

**SECTION 26 3213**  
**ENGINE GENERATORS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Packaged engine generator system and associated components and accessories:
  - 1. Engine and engine accessory equipment.
  - 2. Alternator (generator).
  - 3. Generator set control system.
  - 4. Generator set enclosure.

**1.02 RELATED REQUIREMENTS**

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 23 1113 - Facility Fuel-Oil Piping:
  - 1. Diesel fuel piping.
  - 2. Remote main diesel fuel tank (bulk tank).
  - 3. Installation of diesel fuel system day tank specified in this section.
- C. Section 23 1123 - Facility Natural-Gas Piping.
- D. Section 23 5100 - Breechings, Chimneys, and Stacks: Engine exhaust piping.
  - 1. Includes installation of exhaust silencer specified in this section.
- E. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- F. Section 26 0529 - Hangers and Supports for Electrical Systems.
- G. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- H. Section 26 3600 - Transfer Switches.

**1.03 REFERENCE STANDARDS**

- A. ASTM D975 - Standard Specification for Diesel Fuel Oils; 2015b.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.
- D. NEMA MG 1 - Motors and Generators; 2014.
- E. NFPA 30 - Flammable and Combustible Liquids Code; 2015.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. NFPA 99 - Health Care Facilities Code; 2015.
- H. NFPA 110 - Standard for Emergency and Standby Power Systems; 2013.
- I. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.
- J. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.
- K. 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.
    - b. Paralleling Switchgear: See Section \_\_\_\_\_.
    - c. Coordinate with M.C. and Trane Corp for building BAS Modbus connection. \_\_\_\_\_.

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

#### **1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. 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 upon request.
  3. Include alternator thermal damage curve upon request.
- 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. Derating Calculations: Indicate ratings adjusted for applicable service conditions.
- E. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.
- F. Specimen Warranty: Submit sample of manufacturer's warranty.
- G. 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.
- H. Manufacturer's factory emissions certification.
- I. Manufacturer's certification that products meet or exceed specified requirements.
- J. Source quality control test reports.
- K. 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.
- L. Manufacturer's detailed field testing procedures.
- M. Field quality control test reports.
- N. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- O. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- P. Maintenance contracts.
- Q. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.
- R. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  1. See Section 01 6000 - Product Requirements, for additional provisions.
  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 99 (Health Care Facilities Code).
  - 4. NFPA 30 (Flammable and Combustible Liquids Code).
- 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. 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.
- E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- F. 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. 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 generator set components, enclosure, and finish.

## **1.08 FIELD CONDITIONS**

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

## **1.09 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Packaged Engine Generator Set - Basis of Design: Caterpillar.
- B. Packaged Engine Generator Set - Other Acceptable Manufacturers:
  - 1. Caterpillar Inc; Base Bid: [www.cat.com/#sle](http://www.cat.com/#sle).
- C. Substitutions: See Section 01 6000 - Product Requirements.
- D. 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, Construction Manager accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

### **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. Configuration: Single packaged engine generator set operated independently (not in parallel).
- D. Packaged Engine Generator Set:
  - 1. Type: Diesel (compression ignition).
  - 2. Basis of Design: \_\_\_\_\_.
  - 3. Voltage: As indicated on drawings.
  - 4. Main Line Circuit Breaker:
    - a. Type: Thermal magnetic.
    - b. Trip Rating: Select according to generator set rating.
- 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.
- 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. 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 86 dBA when measured at 7 meters 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.
- J. Interface with building automation system Trane Ensemble/ (BACnet) EC to coordinate and include wire pull and Trane connection fees.

