictorial "exploded" parts list with part numbers. The list shall indicate source of supply, recommended spare and replacement parts, and name of servicing organization.

C. In addition to required submittals, include copies of all test reports required in Part 3, "Execution" of section 26 0500.

D. Provide completed warranty certificates for systems and equipment.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. All equipment and materials shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwrites Laboratories, UL. (UL), standards where standards have been established. Equipment and materials which are not covered by UL standards will be accepted, providing that equipment and materials are listed, labeled, certified or otherwise determined to meet the safety requirements of a NRTL.

B. Specifications and Drawings indicate name, type and/or catalog number of materials and equipment to establish standards of quality. Submittals shall be based on the standards specified. The standards should not be construed as limiting competition.

C. Equipment and materials furnished shall be of current production by manufacturers regularly engaged in the manufacture of such products, and for which replacement parts shall be available

PART 3 - EXECUTION

3.01 COORDINATION

A. Install equipment in accordance with manufacturer's recommendations. Where conflicts occur between Contract Documents and these recommendations, request a ruling before proceeding with such Work.

B. Visit site and observe conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform work required by these documents.

C. Examine Specifications and Drawings to be familiar with items which require electrical connections and coordination. Electrical Drawings are diagrammatic and shall not be scaled for exact sizes.

3.02 FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.

3.03 TEMPORARY LIGHTS AND POWER

A. Power is available at existing electrical rooms. Coordinate with Owner for additional requirements.

B. Provide feeders, disconnects, connections, etc., required for construction equipment, e.g., cranes, pumps, etc.

C. Prior to installation, determine if any lighting or power outlets over the minimum quantity noted above are required and if so, provide them.

D. Provide service and panelboards required for above lighting and power outlets.

E. Provide single phase and three phase service as required by Project.

F. Remove temporary wiring upon completion of use.

3.04 CUTTING AND PATCHING

A. Repair or replace routine damage caused by cutting in performance of Work under this Division.

B. Correct unnecessary damage caused due to installation of electrical Work, brought about through carelessness or lack of coordination.

C. Holes cut through floor slabs shall be core drilled with drill designed for this purpose. All openings, sleeves, and holes in slabs between floors shall be properly sealed, fire proofed and water proofed.

D. Holes cut through walls shall be drilled or cut with tools designed for the purpose. All openings, sleeves and holes in walls that extend to underside of floor above shall be properly sealed and fire proofed.

E. Repairs shall be performed with materials which match existing materials and be installed in accordance with appropriate sections of these Specifications.

F. Contractor shall not be permitted to cut or modify any structural members without the written permission of the Architect .

3.05 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

A. Provide trenching, excavation, and backfilling necessary for performance of Work under this Division.

B. Provide sheathing, shoring, dewatering, and cleaning necessary to keep trenches and their grades in proper condition for Work to be performed.

C. Trenching and excavation shall be unclassified. No extra will be paid in event that rock is encountered.

3.06 FOUNDATIONS AND PADS

A. Provide concrete foundations and pads for equipment as indicated on plans. Locate and size foundations, pads, and anchor bolts as required for equipment in this Division.

B. Provide concrete foundations and pads as required for electrical utility company's equipment such as transformers, CT cabinets, metering cabinets, switches, fused disconnects, and circuit breakers. All work shall be in compliance with the utility company's specifications.

3.07 CONTROL SYSTEMS AND INTERLOCK WIRING

A. Control systems, components and control and interlock wiring for mechanical equipment will be furnished under Divisions 21, 22 and 23. Control devices including, but not limited to VFD's, thermostats, fan speed and level control switches, relays and electro-pneumatic switches shall be furnished under Divisions 22 and 23.

B. Provide power wiring to starters and contactors under Division 26. Power wiring to magnetic starters shall consist of wiring to the line side terminals of the magnetic starter or contactor and wiring away from the load side terminals to the equipment, except where such wiring is installed pre-wired by the equipment vendor.

3.08 UTILITY COMPANY COORDINATION

A. Electrical service entrance equipment and arrangements for temporary and permanent connection to the utility company electrical system shall conform to the electrical utility company specifications. Coordinate with the utility company as to all types of work required to be done by the contractor for the utility company equipment.

B. Confirm exact location of point of common coupling, duct banks, pads, etc.

C. Obtain copies of all pertinent utility company specifications relating to duct banks, concrete pads, raceways, and cable that are contractor installed for the utility company use. Maintain copies at project site.

D. Install at components in compliance with utility company specifications and project specifications.

3.09 TESTING ELECTRICAL SYSTEMS

A. On completion of work, installation shall be completely operational and entirely free from grounds, short circuits, and open circuits. Perform operational tests as required to demonstrate substantial completion of the Work. Balance circuits so that feeders to panels are not more than 10% out of balance between phases with all available load energized and operating. Furnish all labor, materials and instruments for above tests. All ampere readings shall be made with a true RMS reading meter.

B. Perform megger tests of all service entrance circuits, feeder and branch circuits size #4 AWG and larger. Provide a report of all such megger test results.

C. Furnish the Engineer a copy of test reports and required certification including but not limited to the following:
   1. Service ground resistance test
   2. Switchboard and panelboard load test - include ampere readings of all panels and major circuit breakers
   3. Ground Fault Test
   4. Megger test results

D. Prior to final observation and acceptance test, install all electrical systems and equipment complete and in satisfactory operating condition.

END OF SECTION

SECTION 26 0501
MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

B. Comply with provision of Section 26 0500 Common Work Results for Electrical.

C. Basic materials and methods, along with Division 01, General Requirements, that are applicable to all Division 26 sections

1.02 RELATED REQUIREMENTS

A. Section 01 7000 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

A. Visit the site to observe existing conditions before submitting a bid.

B. Verify field measurements and circuiting arrangements are as shown on Drawings.

C. Verify that abandoned wiring and equipment serve only abandoned facilities.

D. Demolition drawings are based on casual field observation and existing record documents.

E. Report discrepancies to Owner before disturbing existing installation.

F. Report discrepancies to Engineer before disturbing existing installation.

G. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

A. Work in existing buildings shall be scheduled well in advance with the Owner's Representative. Work shall be performed at such times and under such conditions as suit the convenience of the Owner's Representative. Plan the Work to minimize disruption of normal operations. Notify Owner's Representative before any circuit is de-energized in occupied areas.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.

1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
2. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Reconnect circuits to other panelboards when required to complete the renovation shown.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Where a circuit is interrupted by removal of a device or fixture from that circuit, install wire and conduit as required to restore service to the remaining devices and fixtures on that circuit. Ensure proper grounding is maintained.

F. Disconnect and remove abandoned panelboards and distribution equipment. Coordinate with Owner before removal.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Repair adjacent construction and finishes damaged during demolition and extension work.

I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

K. Lighting fixtures, wiring devices, panelboards, equipment, conduits and conductors removed shall be transported to the Owner's designated location and offered to the OWNER. If he chooses to retain these items or a part of these items, turn those chosen over to him. Items rejected by the OWNER shall be removed completely from the project site and disposed of legally by the CONTRACTOR.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or that are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION

SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and specification Sections apply to to this Section.

B. Comply with provision of Section 26 0500 Common Work Results for Electrical.

C. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

D. Furnish and install electrical systems, materials, equipment, and accessories in accordance with this specifications and drawings.

1.02 RELATED REQUIREMENTS

A. Section 26 0500 - Common Work Results for Electrical.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

C. Section 26 0534 - Raceways and Conduit Systems.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

E. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association; 2009 (ANSI/NEMA WC 70/ICEA S-95-658).

F. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

I. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

J. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

K. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.

2. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

B. Manufactured Wiring System Shop Drawings: Provide plan views indicating proposed system layout with components identified; indicate branch circuit connections.

C. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Furnish wires and cables on reels or coils factory-wrapped with waterproof flexible covering to protect against physical damge. Each cable and the outside of each reel or coil, shall be plainly marked or tagged to indicate the cable langht, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel shall contain only one continuos cable withot splices. Damaged cable, wire or connectors shall be removed from project site.

B. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

2.02 CONDUCTOR AND CABLE MANUFACTURERS

A. Cerro Wire LLC: www.cerrowire.com.

B. Encore Wire Corporation: www.encorewire.com.

C. Southwire Company: www.southwire.com.

D. American Insulated Wire
E. Superior Essex
F. General Cable
G. The Okonite Co.
H. Republic Wire
I. United copper
J. Alcan Product Corporation
K. Prysmian Power Cables and Systems

2.03 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Provide new conductors and cables manufactured not more than one year prior to installation.
D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
E. Comply with NEMA WC 70.
F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
H. Conductors for Grounding and Bonding: Also comply with Section 26 0526.
I. Conductor Material:
    1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
    2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
    3. Tinned Copper Conductors: Comply with ASTM B33.
J. Minimum Conductor Size: 10 AWG.
    1. Branch Circuits: 10 AWG.
        a. Exceptions:
            1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
            2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
            3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
    2. Control Circuits: 14 AWG.
K. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
L. Conductor Color Coding:
    1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
    2. Install in each branch circuit panelboard a legend explaining the color code for ungrounded conductors
    3. Color Coding Method: Integrally colored insulation.
        a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
    4. Color Code:
        a. 480Y/277 V, 3 Phase, 4 Wire System:
            1) Phase A: Brown.
            2) Phase B: Orange.

3) Phase C: Yellow.
4) Neutral : Gray.
5) Ground : Green.

b. 208Y/120 V, 3 Phase, 4 Wire System:
1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral : White.
5) Ground : Green.

c. Equipment Ground, All Systems: Green.

d. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.

e. For control circuits, comply with manufacturer's recommended color code.

2.04 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
1. Feeders and Branch Circuits:
a. Size 10 AWG and Smaller: stranded.
b. Size 8 AWG and Larger: Stranded.
2. Control Circuits: solid.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
a. Size 4 AWG and Larger: Type THHN/THWN.
b. Installed Underground: Type XHHW-2.

2.05 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 0526.

C. Wiring Connectors for Splices and Taps:
1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

D. Wiring Connectors for Terminations:
1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
6. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.

7. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Compression Connectors: Provide circumferential type or hex type crimp configuration.

H. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage wire and cable has been completed.

B. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

C. Verify that field measurements are as shown on the drawings.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

B. Complete conduit system, including bushings, before pulling wires or cables.

3.03 INSTALLATION

A. Circuiting Requirements:
1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated and routing is not shown, determine exact routing required.
3. Arrange circuiting to minimize splices.
4. Include circuit lengths required to install connected devices within 10 ft of location shown.
5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is not permitted.
   a. Provide no more than three current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
   b. Increase size of conductors as required to account for ampacity derating.
   c. Size raceways, boxes, etc. to accommodate conductors.
8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.

D. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

E. Install conductors with a minimum of 12 inches of slack at each outlet.

F. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

G. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

H. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

I. Make wiring connections using specified wiring connectors.
   1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
   2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
   3. Do not remove conductor strands to facilitate insertion into connector.
   4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
   5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

J. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
      b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
   2. Wet Locations: Use heat shrink tubing.

K. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

L. Identify conductors and cables in accordance with Section 26 0553.

M. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 01 4000.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Electrical tests:
   1. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
   2. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.
      a. Service entrance circuits and feeder (800A & larger) circuits
         1) Use a motor driven megger such as Biddle MJ359 or equal
         2) Perform a polarization index test using a 10-minute test period. Record the megohm readings at 1 minute and at 10 minutes. Calculate the polarization index (10 min / 1 min readings) and record.

b. Feeder (600A & smaller) circuits and branch circuits
   1) Use either a motor driven (Biddle 359) or a hand crank (Biddle MJ159) megger.

D. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with new SPDs.

E. Correct deficiencies and replace damaged or defective conductors and cables.

F. Provide 2 copies of the megger test report to the Engineer. The report shall be in a tabulated format and shall include the following as a minimum.
   1. Circuit identification
   2. Type of raceway
   3. Approximate length of circuit
   4. Megohm readings
   5. Ambient temperature
   6. Approximate humidity (dry, average, or humid)

END OF SECTION

SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and specification Sections apply to all Division 26 sections.

B. Comply with provision of Section 26 0500 Common Work Results for Electrical.

C. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.

D. “Grounding electrode system” refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.

E. Grounding and bonding requirements.

F. Conductors for grounding and bonding.

G. Connectors for grounding and bonding.

H. Ground bars.

I. Ground rod electrodes.

J. Ground access wells.

1.02 RELATED REQUIREMENTS

A. Section 26 0500 - Common Work Results for Electrical.

B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

C. Section 26-0533 - Raceways and Conduit Systems.

D. Section 26 3213 - Engine generators.

E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 4113 - Lightning Protection for Structures.

1.03 REFERENCE STANDARDS

A. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System; Institute of Electrical and Electronic Engineers; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; National Electrical Manufacturers Association; 2007.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 780 - Standard for the Installation of Lightning Protection Systems; National Fire Protection Association; 2014.

G. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions, 2007

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
   2. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

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

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

E. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.

F. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.

G. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

H. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

I. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

J. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
   2. Metal Underground Water Pipe(s):
      a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
      b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
      c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
   3. Metal Building or Structure Frame:
      a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
   4. Ground Rod Electrode(s):
      a. Provide single electrode unless otherwise indicated or required.
      b. Space electrodes not less than 10 feet from each other and any other ground electrode.
      c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
   5. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

K. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
   1. Provide grounding electrode system for each separate building or structure.
   2. Provide equipment grounding conductor routed with supply conductors.
   3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
   4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

L. Separately Derived System Grounding:
   1. Separately derived systems include, but are not limited to:
      a. Transformers (except autotransformers such as buck-boost transformers).
      b. Generators, when neutral is switched in the transfer switch.
   2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
   3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
   4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building

frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.

5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

M. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
   b. Metal process piping.

N. Lightning Protection Systems, in Addition to Requirements of Section 26 4113:
1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
1. Use insulated copper conductors unless otherwise indicated.
   a. Exceptions:
      1) Use bare copper conductors where installed underground in direct contact with earth.
2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gauge of specified conductors.

C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.

2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   a. Exceptions:
      1) Use mechanical connectors for connections to electrodes at ground access wells.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

D. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 5/8 inch diameter by 10 feet length, unless otherwise indicated.
4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.

E. Ground Access Wells:
1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
   a. Round Wells: Not less than 8 inches in diameter.
   b. Rectangular Wells: Not less than 12 by 12 inches.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as shown on the drawings.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, provide ground plates.
1. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

D. Make grounding and bonding connections using specified connectors.
1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
4. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 26 0553.

F. Raceway
   1. Conduit Systems:
      a. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
      b. Metallic conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
      c. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a equipment grounding conductor to the equipment ground bus.
   2. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and power and lighting branch circuits.
   3. Boxes, Cabinets, Enclosures, and Panelboards:
      a. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
      b. Provide lugs in each box and enclosure for equipment grounding conductor termination.
   4. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.
   5. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

G. Lightning protection system:
   1. Bond the lightning protection system to the electrical grounding electrode system.
   2. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

H. Ground resistance:
   1. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance. Final tests shall ensure that this requirement is met.

I. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS except Section 4.

B. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer 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.

4. Perform tests by fall-of-potential method according to IEEE 81.

C. Grounding system will be considered defective if it does not pass tests and inspections

D. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.

E. Perform tests under the supervision of the Master Electrician licensed in the jurisdiction who will certify the findings. The use of a NETA certified testing agency is acceptable

F. Perform inspections and tests listed in NETA ATS, Section 7.13.

G. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

H. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

I. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Comply with provision of Section 26 0500 Common Work Results for Electrical.

B. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 05 5000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

B. Section 26 0534 - Raceways and Conduit Systems: Additional support and attachment requirements for conduits.

C. Section 26 0537 - Pull and Junction Boxes: Additional support and attachment requirements for boxes.

1.03 REFERENCE STANDARDS

A. MFMA-4 - Metal Framing Standards Publication; Metal Framing Manufacturers Association; 2004.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

C. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
   6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use stainless steel unless otherwise indicated.

B. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

C. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   1. Comply with MFMA-4.
   2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
   3. Channel Material:
      a. Outdoor and Damp or Wet Indoor Locations: Use stainless steel.
   4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
   5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
   6. Manufacturers:
      a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
      b. Thomas & Betts Corporation: www.tnb.com.
      c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
      d. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

D. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch diameter.
      b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
      c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch diameter.

d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
e. Outlet Boxes: 1/4 inch diameter.

E. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use expansion anchors or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Plastic and lead anchors are not permitted.
9. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Equipment Support and Attachment:
1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 4 inch high concrete pad. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Conduit Support and Attachment: Also comply with Section 26 0534.

J. Box Support and Attachment: Also comply with Section 26 0537.

K. Secure fasteners according to manufacturer's recommended torque settings.

L. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 0533
RACEWAYS AND CONDUIT SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Comply with provision of Section 26 0500 Common Work Results for Electrical.

B. Galvanized steel rigid metal conduit (RMC).

C. Intermediate metal conduit (IMC).

D. Liquidtight flexible metal conduit (LFMC).

E. Electrical metallic tubing (EMT).

F. Rigid polyvinyl chloride (PVC) conduit.

G. Conduit fittings.

H. Accessories.

1.02 REFERENCE STANDARDS

A. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2006.

D. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; National Electrical Manufacturers Association; 2005.

E. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2003.

F. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2004.

G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

I. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

J. UL 651 - Schedule 40 and 80 Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

K. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

1.03 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the

most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
   1. Under Slab on Grade: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
   2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
   3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
   4. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
   5. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.

D. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

E. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

F. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
   1. Locations subject to physical damage include, but are not limited to:
      a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
      b. Where exposed below 20 feet in warehouse areas.

G. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit or aluminum rigid metal conduit.
   1. Corrosive locations include, but are not limited to:
      a. Cooling towers.

H. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), aluminum rigid metal conduit, or PVC-coated galvanized steel rigid metal conduit.

I. Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit.
   2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
   3. Maximum Length: 6 feet unless otherwise indicated.
   4. Vibrating equipment includes, but is not limited to:
      a. Transformers.
      b. Motors.

2.02 CONDUIT REQUIREMENTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

B. Fittings for Grounding and Bonding: Also comply with Section 26 0526.

C. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

D. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

E. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 3/4 inch (21 mm) trade size.

2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
3. Control Circuits: 3/4 inch trade size.
4. Underground, Exterior: 1 inch (27 mm) trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:
1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
3. Material: Use steel or malleable iron.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.

C. Interior Coating: Urethane, minimum thickness of 2 mil.

D. PVC-Coated Fittings:
1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
4. Material: Use steel or malleable iron.
5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
6. Interior Coating: Urethane, minimum thickness of 2 mil.

E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2.07 ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:
   1. Connectors and Couplings: Use compression (gland) or set-screw type.
      a. Do not use indenter type connectors and couplings.
   2. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install intermediate metal conduit (IMC) in accordance with NECA 101.

E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

G. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated and routing is not shown, determine exact routing required.
   3. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
   4. Arrange conduit to maintain adequate headroom, clearances, and access.
   5. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
   6. Arrange conduit to provide no more than 100 feet between pull points.
   7. Route conduits above water and drain piping where possible.
   8. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
   9. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
   10. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
      a. Heaters.
      b. Hot water piping.
      c. Flues.
   11. Group parallel conduits in the same area together on a common rack.

H. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
9. Use of wire for support of conduits is not permitted.
10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.
11. Support within 12 in of changes of direction, and within 12 in of each enclosure to which is connected.

I. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
8. Provide insulated bushing on both ends of empty conduits.
9. Where conduits stub up in conduit space beneath switchboards or switchgear and do not connect directly to equipment enclosures, install malleable iron nylon insulated ground bushing complete with bonding connection and bond to switchboard ground bus.
10. Where feeder or branch conduits enter pull boxes or junction boxes, clearly mark onconduit on the entering and leaving side of each box the panel name and circuit number(s) contained within the conduit using a permanent black marker.

J. Motors and Vibrating Equipment:
1. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
2. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water. Provide a green equipment grounding conductor with flexible metal conduit.

K. Penetrations:
1. Make penetrations perpendicular to surfaces unless otherwise indicated.

2. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
3. Conceal bends for conduit risers emerging above ground.
4. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
5. Provide suitable modular seal where conduits penetrate exterior wall below grade.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.

L. Underground Installation:
1. Provide trenching and backfilling.
2. Minimum Cover, Unless Otherwise Indicated or Required:
   a. Underground, Exterior: 24 inches.
   b. Under Slab on Grade: 12 inches to bottom of slab.
3. No PVC shall emerge from the ground, concrete slab, or concrete encasement. PVC shall convert to galvanized rigid steel conduit at least 6 inches before exiting concrete slab or concrete encasement. Schedule 80 PVC shall be used if shown on drawing.
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length for service entrance where not concrete-encased.

M. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.
1. Use rigid steel conduit only, notwithstanding requirements otherwise specified in this or other sections of these specifications.
2. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

N. Wet or Damp Locations:
1. Unless otherwise shown, use conduits of rigid steel or IMC.
2. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.
3. Do not use aluminum conduits in wet locations.
4. Unless otherwise shown, use rigid steel or IMC conduit within 5 feet of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.
5. For damp or wet locations, indoor or outdoor locations where NEMA 4 or 4X enclosures are used, secure conduits to boxes and cabinets with Myers Scru-Tite hub.

O. Provide grounding and bonding in accordance with Section 26 0526.

P. Identify conduits in accordance with Section 26 0553.
   1. Where feeder or branch conduits enter pull boxes or junction boxes, clearly mark on conduit on the entering and leaving side of each box the panel name and circuit number(s) contained within the conduit using a permanent black marker.

3.02 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.03 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 0537
PULL AND JUNCTION BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Boxes for hazardous (classified) locations.

D. Floor boxes.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0534 - Raceways and Conduit Systems:
   1. Conduit bodies and other fittings.
   2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.

C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
   1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
   2. Use suitable masonry type boxes where flush-mounted in masonry walls.
   3. Use shallow boxes where required by the type of wall construction.
   4. Do not use "through-wall" boxes designed for access from both sides of wall.
   5. Minimum Box Size, Unless Otherwise Indicated:
      a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.

6. Wall Plates: Comply with Section 26 2726.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

E. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

F. Box Locations:
1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
2. Locate boxes as required for devices installed under other sections or by others.
   a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 2726.
3. Locate boxes so that wall plates do not span different building finishes.
4. Locate boxes so that wall plates do not cross masonry joints.
5. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0534.

G. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

H. Install boxes plumb and level.

I. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
2. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

J. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

K. Close unused box openings.

L. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

M. Provide grounding and bonding in accordance with Section 26 0526.

N. Identify boxes in accordance with Section 26 0553.

O. Color code pull and junction boxes and identify feeders and circuits entering pull and junction boxes as called for in Section 26 0553.

3.02 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.03 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 0543
ELECTRICAL UNDERGROUND DUCTS AND MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal conduit.

B. Nonmetallic duct.

C. Manholes.

1.02 RELATED REQUIREMENTS

A. Section 26 0500 - Common Work Result for Electrical.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

1.03 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.

B. ASTM C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures; 2008.

C. IEEE C2 - National Electrical Safety Code; Institute of Electrical and Electronic Engineers; 2012.

D. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2003.

E. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2004.

F. NEMA TC 6&8 - Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations; National Electrical Manufacturers Association; 2003.

G. NEMA TC 9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation; National Electrical Manufacturers Association; 2004.

H. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. Product Data: Provide for metallic conduit, nonmetallic conduit, and manhole accessories.

B. Submit information on manholes, pullboxes, ducts, and hardware. Submit manhole plan and elevation drawings, showing openings, pulling irons, cable supports, cover, ladder, sump, and other accessories.

C. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Conform to requirements of ANSI C2.

C. Coordinate layout and installation of ducts, manholes, and pullboxes with final arrangement of other utilities, site grading, and surface features.

D. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

E. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.Protect on-site storage from weather.

B. Lift and support precast concrete units only at designated lifting or supporting points.

C. Accept conduit on-site. Inspect for damage.

D. Protect nonmetallic conduit from entrance of debris, and provide appropriate covering to protect from sunlight.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ARNCO Corp.

B. Allied Tube and Conduit

C. Beck Manufacturing.

D. Cantex, Inc.

E. CertainTeed Corp.; Pipe & Plastics Group.

F. Condux International, Inc.

G. ElecSys, Inc.

H. Electri-Flex Company.

I. Quazite.

J. Lamson & Sessions; Carlon Electrical Products.

K. Manhattan/CDT; a division of Cable Design Technologies.

L. Prime Conduit, Inc.

M. Spiraduct/AFC Cable Systems, Inc.

2.02 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.
   1. Color: Gray.
   2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, ELECTRIC.
   6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
   7. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

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

E. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be hot-dip galvanized-steel diamond plate.

2.03 ACCESSORIES

A. Underground Warning Tape: 4 inch wide plastic tape, detectable type colored red with suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify routing and termination locations of duct bank prior to excavation for rough-in.

C. Verify locations of manholes prior to excavating for installation.

END OF SECTION

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

1.02 RELATED REQUIREMENTS

A. Section 26 0500 - Common Work Results for Electrical

B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

C. Section 26 0573 - Power System Analysis: Arc flash hazard warning labels.

D. Section 26 2726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.

1.03 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. NFPA 70E - Standard for Electrical Safety in the Workplace; National Fire Protection Association; 2015.

1.04 SUBMITTALS

A. Submittal of products furnished under this Section is not required.

1.05 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

B. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

C. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
      a. Switchboards:
         1) Name.
         2) Identify voltage and phase.
         3) Identify power source and circuit number. Include location when not within sight of equipment.
         4) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
      b. Panelboards:
         1) Name.
         2) Identify voltage and phase.

3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

c. Transformers:
1) Name.
2) Identify voltage and phase for primary and secondary.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify load(s) served. Include location when not within sight of equipment.

d. Enclosed switches, circuit breakers, and motor controllers:
1) Identify voltage and phase.
2) Identify power source and circuit number. Include location when not within sight of equipment.
3) Identify load(s) served. Include location when not within sight of equipment.

e. Transfer Switches:
1) Identify voltage and phase.
2) Name.
3) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
4) Identify load(s) served. Include location when not within sight of equipment.

2. Service Equipment:
a. Use identification nameplate to identify each service disconnecting means.

3. Emergency System Equipment:
a. Use identification nameplate to identify emergency system equipment in accordance with NFPA 70.
b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.

4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
5. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
6. Arc Flash Hazard Warning Labels: Comply with Section 26 0573.
7. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment indicated.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. The color code as outlined below shall be used. In addition, on each panelboard, pullbox, control cabient, or other electrical enclosue that contains circuits from more than one system, provide an engraved phenolic plate and indentify the circuit conductors with the following color code:
a. 208Y/120, Phase A, black, Phase B, red, Phase C, blue, grounded conductor, white, equipment grounding conductor, green, isolated equipment grounding conductor, green/yellow stripe.

b. 480Y/277, Phase A, brown, Phase B, orange, Phase C, yellow, grounded conductor, gray, equipment grounding conductor, green, isolated equipment grounding conductor, green/red stripe

4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
   a. At each source and load connection.
   b. Within boxes when more than one circuit is present.
   c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
6. Use underground warning tape to identify direct buried cables.

C. Identification for Boxes:
1. Identify feeder j-boxes and pull boxes with designation of panelboard/switchboard source as "FROM" and load served as "TO" with permanent labels.
2. Identify pull and junction boxes with the designation of panelboard and the circuit number of each circuit contained therein, with permanent marker. Clearly mark information on or in the box, not on the cover, so that the information is easily identifiable.
3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

D. Identification for Devices:
1. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.
2. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Materials:
   a. Indoor Clean, Dry Locations: Use plastic nameplates.
   b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
4. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
   a. System designation where applicable:
      1) Emergency Power System: Identify with text "EMERGENCY".
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
   a. System Designation: 1/2 inch.
   b. Equipment Designation: 1/2 inch.
   c. Other Information: 1/4 inch.
   d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
5. Color:
   a. Normal Power System: White text on black background.
   b. Emergency Power System: White text on red background.

C. Format for Receptacle Identification:
   1. Minimum Size: 3/8 inch by 1.5 inches.
   2. Legend: Power source and circuit number or other designation indicated.
      a. Include voltage and phase for other than 120 V, single phase circuits.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height: 3/16 inch.
   5. Color: Black text on clear background.

D. Format for Control Device Identification:
   1. Minimum Size: 3/8 inch by 1.5 inches.
   2. Legend: Load controlled or other designation indicated.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height: 3/16 inch.
   5. Color: Black text on clear background.

2.03 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

B. Legend: Power source and circuit number or other designation indicated.

C. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

D. Minimum Text Height: 1/8 inch.

E. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   3. Branch Devices: Adjacent to device.
   4. Interior Components: Legible from the point of access.
   5. Boxes: Outside face of cover.
   6. Conductors and Cables: Legible from the point of access.
   7. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 2100
LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical service requirements.

1.02 RELATED REQUIREMENTS

A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0529 - Hangers and Supports for Electrical Systems.

D. Section 26 0534 - Raceways and Conduit Systems.

E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 3213 - Engine Generators: Emergency/standby power systems for interconnection with normal utility electrical supply.

G. Section 26 3600 - Transfer Switches: Service entrance equipment.

H. Section 26 4300 - Surge Protective Devices: Service entrance surge protective devices.

1.03 PRICE AND PAYMENT PROCEDURES

A. Allowances:
   1. Include cash allowance for Utility Company charges associated with providing service.

1.04 DEFINITIONS

A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.05 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code; Institute of Electrical and Electronic Engineers; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.06 ADMINISTRATIVE REQUIREMENTS

A. No later than two weeks following date of the Agreement, notify Utility Company of anticipated date of service.

B. Coordination:
   1. Verify the following with Utility Company representative:
      a. Utility Company requirements, including division of responsibility.
      b. Exact location and details of utility point of connection.
      c. Utility easement requirements.
      d. Utility Company charges associated with providing service.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
   3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with other installers to provide communication lines required for Utility Company meters.

5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.

D. Utility Company charges associated with providing permanent service to be paid by Owner.

E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.

F. Scheduling:
1. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.
2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.07 SUBMITTALS

A. Submittal of products furnished under this Section is not required.

1.08 QUALITY ASSURANCE

A. Comply with the following:
1. IEEE C2 (National Electrical Safety Code).
2. NFPA 70 (National Electrical Code).
3. The requirements of the Utility Company.
4. The requirements of the local authorities having jurisdiction.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 ELECTRICAL SERVICE REQUIREMENTS

A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Electrical Service Characteristics:
1. Service Type: Underground.
2. Service Voltage: 480Y/277 V, 3 phase, 60 Hz.

C. Division of Responsibility:
1. Pad-Mounted Utility Transformers:
a. Transformers: Furnished and installed by Utility Company.
b. Transformer Grounding Provisions: Furnished and installed by Contractor per Utility Company requirements.
c. Primary:
1) Trenching and Backfilling: Provided by Contractor.
2) Conduits: Furnished and installed by Contractor.
3) Conductors: Furnished and installed by Utility Company.

d. Secondary:
   1) Trenching and Backfilling: Provided by Contractor.
   2) Conduits: Furnished and installed by Contractor.
   3) Conductors: Furnished and installed by Contractor (Service Point at transformer).

2. Terminations at Service Point: Provided by Utility Company.
3. Metering Provisions:
   a. Meter Bases: Furnished and installed by Contractor per Utility Company requirements.

D. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Verify and mark locations of existing underground utilities.

3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Utility Company requirements.

B. Perform work in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required protective bollards in accordance with Utility Company requirements.

E. Provide required support and attachment components in accordance with Section 26 0529.

F. Provide grounding and bonding for service entrance equipment in accordance with Section 26 0526.

G. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 0553.

3.04 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION

SECTION 26 2200
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General purpose transformers.

1.02 RELATED REQUIREMENTS

A. Section 26 0500 - Common Work Result for Electrical.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0534 - Raceways and Conduit Systems: Flexible conduit connections.

D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 0534 - Raceways and Conduit Systems: Flexible conduit connections.

F. Section 26 2416 - Panelboards.

1.03 REFERENCE STANDARDS

A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; current edition.

B. IEEE C57.94 - Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; Institute of Electrical and Electronic Engineers; 1982 (R2006).

C. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; Institute of Electrical and Electronic Engineers; 1999 (R2004).

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; National Electrical Contractors Association; 2009.

F. NEMA ST 20 - Dry-Type Transformers for General Applications; National Electrical Manufacturers Association; 2014.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

1.05 SUBMITTALS

A. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
   1. Vibration Isolators: Include attachment method and rated load and deflection.

B. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.

C. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Maintenance Data: Include recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Schneider Electric; Square D Products: www.schneider-electric.us.

B. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Transformers to be compliant with NEMA TP-1 energy efficiency requirements per EPAct 2005/CFR 10 Part 431.

C. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
   1. Altitude: Less than 3,300 feet.
   2. Ambient Temperature:
      a. Greater than 10 kVA: Not exceeding 104 degrees F.
      b. Less than 10 kVA: Not exceeding 77 degrees F.
   3. Ambient Temperature: Not exceeding 86 degrees F average or 104 degrees F maximum measured during any 24 hour period.

D. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

E. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

F. Basic Impulse Level: 10 kV.

G. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

H. Isolate core and coil from enclosure using vibration-absorbing mounts.

I. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

J. Provide NEMA 1 ventilated enclosures of heavy gauge steel construction for indoor transformers. Provide weather shields for ventilated transformers installed outdoors conforming to the requirements of NEMA 250, Type 3R. Finish enclosures in ANSI 61 gray paint.

2.03 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Primary Voltage: 480 volts delta, 3 phase.

C. Secondary Voltage: 208Y/120 volts, 3 phase.

D. Insulation System and Allowable Average Winding Temperature Rise:
   1. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

E. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.

F. Winding Taps:
   1. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.

G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
   1. Test efficiency according to NEMA TP 2.
   2. Label transformer according to NEMA TP 3.

H. Sound Levels: Standard sound levels complying with NEMA ST 20.

I. Mounting Provisions:
   1. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.

J. Transformer Enclosure: Comply with NEMA ST 20.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor clean, dry locations: Type 1.
      b. Outdoor locations: Type 3R.
   2. Construction: Steel.
      a. 15 kVA and Larger: Ventilated.
   3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
   4. Provide lifting eyes or brackets.

K. Accessories:
   1. Mounting Brackets: Provide manufacturer's standard brackets.
   2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
   3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.04 SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

B. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

E. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install transformers in accordance with manufacturer's instructions.

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 26 0534, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

G. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.

H. For suspended transformers provide spring hangers (Mason 30N or equal) with double neoprene elements at the top of the device with spring seated neoprene cups at the base of the device for sway bracing purposes.

I. Mount trapeze-mounted transformers as indicated.

J. Provide grounding and bonding in accordance with Section 26 0526.

K. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

L. Where not factory-installed, install lugs sized as required for termination of conductors as shown on the drawings.

M. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.

N. Identify transformers in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01 4000.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Acceptance Checks and Tests
   1. Perform tests in accordance with the manufacturer's recommendations. In addition, include the following:
      a. Visual Inspection and Tests:
         1) Compare equipment nameplate data with specifications and approved shop drawings.

2) Inspect physical and mechanical condition.
3) Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections.
4) Perform specific inspections and mechanical tests as recommended by manufacturer.
5) Verify correct equipment grounding.
6) Verify proper secondary phase-to-phase and phase-to-neutral voltage after energization and prior to connection to loads.