### **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. Engine Fuel System - Diesel (Compression Ignition):

1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
  2. Fuel for 72 hours continuous operation at 100 percent
  3. rated power output.
  4. Fuel Storage: \_\_\_\_\_.
  5. 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.
  6. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
  7. Fuel System must comply with NFPA and MDEQ requirements.
  8. Main Fuel Tank (Bulk Tank): Comply with Section 23 1113.
  9. Day Tank:
    - a. Provide separately mounted double-wall day tank with secondary containment, with fuel transfer pump(s), valves, and automatic controls suitable for operation in the configuration to be installed; listed and labeled as complying with UL 142.
    - b. Alarm Indications/Shutdowns:
      - 1) Low fuel level alarm; provides local indication and activates remote output contact.
      - 2) Critical low fuel level alarm; provides local indication and activates remote output contact; can be configured to shut down engine to prevent loss of fuel prime.
      - 3) High fuel level; provides local indication and activates remote output contact.
      - 4) Critical high fuel level alarm; provides local indication and activates remote output contact; shuts down fuel transfer supply pump.
      - 5) Secondary containment leak detection alarm; provides local indication and activates remote output contact; shuts down fuel transfer supply pump.
    - c. Features:
      - 1) Direct reading fuel level gauge.
      - 2) Normal atmospheric vent.
      - 3) Emergency pressure relief vent.
  10. 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 72 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.
- C. Engine Fuel System - Gaseous (Spark Ignition):
1. Fuel Source: Natural gas.
  2. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
  3. Provide components/features indicated and as necessary for operation and/or required by applicable codes, including but not limited to:
    - a. Carburetor.
    - b. Gas pressure regulators.
    - c. Fuel shutoff control valves.

- d. Low gas pressure switches.
- D. Engine Starting System:
  - 1. System Type: Electric, with DC solenoid-activated starting motor(s).
  - 2. 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. 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. Include battery pad heater for outdoor units.
  - 3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
  - 4. 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. Recognized as complying with UL 1236.
    - d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
    - e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
    - f. Provide alarm output contacts as necessary for alarm indications.
  - 5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.
- E. 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.
- F. 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. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.
- G. 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.
- H. Engine Air Intake and Exhaust System:
  - 1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
  - 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.

#### **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. 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.
- C. Temperature Rise: Comply with UL 2200.
- D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.
- E. Enclosure: NEMA MG 1, drip-proof.
- F. Total Harmonic Distortion: Not greater than five percent.
- G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

#### **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. Coordinate with M.C. and Trane Corp for building BAS Modbus connection to Gen controls panel.
- 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 (warning).
      - 6) Low oil pressure (shutdown).
      - 7) Overspeed (shutdown).
      - 8) Low fuel level (warning).
      - 9) Low coolant level (warning/shutdown).
      - 10) Generator control not in automatic mode (warning).
      - 11) High battery voltage (warning).
      - 12) Low cranking voltage (warning).
      - 13) Low battery voltage (warning).
      - 14) Battery charger failure (warning).
    - 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. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
    - c. Remote monitoring capability via PC.
- C. Remote Annunciator:
- 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. Generator Set Status Indications:
    - a. Generator powering load (via position signal from transfer switch).
    - b. Communication functional.
  - 3. 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 (warning).
      - 6) Low oil pressure (shutdown).
      - 7) Overspeed (shutdown).
      - 8) Low fuel level (warning).
      - 9) Low coolant level (warning/shutdown).
      - 10) Generator control not in automatic mode (warning).
      - 11) High battery voltage (warning).
      - 12) Low cranking voltage (warning).



- 13) Low battery voltage (warning).
  - 14) Battery charger failure (warning).
  - b. Provide audible alarm with silence function.
  - c. Provide lamp test function that illuminates all indicator lamps.
- D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

## **2.06 GENERATOR SET ENCLOSURE**

- A. Enclosure Type: 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. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.
- I. 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.
- J. Enclosure Space Heater: Provide thermostatically controlled enclosure space heater to prevent condensation and improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature. Provide motorized damper (cold weather kit)

## **2.07 SOURCE QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.
- C. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that field measurements are as indicated.
- 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.

### **3.02 INSTALLATION**

- A. Perform work in accordance with NECA 1 (general workmanship).
- 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. Unless otherwise indicated, mount generator set on properly sized, minimum 6 inch high concrete pad constructed in accordance with Section 03 3000.
- F. Provide required support and attachment in accordance with Section 26 0529.