3.04 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

C. Check the insulation resistance of primary and secondardy windings with a 1000 vdc "megger". Minimum acceptable value is 3 megohms.

D. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Vacuum dirt and debris from transformer components according to manufacturer's instructions. Do not use compressed air to assist in cleaning

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 2416
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Power distribution panelboards.

B. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 4300 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

E. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; 2011.

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2013 (ANSI/NEMA PB 1.1).

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

H. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

K. UL 67 - Panelboards; Current Edition, Including All Revisions.

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.

4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
4. Include documentation of listed series ratings upon request.

C. Field Quality Control Test Reports.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70. 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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:
1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
2. 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.

3. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   a. Notify Architect, Construction Manager, and Owner no fewer than 7 days in advance of proposed interruption of electric service.
   b. Indicate method of providing temporary electric service.
   c. Do not proceed with interruption of electric service without Architect, Construction Manager, and Owner written permission.
4. 4. Comply with NFPA 70E.

1.09 WARRANTY

A. Warrants equipment to be free from defects in materials and workmanship for 1 year from the Manufacturer date of acceptance by the owner or 18 months from date of delivery, whichever occurs first.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Schneider Electric; Square D Products; _____: www.schneider-electric.us.

B. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

F. Provide circuit breakers with lugs (both main and branch circuit lugs) suitable and UL listed for both aluminum and copper conductors and rated for minimum 75 degrees C.

G. Provide thermal magnetic circuit breakers which are fully rated and temperature rated for a 40 degrees C ambient. Breakers shall be quick-make, quick-break type with trip indication shown by handle position other than ON or OFF and with a common trip on all multi-pole breakers.

H. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
   2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   3. Material: Hard-drawn copper, 98 percent conductivity.
   4. Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Single-phase, three-wire panelboard busing shall be such that when any two adjacent single-pole breakers are connected to opposite phases, two-pole breakers can be installed in any location. Three-phase, four-wire busing shall be such that

when any three adjacent single-pole breakers are individually connected to each of the three different phases, two- or three-pole breakers can be installed at any location. Current-carrying parts of the bus assembly shall be plated. Mains ratings shall be as shown.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Boxes: Galvanized steel unless otherwise indicated.
      a. Provide wiring gutters sized to accommodate the conductors to be installed.
      b. Provide removable end walls for NEMA Type 1 enclosures.
      c. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
   3. Fronts:
      a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
      b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
      c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
      d. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   4. Lockable Doors: All locks keyed alike unless otherwise indicated.
      a. Cabinets shall be equipped with spring latch and tumbler lock on door of trim. Doors over 48" long shall be equipped with three point latch and vault lock. All locks shall be keyed alike.
   5. Directory Card: Inside panelboard door, mounted in transparent card holder.
   6. Exposed external surfaces of the enclosure and cover shall be properly cleaned and painted gray, ANSI 61.

K. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
   1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
   2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
      a. Use zero sequence ground fault detection method unless otherwise indicated.
      b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Circuit breaker type power distribution panelboards for 120/208 volts, 3-phase, 4-wire service shall be equipped with circuit breakers having AIC rating as indicated on the drawings. Where AIC ratings are not shown on drawings obtain the rating requirements from the Engineer. Panelboards shall be equal to:
   1. Square D, "I-Line" series distribution type

C. Circuit breaker type power distribution panelboards for 277/480 volts, 3-phase, 4-wire service shall be equipped with circuit breakers having AIC rating as indicated on the drawings. Where AIC ratings are not shown on drawings, obtain the rating requirements from the Engineer. Panelboards shall be equal to:
   1. Square D, "I-Line" series distribution type

D. Conductor Terminations:
   1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
   2. Main and Neutral Lug Type: Mechanical.

E. Bussing:
   1. Power distribution panelboards shall be furnished with full-height bussing.
   2. Phase and Neutral Bus Material: Copper.
   3. Ground Bus Material: Copper.

F. Circuit Breakers:
   1. Provide bolt-on type.
   2. Provide thermal magnetic circuit breakers unless otherwise indicated.
   3. Provide electronic trip circuit breakers where indicated.

G. Enclosures:
   1. Provide surface-mounted enclosures unless otherwise indicated.
   2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
   3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Circuit breaker type lighting and appliance panelboards for 120/208 volts, 3-phase, 4-wire service shall be equipped with circuit breakers having AIC ratings as indicated on the drawings, but not less than 10,000 AIC. Panelboards shall be equal to:
   1. Square D, "N" series

C. Circuit breaker type lighting and appliance panelboards for 277/480 volts, 3-phase, 4-wire service shall be equipped with circuit breakers having AIC ratings as indicated on the drawings, but not less than 14,000 AIC. Panelboards shall be equal to:
   1. Square D, "N" series

D. Conductor Terminations:
   1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
   2. Main and Neutral Lug Type: Mechanical.

E. Bussing:
   1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
   2. Phase and Neutral Bus Material: Copper.
   3. Ground Bus Material: Copper.

F. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

G. Enclosures:
   1. Provide surface-mounted or flush-mounted enclosures as indicated.
   2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
   3. Provide clear plastic circuit directory holder mounted on inside of door.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
   1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
   2. Circuit breakers shall be bolt-on type. Plug-in type is not acceptable.
   3. Interrupting Capacity:
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
         1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
         2) 18,000 rms symmetrical amperes at 480 VAC.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   4. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
      b. Provide compression lugs where indicated.
      c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   5. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
      a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
      b. Provide interchangeable trip units where indicated.
   6. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
      a. Provide the following field-adjustable trip response settings:
         1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
         2) Long time delay.
         3) Short time pickup and delay.
         4) Instantaneous pickup.
         5) Ground fault pickup and delay where ground fault protection is indicated.
   7. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
   8. Provide the following circuit breaker types where indicated:
      a. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
   9. Do not use tandem circuit breakers.
   10. Do not use handle ties in lieu of multi-pole circuit breakers.
   11. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
   12. Provide the following features and accessories where indicated or where required to complete installation:
      a. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

2.06 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.

C. Directory-card information shall be typewritten in capital letters to indicate outlets controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering. Space names and numbers shall match the graphics installed if different from the space names and numbers on the drawings

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required supports in accordance with Section 26 0529.

F. Install panelboards plumb.

G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

I. Provide grounding and bonding in accordance with Section 26 0526.
   1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.

J. Install all field-installed branch devices, components, and accessories.

K. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

L. Install branch circuits using a separate neutral for each circuit. Mulitwire circuit are not acceptable.

M. Set field-adjustable circuit breaker tripping function settings as indicated.

N. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

O. Provide filler plates to cover unused spaces in panelboards.

P. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated.

Q. Identify panelboards in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 01 4000.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

E. Conduct insulation tests on panelboards rated 300 volts or less using a 500-volt minimum insulation-resistance test set. Record readings after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

F. Conduct insulation tests on 480-volt panelboards using a 1,000-volt insulation-resistance test set. Record readings every minute until three equal and consecutive readings have been

obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

G. Record test data and include the location and identification of panelboards and megohm readings versus time.

H. Perform the following infrared scan tests and inspections and prepare reports:
   1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
   2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
   3. Instruments and Equipment:
      a. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

I. Correct deficiencies and replace damaged or defective panelboards or associated components. Panelboards will be considered defective if they do not pass tests and inspections.

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

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Measure as directed during period of normal system loading.

D. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records. machines and on-line data processing, computing, transmitting, and receiving equipment.

E. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing].

3.05 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 2913
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Magnetic motor controllers.

B. Combination magnetic motor controllers and disconnects.

1.02 SUBMITTALS

A. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Schneider Electric; Square D Products; Model _____: www.schneider-electric.us.

2.02 AUTOMATIC CONTROLLERS

A. Full voltage, across the line, electrically held.

B. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

C. Non-reversing controller.

D. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

E. Coil Operating Voltage: 120 volts, 60 Hertz.

F. Melting Alloy Overload Relays:
1. Inverse-time-current characteristic.
2. Class 10 tripping characteristic.
3. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

G. Solid-State Overload Relay:
1. Switch or dial selectable for motor running overload protection.
2. Sensors in each phase.
3. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5. Analog communication module.

H. External overload reset push button.

I. Enclosures: NEMA ICS 6, Type 1.

2.03 COMBINATION MAGNETIC CONTROLLER

A. Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

B. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

C. MCP Disconnecting Means:
1. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front- mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
4. N.C. alarm contact that operates only when MCP has tripped.
5. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

2.04 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS

A. General Requirements for Reduced-Voltage Solid-State Controllers: Comply with UL 508.

B. Reduced-Voltage Solid-State Controllers: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

2.05 ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact.

B. Cover Mounted Pilot Devices: NEMA ICS 5, standard duty oiltight type.

C. Pushbuttons: Unguarded type.

D. Indicating Lights: Transformer, incandescent type.

E. Selector Switches: Rotary type.

F. Control Power Transformers: 120 volt secondary, as scheduled. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

G. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

2.06 DISCONNECTS

A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.

B. Thermal Magnetic Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole; UL listed.

C. Motor Circuit Protector: Circuit breakers with integral instantaneous magnetic trip in each pole; UL listed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.

B. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

C. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

D. Provide supports in accordance with Section 26 0529.

E. Height: 5 ft to operating handle.

F. Select and install overload heater elements in motor controllers to match installed motor characteristics.

G. Identify enclosed controllers and control wiring in accordance with Section 26 0553.
   1. Label each enclosure with engraved nameplate.
   2. Label each enclosure-mounted control and pilot device.
   3. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 4000.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

D. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.

E. Test continuity of each circuit.

F. Perform the following infrared scan tests and inspections and prepare reports:
   1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
   2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
   3. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

G. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

H. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

I. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

END OF SECTION

SECTION 26 3213
ENGINE GENERATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section defines requirements for an emergency engine generator system. Provide system complete for automatic, unattended operation for the duration of any loss of normal utility power as defined herein. Include the following features and accessories with the system:
   1. Engine and engine accessory equipment.
   2. Alternator (generator).
   3. Generator set control system.
   4. Generator set enclosure.
   5. Battery charger.
   6. Remote annunciator.
   7. Silencer.

1.02 RELATED REQUIREMENTS

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

B. Section 26 0500 - Common Work Result for Electrical.

C. Section 26 0526 - Grounding and Bonding for Electrical Systems.

D. Section 26 0529 - Hangers and Supports for Electrical Systems.

E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 3600 - Transfer Switches.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NECA/EGSA 404 - Standard for Installing Generator Sets; National Electrical Contractors Association; 2014.

C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2014.

D. NFPA 30 - Flammable and Combustible Liquids Code; National Fire Protection Association; 2012.

E. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; National Fire Protection Association; 2015.

F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NFPA 110 - Standard for Emergency and Standby Power Systems; National Fire Protection Association; 2013.

H. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

I. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

J. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.

a. Transfer Switches: See Section 26 3600.

2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
1. Include generator set sound level test data.
2. Include characteristic trip curves for overcurrent protective devices.
3. Include alternator thermal damage curve.
4. Short-circuit current capacity and subtransient reactance.
5. Time-current characteristic curves for generator protective device
6. Thermal damage & decrement curves, positive, negative, & zero sequence impedances, sub-transient & transient reactance, X/R ratio, and time constraints

B. Wiring diagrams of all power, signal and control wiring indicating factory and field wiring.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

D. Motor Starting Data:
1. Provide a computerized motor starting analysis indicating voltage drop at each stage using load schedule provided by Engineer.

E. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.

F. Specimen Warranty: Submit sample of manufacturer's warranty.

G. Evidence of qualifications for installer.

H. Evidence of qualifications for maintenance contractor (if different entity from installer).

I. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

J. Manufacturer's factory emissions certification.

K. Manufacturer's certification that products meet or exceed specified requirements.

L. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
1. Certified prototype tests.
2. Torsional vibration compatibility certification.
3. NFPA 110 compliance certification.
4. Certified rated load test at rated power factor.

M. Manufacturer’s detailed field testing procedures.

N. Field quality control test reports.

O. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

P. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

Q. Maintenance contracts.

R. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

S. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Extra Fuses: One of each type and size.
   2. Extra Filter Elements: One of each type, including fuel, oil and air.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.
   3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
   4. NFPA 30 (Flammable and Combustible Liquids Code).
   5. Florida Building Code, 2014 Edition.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   1. Authorized service facilities located within 200 miles of project site.

C. Engine-generators shall be completely factory assembled and tested. The engine-generator set shall be the product of a single manufacturer.

D. Manufacturer's Certificate of ISO 9002 Compliance

E. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.

F. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
   1. Contract maintenance office located within 200 miles of project site.

G. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

B. Deliver to the designated job site and unload on the designated concrete pad.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

E. Provide proper and adequate protection during construction to protect all components from dust, moisture, and physical damage.

1.08 REGULATORY REQUIREMENTS

A. In accordance with Florida Building Codes, NFPA Code and Standards, and City of Dunedin requirements, manufacturer shall test or analyze the engine-generator components and its mounting system or anchorage and submit a certificate of compliance for review and acceptance by Engineer and by the building official. Qualification shall be by an actual test on a shake table, by three-dimensional shock tests, by an analytical method using dynamic characteristics and forces, by the use of experience data or by a more rigorous analysis providing for equivalent safety.

B. Low voltage circuit breakers and equipment shall be listed by Underwriters Laboratories in accordance with standards listed in section 1.03 of this specification and shall bear the UL label.

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Job conditions shall conform to the arrangements and details shown on the drawings. The dimensions, enclosures, and arrangements of the engine generator system shall permit the operating personnel to safely and conveniently operate and maintain the system in the space designated for installation.

C. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
   1. Ambient Temperature: 5 to 40 deg C.
   2. Relative Humidity: 0 to 95 percent.
   3. Altitude: Sea level to 1000 feet.

1.10 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified by others.

B. Contractor is responsible for installation of fuel system. Remove fuel from existing above ground fuel tank and transfer to new sub-base tank.

1.11 WARRANTY

A. General Warranty
   1. Provide written warranty executed by manufacturer, agreeing to repair or replace the engine, generator, and associated components that fail in materials or workmanship for a period of one year from date of Owner's acceptance of equipment.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

1.12 MAINTENANCE SERVICE

A. After acceptance by owner, begin a 12 month full service maintenance contract. Provide a minimum of quarterly exercising to check for proper starting, load pick up, load shedding, running under load. Perform routine preventive maintenance as recommended by the manufacturer and adjusting as required for proper operation. Provide all parts and supplies as required.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Packaged Engine Generator Set - Basis of Design: Cummis Power Generation Inc..

B. Packaged Engine Generator Set - Other Acceptable Manufacturers:
   1. Caterpillar Inc; _____: www.cat.com.
   2. Cummins Power Generation Inc; _____: www.cumminspower.com.
   3. Kohler Co; _____: www.kohlerpower.com.

4. PowerSecure. www.powersecure.com.

C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

D. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:
   1. Application: Emergency/standby.
   2. Classification: Suitable for use on a Level 1, Type 10, Class 48 EPSS.
   3. Configuration: Single packaged engine generator set operated independently (not in parallel).
   4. Total System Power Rating: 500 kW, standby.

D. Packaged Engine Generator Set:
   1. Type: Diesel (compression ignition).
   2. Power Rating: 500 kW, standby.
   3. Voltage: 480Y/277 V, 3 phase, 60 Hz.
   4. Main Line Circuit Breaker:
      a. Type: Electronic trip with long time and short time delay and instantaneous pickup.
      b. Trip Rating: As indicated on drawings.
      c. Features:
         1) Shunt trip.
         2) Auxiliary contacts.

E. Generator Set General Requirements:
   1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
   2. Factory-assembled, with components mounted on suitable base.
   3. List and label engine generator assembly as complying with UL 2200.
   4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
   5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
   6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.

G. Starting and Load Acceptance Requirements:
   1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
   2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
   3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
   4. Maximum Load Step: Supports 100 percent of rated load in one step.

5. Motor Starting Capability: Supports starting of motor load indicated with a maximum voltage dip of 10 percent.

H. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Comply with EPA “New Source Performance Standard” (NSPS) for stationary reciprocating compression ignition engines as applied by state and local authorities having jurisdiction (AHJ). Provide engines with the following levels of certification as defined by NSPS unless otherwise required by AHJ:
3. Tier 4 Certification
4. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

I. Sound Level Requirements:
1. Do not exceed 78 dBA when measured at 23 feet from generator set in free field (no sound barriers) while operating at full load; include manufacturer's sound data with submittals.
2. Comply with applicable noise level regulations.

2.03 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Rated Engine Speed: 1800 rpm

C. Four cycle engine with maximum piston speed of 2250 fpm

D. Engine Fuel System - Diesel (Compression Ignition):
1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
2. Fuel Storage: Main fuel tank (bulk tank) without day tank.
3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
5. Sub-Base Fuel Tank:
   a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
   b. Tank Capacity: Size for minimum of 2000 GLS or 48 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
   c. Features:
      1) Direct reading fuel level gauge.
      2) Normal atmospheric vent.
      3) Emergency pressure relief vent.
      4) Fuel fill opening with lockable cap.
      5) Dedicated electrical conduit stub-up area.
      6) Low fuel level switch.
      7) Leak detection switch; located within secondary containment interstitial space for detection of primary tank fuel leak.
      8) Field anchoring of the tank to the concrete pad will be accomplished with anchor plates spaced approximately on 24 inch centers and provided by the enclosure manufacturer with the frame and shipped loose with the enclosure package. Appropriate 3/4 inch anchor bolts will be provided by installing contractor

9) Fuel tank venting in compliance with NFPA and UL, 2" Manual fuel fill cap, mechanical fuel level gauge, 7-gallon overspill containment around fuel fill, high level alarm set at 90% of tank capacity, low level alarm set at 40% of tank capacity, rupture basin alarm with normally open contacts, two (2) spare 2" NPT ports with installed plug, fuel supply and return ports with full length pick-up tubes.

E. Engine Starting System:
1. System Type: Electric, 24 VDC, with DC solenoid-activated starting motor(s).
2. Starter Motors: Dual heavy duty starter motors connected in parallel, each capable of cranking the engine for 45 seconds continuous and for 3 cycles for 75 seconds, (15 seconds cranking, 15 seconds at rest.), with the other starter out of service
3. Battery(s):
   a. Battery Type: Lead-acid.
   b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
   c. Starting Batteries: Provide batteries capable of starting unit in time specified under installed conditions and capable of 45 seconds of continuous engine cranking and 3 cranking cycles for 75 seconds, (15 seconds cranking, 15 seconds at rest.) Install batteries in steel, insulated rack(s). Provide heavy-duty long life, lead-acid high discharge rate type batteries with plastic case. Engine manufacturer to size and furnish battery cables.
   d. Each battery cell shall have minimum and maximum electrolyte level indicators and a flip-top flame arrestor vent cap.
   e. Batteries shall have connector covers for protection against external short circuits.
   f. With the charger disconnected, the batteries shall have sufficient capacity so that the total system voltage does not fall below 85% of the nominal system voltage with the following demands:
      1) Five consecutive starting attempts of 10 seconds cranking at 10 second intervals for a total of 50 seconds of actual cranking (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).
   g. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
4. Battery-Charging Alternator: Engine-driven, factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
5. Battery Charger:
   a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
   b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
   c. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
   d. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   e. Recognized as complying with UL 1236.
   f. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
   g. Provide integral DC output ammeter and voltmeter with five percent accuracy.

h. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
i. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

6. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.

F. Engine Speed Control System (Governor):
1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

G. Engine Lubrication System:
1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
2. Filter & Strainer: Rated to remove 90% of particles, 5 micrometers and smaller while passing full fuel flow
3. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Provide unit capable of full flow, designed to be fail-safe
4. Crankcase Drain: Arranged for complete gravity drainage to an easy removable container without any disassembly and without use of pumps or siphons or special tools

H. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.
4. Coolant: Anti-freeze coolant, 50% ethylene-glycol and 50% water mixture, with anticorrosion additives as recommended by engine manufacturer, supplied by the Contractor at start-up.
5. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gauge glass and petcock.
6. Fuel Oil Cooler: Equip radiator with a factory installed, radiator mounted fuel oil cooler sized per manufacturer’s recommendation.

I. Engine Air Intake and Exhaust System:
1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter, pre-filter, and a "blocked filter" indicator. .
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.
4. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing rain cover.
5. Silencer Mounting: Equip silencer with mounting brackets for horizontal mounting from the structure above.

6. Condensate Drain: Install condensate trap and petcock drain in silencer and connect with schedule 40, black steel pipe. Extend drain and drain plug beyond insulation to facilitate draining.
7. Connection from Engine to Exhaust System: Install a stainless steel, bellows type, flexible section of a minimum 36 inches between the exhaust manifold and the exhaust silencer.
8. System Insulation: Fully insulate exhaust systems (under Division 23) that are installed inside structures. Install sleeves for lines passing through walls to pass through.
9. The installed insulation shall be covered with aluminum jacket 0.016 inch thick. The jacket is to be held in place by bands of 0.015 inch thick by 0.5 inch wide aluminum.

2.04 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. 3/4 to 5/6 pitch, form wound, single bearing, brushless type, with six leads. Two or more generators that will be paralleled shall have identical pitch, impedances, and 3rd harmonic voltages. Where one or more generators will be paralleled with an existing generator(s), the the pitch, impedances, and 3rd harmonic voltages will be optimized for best possible performance.

C. 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.

D. Exciter:
   1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
   2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
   3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.
   4. Rotating rectifier shall employ three phase sensing.
   5. Voltage Regulator: Static type with a voltage adjusting rheostat furnished in the control panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

E. Temperature Rise: Comply with UL 2200.

F. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.

G. Enclosure: NEMA MG 1, drip-proof.

H. Total Harmonic Distortion: Not greater than five percent.

I. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

J. Steady-State Voltage Regulation: Plus or minus 1% from no load to full load with steady state modulation of ½%.

K. Transient Voltage Regulation: Not more than 25% variation upon application of full load with recovery to steady sate conditions within 3 seconds.

L. Steady-State Frequency Regulation: Plus or minus 1/2%.

M. 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.

N. Transient Frequency Regulation: Not more than 2% variation upon application of full load.

O. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

P. Sustained Short Circuit Current: Capable of supplying a minimum of 300% of rated full load current for a minimum 10 seconds for a three-phase bolted short circuit with automatic clearing of the fault without damage to winding insulation or other generator system components.

Q. Start Time: Capable of reaching operating voltage and frequency within the shortest time practicable and within eight (8) seconds.

2.05 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:
   1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
   2. Generator Set Control Functions:
      a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
      b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
      c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
      d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
      e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
      f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
      g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
   3. Generator Set Status Indications:
      a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
      b. Current (Amps): For each phase.
      c. Frequency (Hz).
      d. Real power (W/kW).
      e. Reactive power (VAR/kVAR).
      f. Apparent power (VA/kVA).
      g. Power factor.
      h. Duty Level: Actual load as percentage of rated power.
      i. Engine speed (RPM).
      j. Battery voltage (Volts DC).
      k. Engine oil pressure.
      l. Engine coolant temperature.
      m. Engine run time.
      n. Generator powering load (position signal from transfer switch).
   4. Generator Set Protection and Warning/Shutdown Indications:
      a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
         1) Overcrank (shutdown).
         2) Low coolant temperature (warning).
         3) High coolant temperature (warning).
         4) High coolant temperature (shutdown).
         5) Low oil pressure (shutdown).
         6) Overspeed (shutdown).
         7) Low fuel level (warning).
         8) Low coolant level (warning/shutdown).
         9) Generator control not in automatic mode (warning).
         10) High battery voltage (warning).
         11) Low cranking voltage (warning).