- G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
- H. Provide diesel fuel piping and venting in accordance with Section 23 1113, where not factory installed.
- I. Install day tank in accordance with Section 23 1113.
- J. Provide natural gas piping in accordance with Section 23 1123.
- K. Provide engine exhaust piping in accordance with Section 23 5100, where not factory installed.
  - 1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
  - 2. Do not exceed manufacturer's maximum back pressure requirements.
- L. Install exhaust silencer in accordance with Section 23 5100, where not factory installed.
- M. Provide grounding and bonding in accordance with Section 26 0526.
- N. Identify system wiring and components in accordance with Section 26 0553.

### **3.03 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- 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 Architect 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. Perform acceptance test in accordance with NFPA 110.
- I. Inspection and testing to include, at a minimum:
  - 1. Verify compliance with starting and load acceptance requirements.
  - 2. Verify voltage and frequency; make required adjustments as necessary.
  - 3. Verify phase sequence.
  - 4. Verify control system operation, including safety shutdowns.
  - 5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
  - 6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test).
- J. Provide field emissions testing where necessary for certification.
- K. Sound Level Tests: Measure sound levels for compliance with specified requirements. Identify and report ambient noise conditions.
- L. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- M. Submit detailed reports indicating inspection and testing results and corrective actions taken.

### **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. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
- C. Provide 4 hour load bank testing.
- D. 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. Provide minimum of four hours of training.
  - 3. Instructor: Manufacturer's authorized representative.
  - 4. Location: At project site.
- E. 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. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. 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 3305**  
**BATTERY EMERGENCY POWER SUPPLY**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Emergency power supply.
- B. Remote trouble alarm indicator.

**1.02 REFERENCE STANDARDS**

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. NFPA 111 - Standard on Stored Electrical Energy Emergency and Standby Power Systems; 2013.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog and data sheets showing electrical characteristics and connection requirements. Include unit ratings, dimensions, and finishes. Include performance data for batteries.
- C. 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 starting of product.
- D. Maintenance Data: Include battery maintenance and unit testing procedures.

**1.04 QUALITY ASSURANCE**

- A. Perform Work in accordance with NFPA 70.
  - 1. Maintain one copy of each document on site.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Acuity Brands, Inc; \_\_\_\_\_: www.acuitybrands.com.
- B. Cooper Lighting, a division of Cooper Industries; \_\_\_\_\_: www.cooperindustries.com.
- C. Hubbell Lighting, Inc; \_\_\_\_\_: www.hubbellighting.com.
- D. Substitutions: See Section 01 6000 - Product Requirements.

**2.02 EMERGENCY POWER SUPPLY**

- A. Description: NFPA 111 Type A, Class 1.5 stored emergency power supply system designed for Level 1 applications and consisting of rectifier/charger unit, storage battery, and solid state inverter with mechanical transfer switch, in one or several enclosures. Provide unit suitable for operating HID lamps without extinguishing lamp on transfer.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install units plumb and level.
- C. Provide interconnection between cabinets.

**3.02 CLOSEOUT ACTIVITIES**

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstrate normal operation of unit.

**END OF SECTION**

**SECTION 26 3353**  
**STATIC UNINTERRUPTIBLE POWER SUPPLY**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Charger/rectifier unit.
- B. Inverter unit.
- C. Batteries.

**1.02 REFERENCE STANDARDS**

- A. IEEE 519 - IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems; 2014.
- B. NEMA PE 1 - Uninterruptible Power Systems (UPS) - Specification and Performance Verification; 2012.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.03 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate electrical characteristics and connection requirements. Provide battery rack dimensions; battery type, size, dimensions, and weight; detailed equipment outlines, weight, and dimensions; location of conduit entry and exit; single-line diagram indicating metering, control, and external wiring requirements; heat rejection and air flow requirements.
- C. Product Data: Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.
- 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, installation, and starting of product. Include equipment installation outline, connection diagram for external cabling, internal wiring diagram, and written instruction for installation.
- E. Maintenance Data: Description of servicing procedures; list of major components; recommended remedial and preventive maintenance procedures; spare parts list.

**1.04 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Protect equipment from extreme temperature and humidity by storing in a conditioned space.
- B. Protect equipment from dust and debris by wrapping unit in dusttight cover and storing away from construction activity.
- C. Deliver batteries no sooner than 7 days before charging.

**1.06 FIELD CONDITIONS**

- A. Do not store or install unless temperature is maintained between 32 degrees F and 104 degrees F, at a relative humidity less than 95 percent (non-condensing).
- B. Maintain conditions during and after installation of products.

**1.07 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year warranty including coverage for batteries.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Uninterruptible Power Supply (UPS) System:
  - 1. Liebert Base Bid.
- B. Substitutions: See Section 01 6000 - Product Requirements.

### **2.02 UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEMS**

- A. System Configuration: Non-redundant type with reverse transfer. Designed for capacity expansion by addition of parallel modules in field with minimum downtime.
- B. Components:
  - 1. Battery.
  - 2. Rectifier/charger to maintain battery charge and to provide input to inverter when utility power is available.
  - 3. Inverter to provide power to load during normal operation.
  - 4. Static switch to transfer load automatically and without disturbance between inverter and utility power.
  - 5. Manual switch to bypass static switch for maintenance.
  - 6. Input and output isolation transformers and filters to provide appropriate isolation and disturbance attenuation.
  - 7. Monitors, sensors, and control circuits.
- C. Design Standards: IEEE 519 and NEMA PE 1.

### **2.03 SYSTEM RATINGS AND OPERATING CHARACTERISTICS**

- A. System Continuous Rating: As indicated on Drawings, over entire battery voltage range at specified power factor. Maintain output voltage within specified limits at any load from full load to no-load.

### **2.04 DESIGN**

- A. Inverter Type: Pulse-width modulated.

### **2.05 FABRICATION**

- A. Electroplate brackets and securing hardware with corrosion resistant material. Secure bolts, studs and nuts with lock washers.
- B. Equip air inlet with permanent type filters and pressurize cabinet, or use gaskets around door and panel openings to prevent entry of dirt.
- C. Cabinet finish: Primed and painted inside and outside with suitable semi-gloss enamel.

### **2.06 BATTERY**

- A. Storage Battery: Lead calcium heavy duty industrial battery, designed for auxiliary power service. Provide battery with impact resistant plastic case. Provide cells with explosion proof vents, clear containers, and ample space for plate growth without stressing container and cover.
- B. Battery Racks: Maximum of three-tier, all steel construction, with plastic insulating rails at all points of contact with the battery case. Paint racks with acid resistant paint.

### **2.07 CONTROLS AND INDICATORS**

- A. Controls:
  - 1. AC input circuit breaker.
  - 2. Inverter operate switch to initiate inverter operation.
  - 3. Static switch transfer switch to permit manual actuation of static transfer switch.
  - 4. Indicator test switch.
  - 5. Static switch preferred input circuit breaker
  - 6. Static switch output circuit breaker.
  - 7. Static switch bypass circuit breaker.
  - 8. Controls for maintenance bypass switch.

- B. Indicators:
  - 1. Inverter synchronized to utility.
  - 2. Load connected to utility.
  - 3. Static transfer switch inhibited.
  - 4. Overtemperature.
- C. Meters: Use 1 percent accuracy meters to indicate the following:
  - 1. Rectifier/charger DC voltage and current.
  - 2. Utility, inverter output, and load AC voltage.
  - 3. Load AC current.
  - 4. Inverter output and utility frequency.
  - 5. UPS output watts.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

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

#### **3.02 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide the services of the manufacturer's field technician to supervise adjustments, final connections, and system testing.
- C. Verify specification performance criteria.
- D. Measure battery discharge and recharge times.
- E. Simulate fault in each system component and utility power.
- F. Perform other tests as recommended by manufacturer.

#### **3.03 CLOSEOUT ACTIVITIES**

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. Demonstrate operation uninterruptible power supply by simulating an outage.
- C. Training: Provide one hour hours of instruction each for two persons.

#### **3.04 MAINTENANCE**

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of uninterruptible power supply for one year from Date of Substantial Completion.
- D. Include all costs, including labor, parts, and travel.

**END OF SECTION**





## SECTION 26 3513

### LOW-VOLTAGE POWER FACTOR CORRECTION CAPACITORS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Capacitors for low voltage (600 V or less) power factor correction applications:
  - 1. Fixed capacitors.
  - 2. Automatic capacitor systems.

##### 1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 2419 - Motor-Control Centers.
- F. Section 26 2813 - Fuses.

##### 1.03 REFERENCE STANDARDS

- A. IEEE 18 - Standard for Shunt Power Capacitors; 2012.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- G. UL 810 - Capacitors; 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 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 placement of supports, anchors, etc. required for mounting.
  - 4. Capacitors for Installation Within Motor Control Centers (MCCs): Coordinate work to provide capacitors suitable for installation in equipment to be provided.
  - 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

##### 1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for capacitor assemblies, including ratings, configurations, materials, fabrication details, dimensions, finishes, weights, and service condition requirements.
  - 1. Fixed Capacitors for Individual Motor Applications: Include motor manufacturer's capacitor sizing recommendations.
  - 2. Automatic Capacitor Systems: Include quantity and size of switched steps and information on control and monitoring functions.

- C. Shop Drawings: Include outline and support point dimensions, voltage, reactive power (kVAR), and current ratings, short circuit current ratings, and installed features and accessories.
  - 1. Include dimensioned plan and elevation views of capacitor assemblies and adjacent equipment with all required clearances indicated.
  - 2. Include wiring diagrams showing all factory and field connections.
  - 3. Fixed Capacitors for Individual Motor Applications: For each application, include wiring diagrams showing proposed capacitor connection method in relation to motor starter contacts and overload devices.
  - 4. Capacitors with Inductors/Reactors (Harmonic Filters): Include frequency tuning information.
- D. Motor Overload Protective Device Calculations: Where capacitors are to be connected on the load side of motor overload protective devices (when permitted), indicate overload device ratings adjusted for reduced current.
- E. 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.
- F. Manufacturer's detailed field testing procedures.
- G. Field Quality Control Test Reports.
- H. Project Record Documents: Record actual installed ratings and locations of capacitors, and final equipment settings.
- I. Operation and Maintenance Data: Include information on equipment programming and setup, replacement parts and 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. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience with power factor correction systems of similar size, type, and complexity.
- 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. 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 carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

#### **1.08 FIELD CONDITIONS**

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

#### **1.09 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Capacitor Assemblies: Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
- C. Capacitor Cells: Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Power Factor Correction Capacitors:
  - 1. Eaton Corporation; \_\_\_\_\_: www.eaton.com.
  - 2. General Electric Company: www.geindustrial.com.
  - 3. Myron Zucker, Inc: www.myronzucker.com.
  - 4. Schneider Electric; Square D Products: www.schneider-electric.us.
- B. Substitutions: See Section 01 6000 - Product Requirements.

### **2.02 POWER FACTOR CORRECTION CAPACITORS**

- A. Provide complete power factor correction capacitor 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. Total System Power Factor: Achieve corrected total system power factor of \_\_\_\_\_.
- D. Power Factor Correction Capacitors Required:
  - 1. Motors Larger Than \_\_\_\_\_ HP: Fixed Capacitors.
    - a. Voltage: As indicated on drawings.
    - b. Capacity: Size per motor manufacturer's recommendations.
  - 2. Variable Frequency Drives Larger Than \_\_\_\_\_ HP: Fixed capacitors with inductors/reactors (harmonic filters).
  - 3. Main Service Entrance Equipment: Automatic capacitor system.
  - 4. Motor Control Center: Automatic capacitor system.
- E. Capacitor Assemblies: Manufactured units consisting of capacitor cells, enclosures, and associated components specifically designed for three phase power factor correction applications. Comply with IEEE 18, and list and label as complying with UL 508A or UL 810 as applicable.
- F. Provide capacitors and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
- G. Capacitor Cells:
  - 1. Construction: Self-healing, metalized polypropylene film; dry (resin-encapsulated) or liquid-impregnated with non-PCB, non-toxic, biodegradable dielectric fluid; provide three phase cells (configurations utilizing factory-wired single phase capacitor cells are not acceptable).
  - 2. Losses: Not greater than 0.5 W per kVAR.
  - 3. Furnished with pressure-actuated interrupter to prevent cell rupture.
  - 4. Rated Life: 20 years.
- H. Discharge Resistors: Provide discharge resistors as required to reduce residual voltage to less than 50 V within one minute after capacitor is disconnected from source of supply in accordance with NFPA 70.
- I. Fuses: Provide fusing for all three phases; provide replaceable fuses (inaccessible fuse links are not acceptable).
- J. Contactors: Suitable for high inrush currents associated with capacitor switching.
- K. Enclosures:
  - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
  - 2. Hinged Doors: Lockable, with all locks keyed alike.
  - 3. Finish: Manufacturer's standard unless otherwise indicated.
- L. Short Circuit Current Rating: Provide capacitor assemblies with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.