12) Low battery voltage (warning).
13) Battery charger failure (warning).
14) Indicating lamp for ground fault sensed on system (only if generator circuit breaker is 1000 A or larger)

b. In addition to NFPA 110 requirements, provide the following protections/indications:
1) High AC voltage (shutdown).
2) Low AC voltage (shutdown).
3) High frequency (shutdown).
4) Low frequency (shutdown).
5) Overcurrent (shutdown).
6) Fuel tank leak (warning), where applicable.

c. Provide contacts for local and remote common alarm.
d. Provide lamp test function that illuminates all indicator lamps.

5. Other Control Panel Features:
a. Event log.
b. Silence switch.

C. Remote Annunciator:
1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted or surface-mounted annunciator as indicated.
2. Include control wiring between the remote annunciator panel and the engine generator. Wiring shall be as required by the manufacturer.
3. Generator Set Status Indications:
a. Generator powering load (via position signal from transfer switch).
b. Communication functional.
4. Generator Set Warning/Shutdown Indications:
a. Comply with NFPA 110 for Level 1 systems including but not limited to the following indications:
1) Overcrank (shutdown).
2) Low coolant temperature (warning).
3) High coolant temperature (warning).
4) High coolant temperature (shutdown).
5) Low oil pressure (shutdown).
6) Overspeed (shutdown).
7) Low fuel level (warning).
8) Low coolant level (warning/shutdown).
9) Generator control not in automatic mode (warning).
10) High battery voltage (warning).
11) Low cranking voltage (warning).
12) Low battery voltage (warning).
13) Battery charger failure (warning).
b. Provide audible alarm with silence function.
c. Provide lamp test function that illuminates all indicator lamps.
d. Indicating lamp for ground fault sensed on system (only if generator circuit breaker is 1000 A or larger)

D. Remote Emergency Stop: Provide (2) approved red, mushroom style remote emergency stop button with a breakable glass enclosure.

2.06 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.

3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 125 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

C. 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 SET ENCLOSURE

A. Enclosure Type: Level 1, Sound attenuating, weather protective.

B. Enclosure Material: Aluminum.

C. Hardware Material: Stainless steel.

D. Color: Manufacturer's standard.

E. Access Doors: Lockable, with all locks keyed alike.

F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

H. Enclosure shall be suitable for winds up to 150 miles per hour roof load shall be equal to or greater than 40 pounds per square foot Non-distributed loading as required.

I. Enclosure components shall meet the HVHZ Large Missile Impact requirements of Section 1626 of the Florida Building Code

J. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material. Maximum 85 dBA at 5 feet from any side, top and bottom to no more than 78 dBA when measured at 23 feet horizontally from any part of the enclosure unless otherwise noted on plans. Sound ratings shall be based on full load condition of engine generator in a single unit operation condition.

K. The enclosure shall be provided with a factory-installed and factory-wired panelboard 100 A, 120/240 V, single phase, 20A 120V receptacles for maintenance, and compact fluorescent vaporproof-type fixtures with guards and switches. Provide lighting fixtures for task illumination, battery-powered lighting units (minimum 2).

L. The panelboard shall serve the followings loads:
1. Water jacket heater
2. Battery heating pads
3. Duplex receptacle and maintenance lights
4. Battery charger

5. Strip heater in alternator enclosure
6. Return fuel pump

M. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

2.08 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
   1. Material: Standard neoprene.
   2. Durometer Rating: 30.
   3. Number of Layers: One.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.09 SOURCE QUALITY CONTROL

A. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

B. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive equipment.

E. Verify that conditions are satisfactory for installation prior to starting work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install products in accordance with manufacturer's instructions.

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Install packaged engine generator to provide access without removing connections or accessories for periodic maintenance.

F. All connections between the engine generator and exterior systems, such as fuel lines, electrical connections, and engine exhaust system and air exhaust shroud, shall be flexible.

G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

I. Provide grounding and bonding in accordance with Section 26 0526.
   1. Ground the engine generator frame and enclosure using an equipment grounding conductor sized in accordance with the NEC.
   2. Neutral connection: Solidly grounded system neutral. The location of the neutral connection shall be as shown on the drawings

J. Engage the services of a factory trained engineer for periodic jobsite visits during installation to ensure that the system is being installed in accordance with manufacturer's recommendations. Have factory engineer coordinate with the switchgear field engineer to ensure proper application of the load shedding and load adding program.

K. Identify system wiring and components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform a complete operational sequence test as directed by the Engineer or as included in the commissioning documents. Coordinate this performance test with testing of automatic transfer switches.

B. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Notify Owner and Engineer at least two weeks prior to scheduled inspections and tests.

D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

F. Preliminary inspection and testing to include, at a minimum:
   1. Inspect each system component for damage and defects.
   2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
   3. Check for proper oil and coolant levels.

G. Prepare and start system in accordance with manufacturer's instructions.

H. Furnish a resistance-type load for the testing of the engine generator. Test loads shall always include adequate resistance to assure stability of the loads and equipment during all of the testing operations. The test load kW rating shall not be less than 100% of the specified kW rating of the engine generator.

I. Perform acceptance test in accordance with NFPA 110.

J. Inspection and testing to include, at a minimum:
   1. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to single-step 100% full-load pickup test.
   2. Verify compliance with starting and load acceptance requirements.
   3. Verify voltage and frequency; make required adjustments as necessary.
   4. Verify phase sequence.
   5. Verify control system operation, including safety shutdowns.
   6. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
   7. Starting System Test:

a. Demonstrate that the batteries and cranking motor are capable of five starting attempts of 15 seconds cranking each at 15-second intervals with the battery charger turned off.

8. 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.
9. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
10. Remote Annunciator Panel Tests:
    a. Simulate conditions to verify proper operation of each visual or audible indication, interconnecting hardware and software, and reset button.
11. 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.
12. 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.
13. Exhaust Emissions Test: Comply with applicable government test criteria.
14. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four designated locations, on the property line, and compare measured levels with required values.
15. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
16. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
17. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
18. Perform load tests using load bank at 100 percent full load for minimum of 2 hours and 25, 50,and 75 percent for a total of 2 hours in addition. Building load may be used if available and approved by Owner.
19. Demonstrate that the engine generator will attain proper voltage and frequency within the specified time limit from a cold start after the closing of a single contact.
20. Automatic Operation Tests:
    a. Test the engine generator and associated automatic transfer switches to demonstrate automatic starting, loading and unloading. The load for this test shall be the actual connected loads. Initiate loss of normal source and verify the specified sequence of operation. Restore the normal power source and verify the specified sequence of operation. Verify resetting of controls to normal.

K. Furnish certifications required by NFPA 110, paragraph 7.13.11.

L. Provide field emissions testing where necessary for certification.

M. Sound Level Tests: Measure sound levels for compliance with specified requirements. Identify and report ambient noise conditions.

N. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

O. Submit one set of detailed reports electronically and hard copy indicating inspection and testing results and corrective actions taken.
   1. Record the following test data at 30-minute intervals:
      a. Time of day, as well as reading of running time indicator.
      b. kW.
      c. Voltage on each phase.
      d. Amperes on each phase.
      e. Engine RPM.
      f. Frequency.
      g. Coolant water temperature.
      h. Fuel pressure.
      i. Oil pressure.
      j. Outdoor temperature.
      k. Average ambient temperature in the vicinity of the engine generator.

P. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

B. Provide field engineer for 1 days of owner training on the system operation. Schedule the training one month in advance with Owner. Prepare an agenda combining class time with hands on demonstrations and experience. Send the agenda to the Owner prior to training for review.

C. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Instructor: Manufacturer's authorized representative.
   3. Location: At project site.

D. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.06 PROTECTION

A. Protect installed engine generator system from subsequent construction operations.

3.07 MAINTENANCE

A. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include two hard copy and an electronic version of description of

preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

B. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 4 hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

C. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION

SECTION 26 3600
TRANSFER SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
   1. Automatic transfer switches.
   2. Includes service entrance rated transfer switches.
   3. Remote annunciators.

B. This Section includes transfer switches rated 600 V and less. Refer to drawings for quantity, rating and configuration of transfer switches. Configurations include the following:
   1. Automatic transfer switches.
   2. Open transition switches.

C. Provide transfer switches and generator as a complete functioning emergency power system through a single vendor.

1.02 RELATED SECTIONS

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

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0500 - Common Work Results for Electrical.

D. Section 26 0519 - Low Voltage Electrical Power conductors and Cables.

E. Section 26 0526 - Grounding and Bonding for Electrical Systems.

F. Section 26 0533 - Raceways and Conduit Systems.

G. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

H. Section 26 3213 - Engine Generators: Testing requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014.

C. UL 1008: Underwriters Laboratories Standard for Automatic Transfer Switches.

D. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; National Electrical Manufacturers Association; 2005.

E. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013. (ANSI/NETA ATS)

F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements

G. NFPA 110 - Standard for Emergency and Standby Power Systems; National Fire Protection Association; 2013.

H. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

I. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

J. NFPA 99: Essential Electrical Systems for Health Care Facilities

K. NFPA 101: Life Safety Code

L. IEEE 241: I.E.E.E. Recommended Practice for Electrical Power Systems in Commercial Buildings.

M. IEEE 446: I.E.E.E. Recommended Practice for Emergency and Standby Power Systems.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
      a. Engine Generators: See Section 26 3213.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

C. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.05 SUBMITTALS

A. Manufacturer's certification that products meet or exceed specified requirements.

B. Maintenance contracts.

C. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.

D. 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.

E. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources and load showing interlocking provisions for each combined transfer switch and bypass/isolation switch.

F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation Data: Instructions for operating equipment under emergency conditions when engine generator is running.

H. Maintenance Data: Routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.06 COORDINATION

1.07 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 2 system.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

D. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

E. Source Limitations: Obtain transfer switches, annunciators and other equipment defined in this section through one source from a single manufacturer.

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

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 DELIVERY, STORAGE AND HANDLING

A. Transfer switches shall be provided with adequate lifting means and shall be able to be rolled or moved into installation position and bolted directly to floor without using floor sills.

B. Deliver, store, protect, and handle products in accordance with recommended practices listed in manufacturer's installation and maintenance manuals.

C. Inspect and report concealed damage to carrier within specified time.

D. Handle transfer switches in accordance with manufacturer's written instructions to avoid damaging equipment, installed devices, and finish. Lift only by installed lifting provisions.

1.11 PROJECT CONDITIONS (SITE ENVIRONMENTAL CONDITIONS)

A. Follow applicable NEMA, ANSI, and NECA standard practices before, during, and after installation.

B. Transfer switches shall be located in well-ventilated areas, free from excess humidity, dust, and dirt and away from hazardous materials. Ambient temperature of area will be between minus 30 and plus 40 degrees C. Indoor locations shall be protected to prevent moisture from entering enclosure.

C. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
   1. Notify Construction Manager and Owner no fewer than five days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's or Owner's written permission.

1.12 WARRANTY

A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of delivery, whichever occurs first.

1.13 EXTRA MATERIALS

A. Provide spare parts as recommended by manufacturer and as indicated on the drawings.

B. Provide a complete set of spare fuses of all sizes and ratings used in the switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
   1. ASCO Power Technologies, LP: www.asco.com.
   2. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
   3. Russelectric: www.russelectric.com.
   4. Caterpillar; Engine Division.
   5. GE Zenith Controls.
   6. Kohler Power Systems. Generator Division.
   7. Onan/Cummins Power Generation; Industrial Business Group.
   8. Generac Power Systems, Inc.
   9. Spectrum Detroit Diesel.

B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

C. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:
   1. Utilize open transition transfer unless otherwise indicated or required.

D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.

E. Automatic Transfer Switch:
   1. Basis of Design: ASCO 4000.
   2. Transfer Switch Type: Service entrance rated bypass/isolation automatic transfer switch.
   3. Transition Configuration: Open-transition (no neutral position).
   4. Voltage: As indicated on the drawings.
   5. Ampere Rating: 1000.
   6. Neutral Configuration: Solid neutral (unswitched), except as indicated.
   7. Load Served: As indicated on the drawings.
   8. Primary Source: Utility.
   9. Alternate Source: Engine generator.

F. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

G. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

H. Switching Methods:

1. Open Transition:
   a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
2. Obtain control power for transfer operation from line side of source to which the load is to be transferred.

I. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

J. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Outdoor Locations: Type 3R or Type 4.
2. Provide lockable door(s) for outdoor locations.
3. Finish: Manufacturer's standard unless otherwise indicated.

K. Short Circuit Current Rating:
1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as indicated on the drawings.

L. Automatic Transfer Switches:
1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
2. Control Functions:
   a. Automatic mode.
   b. Test Mode: Simulates failure of primary/normal source.
   c. Voltage and Frequency Sensing:
      1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
      2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
      3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
   d. Outputs:
      1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
      2) Auxiliary contacts; one set(s) for each switch position.
      3) Signal before transfer (load disconnect) contacts; for selective load disconnection prior to transfer.
   e. Adjustable Time Delays:
      1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
      2) Transfer to alternate/emergency source time delay.
      3) Retransfer to primary/normal source time delay.
      4) Signal before transfer (load disconnect) contact time delay.
      5) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.
   f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.
   g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.

3. Status Indications:
   a. Connected to alternate/emergency source.
   b. Connected to primary/normal source.
   c. Alternate/emergency source available.
4. Automatic Sequence of Operations:
   a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
   b. Where applicable, initiate signal before transfer (load disconnect) contacts at programmable time before transfer.
   c. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
   d. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
   e. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

M. Service Entrance Rated Transfer Switches:
1. Furnished with integral disconnecting and overcurrent protective device on the primary/normal source and with ground-fault protection where indicated.
2. Listed and labeled as suitable for use as service equipment according to UL 869A.

N. Remote Annunciators:
1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Transfer Switch Status Indications:
   a. Connected to alternate/emergency source.
   b. Connected to primary/normal source.
   c. Alternate/emergency source available.
   d. Primary/normal source available.

O. Interface with Other Work:
1. Interface with engine generators as specified in Section 26 3213.

2.03 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Switch Ratings: Refer to drawings for transfer switch types, voltage rating and current rating.

B. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, 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.
1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

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 non-fused, momentarily energized solenoid, electric-motor-operated mechanism, or electrically operated circuit breakers, mechanically and electrically interlocked in both directions.

1. Normal and emergency main contacts shall be mechanically locked in position by the operating linkage upon completion of transfer. Release of the locking mechanism shall be possible only by normal operating action.
2. Contact transfer time shall not exceed six cycles.
3. Operating mechanism components and mechanical interlocks shall be insulated or grounded.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Switch Action: Double action; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225A and higher, shall have separate arcing contacts.

H. Indicating Lights: All indicating lights on front of transfer switch to be LED type.

I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

J. Enclosures: General-purpose NEMA 1 complying with NEMA ICS 6, UL 508,or in a switchboard assembly in accordance with UL 891 unless otherwise indicated.
1. Enclosure shall be constructed so that personnel are protected from energized bypass-isolation components during automatic transfer switch maintenance.
2. Automatic transfer switch components shall be removable without disconnecting external source or load power conductors.
3. Finish: Cabinets shall be given a phosphate treatment, painted with rust-inhibiting primer, and finish-painted with the manufacturer's standard enamel or lacquer finish.

K. Sensing:
1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100% of nominal, and dropout voltage is adjustable from 75 to 98% of pickup value. Factory set for pickup at 90% and dropout at 85%.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to the engine-generator. Pickup voltage shall be adjustable from 85 to 100% of nominal. Factory set for pickup at 90%. Pickup frequency shall be adjustable from 90 to 100% of nominal. Factory set for pickup at 95%.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Indication: Indicate source to which load is connected.
7. Source-Available Indication: Supervise sources via transfer switch normal- and emergency-source sensing circuits.
8. Normal Power Indication: Indicate "Normal Source Available."
9. Emergency Power Indication: Indicate "Emergency Source Available."
10. Transfer Override Control: Overrides automatic retransfer control so that automatic transfer switch shall remain connected to emergency power source regardless of condition of normal source. Control panel shall indicate override status.
11. Engine Starting Contacts: One isolated and normally closed and one isolated and normally open; rated 5 A at 30 V DC minimum.

12. Engine Shutdown Contacts: Time delay adjustable from zero to 15 minutes, and factory set for 5 minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Programmable exerciser starts engine-generator(s) and transfers load to them from normal source for a preset time, then retransfer and shuts down engine-generator(s) 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 shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period.

2.04 MICROPROCESSOR CONTROLLER

A. Furnish a built-in microprocessor to provide sensing and logic for control of the switch with the ability to communicate serially through a serial communication module or Ethernet connectivity module.

B. Provide controller with 12 selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Provide true RMS voltage sensing, accurate to +1% of nominal voltage and frequency sensing accurate to + 0.2%. Provide controller capable of operating over a temperature range of -20 to +60 degrees C. and storage from -55 to +85 degrees C.

C. Store default setup information and calibration data on nonvolatile EPROM.

D. Controller Display and Keypad: Provide a four-line, 20 character LCD display and 5 x 5, tactile keypad as an integral part of the controller for viewing all available data and setting desired operational parameters.

2.05 METERING

A. Provide a three phase digital ammeter with current transformers and shorting blocks. Sense current on the LOAD conductors.

B. Provide a three phase, digital voltmeter.

2.06 SEQUENCE OF OPERATION

A. The specified voltage decrease in one or more phases of the normal power source shall initiate the transfer sequence. The automatic transfer switch shall start the engine-generator(s) after a specified time delay to permit override of momentary dips in the normal power source.

B. The automatic transfer switch shall transfer the load from normal to emergency source when the frequency and voltage of the engine-generator(s) have attained the specified percent of rated value.

C. Engine Start: A voltage decrease, at any automatic transfer switch, in one or more phases of the normal power source to less than the specified value of normal shall start the engine-generator(s) after a specified time delay.

D. Transfer to Emergency System Loads: Automatic transfer switches for Emergency System loads shall transfer their loads from normal to emergency source when frequency and voltage of the engine-generator(s) have attained the specified percent of rated value. Only those switches with deficient normal source voltage shall transfer.

E. Transfer to Equipment Branch Loads: Automatic transfer switches for Equipment Branch loads shall transfer their loads to the engine-generator on a time-delayed, staggered basis, after the Emergency System switches have transferred. Only those switches with deficient normal source voltage shall transfer.

F. Retransfer to Normal (All Loads): Automatic transfer switches shall retransfer the load from emergency to normal source upon restoration of normal supply in all phases to the specified percent or more of normal voltage, and after a specified time delay. Should the emergency source fail during this time, the automatic transfer switches shall immediately transfer to the

normal source whenever it becomes available. After restoring to normal source, the engine-generator(s) shall continue to run unloaded for a specified interval before shut-down.

2.07 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.

2.08 SERVICE CONDITIONS

A. Service Conditions: NEMA ICS 10.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive transfer switches.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide housekeeping pads under the provisions of Section 03 3000.

3.03 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install transfer switches in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required support and attachment in accordance with Section 26 0529.

E. Install transfer switches plumb and level.

F. Provide grounding and bonding in accordance with Section 26 0526.

G. Identify transfer switches and associated system wiring in accordance with Section 26 0553.

H. Mount automatic transfer switches on concrete slab. Unless otherwise indicated, the slab shall be at least 4 inches thick. The top of the concrete slab shall be approximately 4 inches above finished floor. Edges above floor shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turn-ups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface.

I. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

J. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

K. Furnish and install all necessary interconnecting control and monitoring wiring between switches, generators, annunciators and elevator controllers as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

A. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

B. Prepare and start system in accordance with manufacturer's instructions.

C. Automatic Transfer Switches:
   1. Inspect and test in accordance with NETA ATS, except Section 4.
   2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The control wiring insulation-resistance tests listed as optional are not required.

D. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 26 3213.

E. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

F. Provide the services of the manufacturer's technical representative to check out transfer switch connections and operation and place in service.

G. Inspect and test in accordance with NETA STD ATS, except Section 4.

H. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. After installing equipment and after 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.
   3. 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.
   4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
      a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
      b. Simulate loss of phase-to-ground voltage for each phase of normal source.
      c. Verify time-delay settings.
      d. Verify pickup and dropout voltages by data readout or inspection of control settings.
      e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
      f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

I. Coordinate tests with tests of generator and run them concurrently.

J. 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.

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

3.05 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

C. Demonstrate operation of transfer switch in bypass, normal, and emergency modes.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3.07 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

3.08 MAINTENANCE

A. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

B. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 4 hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

C. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

D. Provide a separate maintenance contract for specified maintenance service.

E. Provide service and maintenance of transfer switches for one year from Date of Substantial Completion.

END OF SECTION

SECTION 26 4113
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Strike (air) terminals and interconnecting conductors.

B. Grounding and bonding for lightning protection.

C. Provide labor, materials and equipment required for completion of a functional system of air terminals, conductors, grounds, and other components necessary for protection against damage by lightning.

1.02 REFERENCE STANDARDS

A. LPI-175 Lightning Protection Institute

B. NFPA 70: National Electrical Code (2008)

C. NFPA 780 - Standard for the Installation of Lightning Protection Systems; National Fire Protection Association; 2014.

D. UL 96 - Lightning Protection Components; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.03 QUALITY ASSURANCE

A. Maintain one copy of each referenced system design standard on site.

B. Manufacturer Qualifications: Company specializing in lightning protection equipment with minimum three years documented experience.

C. Designer Qualifications: Person or entity, employed by installer, who specializes in lightning protection system design with minimum three years documented experience.

D. System Certificate:
   1. UL Master Label.
   2. LPI System Certificate.
   3. UL Master Label Recertification.

E. Installer Qualifications: Capable of providing the specified certification of the installed system.

F. Installer Qualifications: Company specializing in lightning protection system design with minimum three years documented experience.

G. Field Quality Control Testing Agency Qualifications: Firm capable of and experienced in grounding and bonding testing with documented experience and minimum of three project references.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Lightning Protection Component. Subject to compliance with requirements, provide products by one of the following manufacturers, but are not limited to, the following:
   1. Advanced Lightning Technology (ALT): www.altfab.com.
   2. Erico International Corporation
   3. Harger Lightning and Grounding; _____: www.harger.com.
   4. Heary Brothers Lightning Protection, Inc
   5. National Lightning Protection Corporation; _____: www.theprotectionsource.com.
   6. Robbins Lightning, Inc; _____: www.robbinslightning.com.
   7. Thompson Lightning Protection, Inc.

2.02 LIGHTNING PROTECTION SYSTEM

A. Lightning Protection System: Provide complete system complying with NFPA 780, including air terminals, bonding, interconnecting conductors and grounding electrodes.

1. Provide system that protects:
   a. The electrical generator enclosure.
2. Coordinate with other grounding and bonding systems specified.
3. Provide copper, bronze, or stainless steel components, except where aluminum is allowed by NFPA 780.
4. Provide system certified by Underwriters Laboratories or the Lightning Protection Institute.

B. Strike Terminals: Provide strike (air) terminals on the following:
   1. Generator enclosure.

2.03 MATERIALS

A. All materials used in the installation shall be new and shall comply in weight, size and composition as required by UL 96A and NFPA 780 and shall be labeled or listed by Underwriters Laboratories Inc. for use in lightning protection systems. The system furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection equipment. The manufacturer shall be listed by UL as a recognized manufacturer of lightning protection components.

B. Class I materials shall be used on structures that do not exceed 75 feet in height and Class II materials shall be used on structures that are 75 feet or higher above average grade.

C. Copper materials shall not be mounted on aluminum surfaces including Galvalume, galvanized steel and zinc; this includes these materials that have been painted.

D. Aluminum materials shall not come into contact with earth or where rapid deterioration is possible. Aluminum materials shall not come into contact with copper surfaces.