- M. Capacitors With Inductors/Reactors (Harmonic Filters):
  - 1. Furnished with iron core inductors/reactors and harmonic rated capacitor cells, specifically designed for power factor correction application in harmonic environments.
  - 2. Filter Tuning: Tuned below 5th harmonic unless otherwise indicated.
  - 3. Furnish inductors/reactors with integral thermistor.
- N. Fixed Capacitors:
  - 1. Description: Capacitor assemblies that supply a fixed amount of reactive power (kVAR).
  - 2. Capacitors for Installation Within Motor Control Centers (MCCs): Suitable for installation in equipment to be provided in accordance with Section 26 2419.
  - 3. Alarm Indications:
    - a. Blown fuse, visible from exterior of enclosure.
- O. Automatic Capacitor Systems:
  - 1. Description: Capacitor assemblies that supply a variable amount of reactive power (kVAR) in discrete kVAR steps by switching capacitor cell groups using contactors and microprocessor-based controllers as required to maintain selected power factor.
  - 2. Provide current transformers (CTs) with appropriate ratio as required for system measurement.
  - 3. Control Functions:
    - a. Manual and automatic modes.
    - b. Adjustable target power factor with range of 0.80 inductive to unity.
    - c. Adjustable step time delay.
  - 4. Status Indications:
    - a. Power factor.
    - b. Voltage.
    - c. Current.
    - d. Real power (kW).
    - e. Reactive power (kVAR).
    - f. Apparent power (kVA).
    - g. Frequency.
    - h. Number of energized steps.
  - 5. Alarm Indications:
    - a. Blown fuse, visible from exterior of enclosure.
    - b. Power factor over compensation.
    - c. Power factor under compensation.
    - d. Overcurrent.
    - e. Undervoltage.
    - f. Overvoltage.
    - g. Capacitor overload.
    - h. Overtemperature.
    - i. Loss of capacitance.
    - j. High total harmonic distortion (THD).
  - 6. Features:
    - a. Integral circuit breaker or disconnect where indicated or required.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings of capacitors are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive capacitors.
- D. 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 capacitors 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 capacitor assemblies plumb and level.
- F. Unless otherwise indicated, mount floor-mounted capacitor assemblies on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
- G. Capacitor Connections at Individual Motors:
  - 1. Unless otherwise indicated, connect capacitors to only be in service when motor is energized. Provide additional contactors as required.
  - 2. Unless otherwise indicated or required, connect capacitors on the load side of motor starter contacts and on the line side of motor overload protective devices.
    - a. Exceptions where capacitor is to be connected on line side of motor starter/controller include, but are not limited to:
      - 1) Reversing motors.
      - 2) Multi-speed motors.
      - 3) Plugging.
      - 4) Jogging/Inching.
      - 5) Soft-start starters.
      - 6) Variable frequency drives.
    - b. If the circuit is not accessible between the starter contacts and motor overload protective devices, capacitor may be connected on the load side of overloads provided that overloads are resized for reduced current.
    - c. Submit wiring diagrams of proposed capacitor connections for approval prior to starting work.
- H. Automatic Capacitor Systems: Locate current transformers (CTs) on line side of capacitor connection so that measurements include power factor correction.
- I. Provide grounding and bonding in accordance with Section 26 0526.
- J. Where not furnished by manufacturer, provide fuses complying with Section 26 2813 as indicated or as required by equipment manufacturer's recommendations.
- K. Remove capacitor fuses prior to bumping motors for testing purposes to prevent blowing fuses caused by energizing capacitor that has not yet discharged.
- L. Identify capacitors in accordance with Section 26 0553.

### **3.03 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. 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.
- C. Prepare and start system in accordance with manufacturer's instructions.
- D. Inspect and test in accordance with NETA ATS, except Section 4.
- E. Perform inspections and tests listed in NETA ATS, Section 7.20.
  - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- F. Current Transformers (CTs) for Automatic Capacitor Systems: Perform inspections and tests listed in NETA ATS, Section 7.10.
- G. Correct deficiencies and replace damaged or defective capacitors or associated components.

### **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. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. Demonstration: Demonstrate proper operation of automatic capacitor systems to Owner, and correct deficiencies or make adjustments as directed.
- C. Training: Train Owner's personnel on operation, adjustment, and maintenance of automatic capacitor systems.
  - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
  - 2. Provide minimum of two hours of training.
  - 3. Instructor: Manufacturer's authorized representative.
  - 4. Location: At project site.

### **3.06 PROTECTION**

- A. Protect installed capacitors from subsequent construction operations.

**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. Non-automatic transfer switches.
  - 3. Manual transfer switches.
  - 4. Includes service entrance rated transfer switches.
  - 5. Includes bypass/isolation transfer switches.
  - 6. Remote annunciators.

**1.02 RELATED REQUIREMENTS**

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 14 2100 - Electric Traction Elevators: For interface with transfer switch.
- C. Section 14 2400 - Hydraulic Elevators: For interface with transfer switch.
- D. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- E. Section 26 0529 - Hangers and Supports for Electrical Systems.
- F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 26 0573 - Power System Studies: Additional criteria for the selection of equipment specified in this section.
- H. Section 26 3213 - Engine Generators: For interface with transfer switches.
  - 1. Includes code requirements applicable to work of this section.
  - 2. Includes additional testing requirements.
  - 3. Includes related demonstration and training requirements.

**1.03 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2005.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 99 - Health Care Facilities Code; 2015.
- G. NFPA 110 - Standard for Emergency and Standby Power Systems; 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.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
  - 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. Closed Transition Transfer Switches:
  - a. Coordinate source interconnection requirements with Utility Company.
  - b. Where applicable, coordinate the work to provide engine generators with isochronous governors suitable for closed transition transfer.
  - c. Coordinate the work to provide shunt trip breakers necessary for protection from source interconnection for longer than specified maximum interconnection time.
  - d. Arrange for inspections necessary to obtain Utility Company approval of installation.
6. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

#### **1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. 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.
  1. Where applicable, include characteristic trip curves for overcurrent protective devices upon request.
- 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. Specimen Warranty: Submit sample of manufacturer's warranty.
- E. Manufacturer's certification that products meet or exceed specified requirements.
- F. Source quality control test reports.
- G. Manufacturer's detailed field testing procedures.
- H. 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.
- I. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- J. Maintenance contracts.

#### **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 system Level specified in Section 26 3213.
  3. NFPA 99 (Health Care Facilities Code).
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. 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 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.

### **1.08 FIELD CONDITIONS**

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

### **1.09 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Transfer Switches - Other Acceptable Manufacturers:
  - 1. ASCO Power Technologies, a brand of Emerson Network Power; \_\_\_\_\_: [www.emersonnetworkpower.com](http://www.emersonnetworkpower.com).
  - 2. Russelelectric.
- B. Substitutions: See Section 01 6000 - Product Requirements.
- 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, Construction Manager accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

### **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.
  - 2. For transfer of highly inductive loads (e.g. large motors and transformers), utilize open transition transfer with in-phase monitor or delayed transition transfer.
  - 3. Provide signal before transfer contacts for transfer switches serving elevators.
- D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.
- E. 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).
- F. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.
- 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.
    - b. Where in-phase transfer is indicated, utilize in-phase monitor to initiate transfer when phase angle difference between sources is near zero to limit in-rush currents.
  - 2. Delayed Transition:

- a. Provide break-before-make transfer with programmable time delay in a neutral position not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
  - 3. Closed Transition:
    - a. When both sources are available and synchronized, provide make-before-break transfer without interruption of power to the load and with momentary interconnection of both sources for not more than 100 ms, unless otherwise approved by Utility Company.
    - b. Provide synchronization/in-phase monitor to initiate transfer when voltage and phase angle difference between sources are within predetermined requirements for synchronization.
    - c. Source Synchronization Requirements: Phase angle differential within five degrees; voltage differential within five volts.
    - d. When sources fail to synchronize within a predetermined time period, remain connected to current source and initiate an alarm.
    - e. When sources remain interconnected for longer than specified maximum interconnection time, provide contact closure signal to shunt trip designated circuit breaker and initiate an alarm.
    - f. Provide additional protective relaying where required by Utility Company.
    - g. When only one source is available, automatically utilizes open transition (break-before-make) transfer.
  - 4. Neutral Switching: Either simultaneously switched neutral (break-before-make) or overlapping neutral (make-before-break) methods are acceptable.
  - 5. 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. Indoor Clean, Dry Locations: Type 1 or Type 12.
    - b. 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 determined by short circuit study performed in accordance with Section 26 0573.
  - 2. Short Time Rating: Where the requirement for selectivity is indicated, provide transfer switches with short time ratings suitable for the maximum short time delay setting of the supply side overcurrent protective device.
- 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. Synchronization/In-Phase Monitor (Closed Transition Transfer Switches): Monitors voltage and phase angle difference between sources for initiating synchronized transfer.
  - h. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.
  - i. Retransfer to Normal Switch: Bypasses time delays for retransfer to primary/normal source.
3. Status Indications:
- a. Connected to alternate/emergency source.
  - b. Connected to primary/normal source.
  - c. Alternate/emergency source available.
  - d. Primary/normal source available.
4. Alarm Indications for Closed Transition Transfer Switches:
- a. Failure to synchronize.
  - b. Extended source interconnection/transfer switch locked out.
  - c. \_\_\_\_\_.
5. Other Features:
- a. Event log.
  - b. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
6. 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. Non-Automatic Transfer Switches:
- 1. Description: Transfer switches with manually initiated transfer between sources; electrically operated and mechanically held.

2. Control Functions:
    - a. Manual source selection.
    - b. Outputs:
      - 1) Auxiliary contacts; one set for each switch position.
  3. Status Indications:
    - a. Connected to alternate/emergency source.
    - b. Connected to primary/normal source.
    - c. Alternate/emergency source available.
    - d. Primary/normal source available.
- N. Manual Transfer Switches:
1. Description: Transfer switches with manually initiated transfer between sources; mechanically operated and mechanically held.
- O. 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.
- P. Bypass/Isolation Transfer Switches:
1. Description: Factory-assembled units consisting of interconnected transfer switch and bypass/isolation switch that permits manual bypass and isolation of the transfer switch with connection of the load to either source.
  2. Bypass/Isolation Switch Type: Provide overlapping (make-before-break) switches with no interruption of power to load. Load break (break-before-make) switches that interrupt power to load are not acceptable.
  3. Bypass/Isolation Operation:
    - a. Operable from exterior of enclosure.
    - b. Normal Mode: Provides for normal operation of transfer switch.
    - c. Test Mode: Provides for operational testing of bypassed transfer switch without affecting power to load.
    - d. Isolate Mode: Provides for complete isolation of transfer switch from all power sources, permitting removal from unit.
- Q. 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.
- R. Interface with Other Work:
1. Interface with engine generators as specified in Section 26 3213.
  2. Interface with elevators as specified in Section 14 2100 and 14 2400.
    - a. Utilize signal before transfer contacts to disconnect elevator(s) served prior to transfer.
  3. Interface with building automation system as specified in Section \_\_\_\_\_.

### **2.03 SOURCE QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

## **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 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. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
- G. Provide grounding and bonding in accordance with Section 26 0526.
- H. Identify transfer switches and associated system wiring in accordance with Section 26 0553.

### **3.03 FIELD QUALITY CONTROL**

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. 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.
- C. Prepare and start system in accordance with manufacturer's instructions.
- D. 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.
- E. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 26 3213.
- F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

### **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. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.
- D. 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.

E. Coordinate with related generator demonstration and training as specified in Section 26 3213.

### **3.06 PROTECTION**

- A. Protect installed transfer switches from subsequent construction operations.

### **3.07 MAINTENANCE**

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. 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.

**END OF SECTION**