2.04 COMPONENTS

A. All Components: Complying with applicable requirements of UL 96.

B. Strike (Air) Terminals: Aluminum, solid, with adhesive bases for single-ply roof installations.
   1. Air terminals shall project a minimum of ten inches above the object or area it is to protect and shall be located at intervals not exceeding 20'-0" along ridges and along the perimeter of flat roofs.
   2. Air terminals shall be installed on stacks, flues, mechanical units and other metallic objects not located within a zone of protection and which have an exposed metal thickness less than 3/16 of an inch. Objects having an exposed metal thickness 3/16 of an inch or greater shall be connected to the lightning protection system as required by the specified standards using main size conductor and bonding plates having a minimum of 3 square inches of surface contact area.
   3. Air terminal bases shall be securely fastened to the structure in accordance with the specified standards including the use of adhesive that is compatible with the surface it is to be used on or stainless steel fasteners.

C. Grounding Rods: Solid copper.
   1. Ground electrodes shall be copper and a minimum 3/4" diameter and 10 feet long. A ground electrode shall be provided for each down conductor. The down conductor shall be connected to the ground electrode using a bronze ground rod clamp having a minimum of 1-1/2" contact between the ground electrode and the conductor measured parallel to the axis of the ground electrode, or by an Ultraweld exothermically welded connection. Ground electrodes shall be located a minimum of 2 feet below grade and shall be installed below the frost line where possible (excluding shallow topsoil conditions).

D. Conductors: Copper cable.
   1. Main conductors shall be sized in accordance with the specified standards for Class I or Class II structures and shall provide a two way horizontal or downward path from each air terminal to connections with the ground system. Conductors shall be free of excessive splices and no bend of a conductor shall form a final included angle of less than neither 90 degrees nor have a radius of bend less than 8 inches.

2. Down conductors shall be sized in accordance with the specified standards and in no case shall be smaller than the main roof conductor. Down conductors shall be spaced at intervals averaging not more than 100 feet around the perimeter of the structure. In no case shall a structure have fewer than two down conductors. Where down conductors are installed exposed on the exterior of a structure and are subject to physical damage or displacement, guards shall be bonded at each end.

E. Connectors and Splicers: Bronze.
1. Bronze clamp-type connectors shall be used for roof conductor splices, and the connection of the roof conductor to air terminals and bonding plates. Crimp-type connectors are not allowed.

F. Equipotential Grounding:
1. This interconnection shall include but is not limited to the electrical service, telephone and antenna system grounds as well as all underground metallic piping systems including water, gas and sewer. Interconnection to a gas or water line shall be made on the customer's side of the meter. Connection to gas line must be approved by the gas utility.
2. Grounded metal bodies located within the required bonding distance as determined by the bonding distance formula in the latest edition of NFPA-780 Standard for the Installation of Lightning Protection Systems shall be bonded to the lightning protection system using the required bonding conductors and connections

G. Surge Protection:
1. Surge suppression shall be provided at all power service entrances and at entrances of conductive signal, data and communication services

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated on shop drawings.

B. Coordinate work with installation of roofing and exterior and interior finishes.

3.02 INSTALLATION

A. Install in accordance with referenced system standards and as required for specified certification.

B. Connect conductors using mechanical connectors or exothermic welding process; protect adjacent construction elements and finishes from damage.

C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends

D. Installation shall be coordinated with the roofing manufacturer and installer.

E. Install the conductors as inconspicuously as practical.

F. Make connections of dissimilar metal with bimetallic type fittings to prevent electrolytic action.

G. Bond down conductors to building structural steel.

H. Connect exterior metal surfaces, located within 3 feet of the conductors, to the conductors to prevent flashovers.

I. Maintain horizontal or downward coursing of main conductor and insure that all bends have at least an 8 inches radius and do not exceed 90 degrees.

J. Conductors shall be rigidly fastened every 3 feet along the roof and down to the building to ground.

K. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure.

L. Install air terminal bases, cable holders and other roof-system supporting means without piercing membrane or metal roofs.

3.03 FIELD QUALITY CONTROL

A. Perform visual inspection as specified in NFPA 780 as if this were a periodic follow-up inspection.

B. Perform continuity testing as specified in NFPA 780 as if this were testing for periodic maintenance.

C. Test the ground resistance to earth by standard methods, and conform to the ground resistance requirements specified in Section 26 0526, Grounding and Bonding for Electrical Systems.

D. UL Inspection: Meet requirements to obtain a UL Master Label for system.

E. Obtain the services of the specified certification agency to provide inspection and certification of the lightning protection system, including performance of any other testing required by that agency.

END OF SECTION

SECTION 26 4300
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the AC surge protection may be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers (MCC). Alternately, SPDs may be mounted external to the equipment using approved methods.

B. All SPDs must comply with UL 1149 Third Edition and service entrance SPDs must also comply with UL 96A.

C. Surge protective devices for service entrance locations.

D. Surge protective devices for distribution locations.

E. Surge protective devices for branch panelboard locations.

1.02 RELATED REQUIREMENTS

A. Section 26 0500 - Common Work Results for Electrical.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 2413 - Switchboards.

D. Section 27 1005 - Structured Cabling for Voice and Data - Inside-Plant: Protectors for communications service entrance.

1.03 ABBREVIATIONS AND ACRONYMS

A. I nominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

I. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.

J. SPD: Surge Protective Device.

1.04 REFERENCE STANDARDS

A. ANSI/IEEE C62.11 - Standard for Metal-Oxide Surge Arresters for AC Power Circuits.

B. ANSI/IEEE C62.33 - Standard Test Specifications for Varistor Surge Protection Devices

C. ANSI/IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Systems

D. ANSI/IEEE C62.45 - IEEE Standard Guide on Surge Testing for Equipment Connected to Low -Voltage AC Power Circuits

E. MIL-STD-220 - Method of Insertion Loss Measurement; Revision C, 2009.

F. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

G. NEMA Standard LS-1 - Low-Voltage Surge Protective Devices.

H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014.

I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

J. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 96A - Standard for Installation Requirements for Lightning Protection Systems.

L. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.

M. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

1.06 SUBMITTALS

A. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
   1. SPDs with EMI/RFI filter: Include noise attenuation performance.

B. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

C. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
   1. UL 96A listing file information for all service entrance SPDs
   2. UL 1449.
   3. UL 1283 (for Type 2 SPDs).

D. Provide verification that the SPD complies with the required ANSI/UL 1449
   1. Third Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR) and Nominal Discharge Current (In).

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

I. Project Record Documents: Record actual connections and locations of surge protective devices.

1.07 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with the above requirement.

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. Manufacturer's Warranty: Provide minimum five year warranty from date of Substantial Completion covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

B. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: PowerLogics.

B. Field-installed, Externally Mounted Surge Protective Devices:
1. Advanced Protection Technologies, Inc (APT); _____: www.aptsurge.com.
2. PowerLogics, Inc.
3. Current Technology; a brand of Thomas & Betts Power Solutions: www.tnbpowersolutions.com.
4. General Electric Company: www.geindustrial.com.
5. Schneider Electric; Square D Brand Surgelogic Products; _____: www.surgelogic.com.
6. Eaton Cutler-Hammer
7. Surge Suppression, Inc.
8. Siemens Industry, Inc

C. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

D. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) or other approved methods as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize any components that may crowbar the system voltage leading to system upset or create any environmental hazards

C. SPDs with the following features and accessories:
   1. Integral disconnect switch.
   2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
   3. Indicator light display for protection status.
   4. Form-C contacts rated at 5 A and 250-V ac one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
   5. Surge counter.

D. Protected Modes:
   1. High Leg Delta Systems: L-N, L-G, N-G, L-L.

E. UL 1449 Voltage Protection Ratings (VPRs):
   1. 208Y/120V System Voltage: Not more than 700 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
   2. 480Y/277V System Voltage: Not more than 1,200 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

H. Nominal Discharge Current (In) - All SPDs applied to the distribution system shall have a 20 kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20kA shall be rejected.

I. SCCR: Equal or exceed 100 kA.

J. Safety Requirements
   1. The SPD shall minimize potential arc flash hazards by containing no user serviceable/replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

K. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   1. Indoor clean, dry locations: Type 1.

L. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
   1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
   2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.

M. System Application:
   1. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies.

All SPDs shall be tested and demonstrate suitability for application within ANSI/EEE C62.41 Category C, B, and A environments.

a. Category C shall be used for the following:
   1) Service entrance, switchgear, switchboards, and motor control centers (MCC)
b. Category B shall be used for the following:
   1) Distribution panelboards, emergency system panelboards, and medical equipment panelboards

2. Surge Current Capacity - The minimum surge current capacity the device is capable of withstanding shall be:
   a. Category C: 250 kA per phase and 125 kA per mode
   b. Category B: 160 kA per phase and 80 kA per mode
3. SPD Type - All SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Unless otherwise indicated, provide field-installed, externally mounted SPDs.

B. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.

C. An external mounted SPD shall have a properly sized circuit breaker mounted as in paragraph 2.03(B) and be connected using a low impedance, flexible, multi-conductor cable supplied by the SPD manufacturer and designed for use with SPDs. The length shall be as short as possible and shall not exceed 36 inches without approval from the Engineer.

D. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

E. Provide SPDs utilizing only field-replaceable modular protection circuits.

F. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.

G. Repetitive Surge Current Capacity: Not less than 5,000 impulses.

H. UL 1449 Nominal Discharge Current (I-n): 20 kA.

I. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

J. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
   1. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.

K. All monitoring and diagnostic features shall be visible from the front of the equipment.

L. Diagnostics:
   1. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
   2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
   3. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
   4. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

M. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.04 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Unless otherwise indicated, provide field-installed, externally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 or Type 2.

C. Distribution locations include SPDs connected to distribution panelboards.

D. The SPD shall not limit the use of through-feed lugs, sub-feed breaker options.

E. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.

F. The panelboard shall be capable of re-energizing upon removal of the SPD.

G. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a properly sized circuit breaker for disconnecting purposes and overcurrent protection may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the circuit breaker.

H. An external mounted SPD shall have a properly sized circuit breaker mounted as in paragraph 2.04(E) and be connected using a low impedance, flexible, multi-conductor cable supplied by the SPD manufacturer and designed for use with SPDs.

I. Sidemount Mounting Applications Installation (SPD mounted external to electrical assembly)
   1. The length shall be as short as possible and shall not exceed 36 inches, linear length or 72" circuit length, without approval from the Engineer. Minimum size shall be #10 AWG. Lengths longer than 36" shall be sized to provide the equivalent impedance of #10 AWG at 36".
   2. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturers recommendation installation and wiring practices.

J. Provide SPDs utilizing only field-replaceable modular protection circuits.

K. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.

L. Repetitive Surge Current Capacity: Not less than 3,500 impulses.

M. UL 1449 Nominal Discharge Current (I-n): 20 kA.

N. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

O. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
   1. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.

P. Diagnostics:
   1. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
   2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
   3. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
   4. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

Q. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of the drawings and manufacturer's instructions.

D. Verify system grounding and bonding is in accordance with Section 26 0526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install SPD in accordance with manufacturer's instructions.

C. Use crimped connectors and splices only. Wire nuts are unacceptable.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.

F. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

G. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.

H. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 0526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

I. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.03 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 01 4000. Prepare test and inspection reports.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Section 7.19.1.

D. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

E. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
   1. Compare equipment nameplate data for compliance with Drawings and Specifications.
   2. Inspect anchorage, alignment, grounding, and clearances.
   3. Verify that disconnecting means and feeder size and maximum length to SPD corresponds to approved shop drawings.

4. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
5. Vacuum-clean enclosure interior. Clean enclosure exterior.
6. Verify the correct operation of all sensing devices, alarms, and indicating devices.

F. An SPD will be considered defective if it does not pass tests and inspections.

G. After completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the SPD are in good operating condition and properly performing the intended function.

3.04 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION