

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Description: Work includes packaged diesel engine-generator sets for emergency or standby power supply as indicated on the Drawings with unit mounted cooling system, unit mounted control and monitoring, outdoor enclosure and associated appurtenances.
- B. General Requirements: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 sections apply to work in this section.

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with applicable city, county and state codes and ordinances.
- B. Codes and Standards:
  - 1. ASCE 7, Minimum Design Loads for Buildings and Other Structures.
  - 2. ASME B15.1, Safety Standard for Mechanical Power Transmission Apparatus.
  - 3. NEMA AB1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
  - 4. NEMA ICS 6, Industrial Controls and System Enclosures.
  - 5. NEMA MG-1, Motors and Generators.
  - 6. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
  - 7. NFPA 30, Flammable and Combustible Liquids Code.
  - 8. NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
  - 9. NFPA 70, National Electrical Code (NEC).
  - 10. NFPA 99, Standard for Health Care Facilities.
  - 11. NFPA 110, Standard for Emergency and Power Standby Systems.
  - 12. UL 142, Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.
  - 13. UL 489, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
  - 14. UL 1236, Standard for Battery Chargers for Charging Engine-Starter Batteries.
  - 15. UL 2200, Standard for Safety Stationary Engine Generator Assemblies.
- C. Manufacturer and/or Supplier Qualifications:
  - 1. Authorized primary distributor with minimum of 5 years in business of distributing, installing and maintaining specific type of generation equipment under present firm name. Second tier dealers are not acceptable.
  - 2. Capable of dispatching maintenance and repair truck with qualified factory trained repairman and spare parts to the job site within 1 hour of request for service on equipment.
  - 3. Equipment manufacturer with minimum of 5 years' experience to regularly assembled and manufactured such equipment.
  - 4. Distributor with local office within 50 miles of project site, with factory trained representatives employed for minimum of 1 year.
  - 5. Distributor shall maintain spare parts stock to minimize down time in case of equipment failure.

- 6. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those included for this Project. Comply with requirements in Section 260548.
- D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to the AHJ and marked for intended use.
- F. Engine Exhaust Emissions: EPA Certified or as required to comply with applicable state and local government requirements.
- G. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

### 1.3 SUBMITTALS

- A. Comply with requirements in Division 01 and Section 260500.
- B. Product Data: Submit manufacturer's technical product data and for each component and appurtenance. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include the following:
  - 1. Thermal damage curve for generator.
  - 2. Time current characteristic curves for generator protective device.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Include the following:
  - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
  - 2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights. Comply with requirements in Section 260548.
  - 3. Wiring Diagrams: Power, signal, and control wiring.
- D. Certification: Manufacturer seismic qualification certification that fuel tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces. Comply with requirements in Section 260548.
  - 1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Test Reports:
  - 1. Factory start-up and test reports.
  - 2. Field start-up and test reports.
  - 3. Report of exhaust emissions showing compliance with applicable regulations.

4. Certified Torsional Vibration Compatibility: Comply with requirements in NFPA 110.
5. Submit completed copy of reports and include copy in the Operation and Maintenance Manual.

#### 1.4 OPERATION AND MAINTENANCE MANUALS

- A. Comply with requirements in Division 01 and Section 260500.
- B. Include step by step instructions for startup and shutdown.
- C. Include copies of test forms, service forms, and maintenance data, including test and servicing intervals, fluid levels, lubrication requirements, filters, antifreeze, and recommended lubricants.

#### 1.5 WARRANTY

- A. Packaged Engine Generator: Two years from date of acceptable on site start up and testing.
- B. Warranty shall cover material, labor and travel time for the entire system. Replacement parts shall be available within 48 hours of initial notification.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Packaged Engine Generator:
  1. Cummins Power Generation as supplied by Cummins Northwest.
  2. Kohler Co. as supplied by Power Systems West.
  3. MTU/Detroit Diesel as supplied by Pacific Power Products.
  4. Caterpillar as supplied by NC Machinery.
  5. No Substitutions.

#### 2.2 ENGINE-GENERATOR SET

- A. Factory assembled and tested, engine generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation. Include lifting attachments.
- C. Capacities and Characteristics:
  1. Power Output Ratings: Nominal ratings as indicated on the Drawings.
  2. Output Connections: Three-phase, four wire.
  3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- D. Generator Set Performance for Sensitive Loads:
  1. Oversizing generator compared with rated power output of engine acceptable to meet specified performance.
    - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Maximum 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within steady-state operating band within 0.5 second.
4. Steady State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady State Frequency Stability: No random speed variations outside the steady state operational band and no hunting or surging of speed when system is operating at any constant load within rated load.
6. Transient Frequency Performance: Less than 2 Hz variation for 50 percent step load increase or decrease. Frequency shall recover and remain within the steady state operating band within 3 seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral not to exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, not to exceed 50 percent.
8. Sustained Short Circuit Current: For 3 phase, bolted short circuit at system output terminals, system shall supply minimum 300 percent of rated full load current for not less than 10 seconds and then clear fault automatically without damage to winding insulation or other generator system components.
9. Excitation System: Performance unaffected by voltage distortion caused by nonlinear load.
  - a. Include permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110 for Type 10 system requirements.

## 2.3 ENGINE

- A. Fuel: Fuel oil, Grade DF-2.
- B. Rated Engine Speed: 1,800 rpm.
- C. Lubrication System: Include the following items mounted on engine or skid:
  1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit capable of full flow and designed to be fail safe.
  3. Crankcase Drain: Arranged for complete gravity drainage to removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Engine Fuel System:
  1. Main Fuel Pump: Mounted on engine to ensure adequate primary fuel flow under starting and load conditions.
  2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- E. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with requirements in NFPA 110 for Level 1 equipment for heater capacity. Heater voltage 120V.

- F. Governor: Control engine speed within plus or minus 3 Hz at 60 Hz (speed regulation 5 percent) from no load to full load generator output. Maintain steady state frequency at any constant load, including no load, within band of plus or minus 0.25 Hz rated frequency. Governor not to permit frequency modulation, defined as number of times per second that frequency varies from average frequency in cyclic manner, in excess 1 Hz per second.
- G. Cooling System: Closed loop, liquid cooled with radiator factory mounted on engine generator set mounting frame, engine driven fan, and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene glycol based antifreeze and 50 percent water with anticorrosion additives as recommended by engine manufacturer.
  2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed loop coolant system pressure for engine used. Include gage glass and petcock.
  4. Temperature Control: Self-contained, thermostatic control valve that modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging, ultraviolet, and abrasion resistant fabric.
    - a. Rating: 50 psig maximum working pressure with coolant at 180 F and non-collapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- H. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system not to exceed engine manufacturer's engine backpressure requirements.
1. Sound Attenuation: Minimum 25 dB at 500 Hz.
  2. Maximum 85 dBA sound level measured at distance of 10 feet from exhaust discharge.
  3. Sound level may be superseded by dBA requirements, under Section 2.9 Outdoor Generator Set Enclosure.
- I. Engine Exhaust Flexible Connectors: Sized to match engine exhaust outlet connection and as recommended by engine manufacturer.
- J. Air-Intake Filter: Heavy duty, engine mounted air cleaner with replaceable dry filter element and "blocked filter" indicator.
- K. Starting System:
1. Components: Sized not to be damaged during full engine cranking cycle at maximum ambient temperature.
  2. Cranking Motor: Heavy duty unit that automatically engages and releases from engine flywheel without binding.
  3. Cranking Cycle: Minimum 60 seconds.
  4. Battery: Capacity within ambient temperature range for specified cranking cycle at least twice without recharging.
  5. Battery Cable: Size as recommended by engine manufacturer. Include required interconnecting conductors and connection accessories.
  6. Battery Charging Alternator: Factory mounted on engine with solid state voltage regulation and 35-A minimum continuous rating.

7. Battery Charger: Current limiting, automatic equalizing and float charging type. Comply with UL 1236. Include the following features:
  - a. Operation: Equalizing charging rate of 10 Amps initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
  - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 C to plus 60 C to prevent overcharging at high temperatures and undercharging at low temperatures.
  - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
  - d. Ammeter and Voltmeter: Flush mounted in door to indicate charging rates.
  - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of AC input or DC output of battery charger. Either condition shall close contacts that provide a battery charger malfunction indication at system control and monitoring panel.
  - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.
  - g. Battery charger voltage: 120V

#### 2.4 FUEL OIL STORAGE

- A. Comply with requirements in NFPA 30.
- B. Base Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Include the following features:
  1. Containment: Integral rupture basin with a capacity of 110 percent of nominal capacity of day tank. Include leak detector in rupture basin and connect for audible and visual alarms in event of day tank leak.
  2. Tank level indicator.
  3. Capacity: 72 hours full rated load.
  4. Vandal resistant fill cap.
  5. Five gallon spill fill containment to comply with requirements of the AHJs.
  6. Low Level Alarm Sensor: Liquid level device operates alarm contacts at 25 percent of normal fuel level.
  7. High Level Alarm Sensor: Liquid level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
  8. Secondary containment leak alarm sensor.
  9. High level alarm sensor.
  10. 12 ft. normal vent pipe extension if required by AHJ.
  11. Emergency vents shall terminate outside of weather housing.
  12. UL listed flame arrester on normal vent if required by AHJ.

## 2.5 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode selector switch on control and monitoring panel is in "AUTO" position, remote control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode selector switch is switched to "ON" position, generator set starts. "OFF" position of same switch initiates generator set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of remote emergency stop switch also shuts down generator set.
- B. Include the Following Indicating and Protective Devices and Controls:
1. AC voltmeter.
  2. AC ammeter.
  3. AC frequency meter.
  4. DC voltmeter (alternator battery charging).
  5. Engine coolant temperature gage.
  6. Engine lubricating oil pressure gage.
  7. Running time meter.
  8. Ammeter and voltmeter and phase-selector switch(es).
  9. Generator voltage adjusting rheostat.
  10. Start/stop switch.
  11. Overspeed shutdown device.
  12. Coolant high temperature shutdown device.
  13. Coolant low level shutdown device.
  14. Oil low pressure shutdown device.
  15. Fuel tank low level alarm.
  16. Fuel tank high level shutdown of fuel supply alarm.
  17. Fuel tank leak alarm.
  18. Generator overload.
  19. Battery charger failure.
  20. Battery charger low and high voltage alarms.
- C. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated on the Drawings.
- D. Alarm Contacts: Include separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication for connections for data link transmission of indications to remote data terminals.
- E. Remote Alarm Annunciator: Comply with NFPA 99. LED labeled with respective alarm conditions shall identify each alarm event and common audible signal shall sound for each alarm condition. Silencing switch on face of panel shall silence signal without altering visual indication. Connect so that after alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate surface mounting type to suit mounting conditions indicated on the Drawings.
- F. Remote emergency stop shall be provided, as per NFPA 110 Table 5.6.5.2 (u).

## 2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, electronic-trip type, 100 percent rated. 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. Ground Fault Indication: Comply with requirements in NFPA 70 for emergency system signals for ground fault. Integrate ground fault alarm indication with other generator set alarm indications.

## 2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with requirements in NEMA MG 1.
- B. Drive: Generator shaft directly connected to engine shaft. Exciter rotated integrally with generator rotor, 2/3 pitch winding.
- C. Electrical Insulation: Class H or Class F.
- D. Stator Winding Leads: Terminate at terminal box to permit future reconnection for other voltages.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Dripproof.
- G. Voltage Regulator: Solid state type, separate from exciter, for performance specified in this section. Include adjustable rheostat on control and monitoring panel for plus or minus 5 percent of output-voltage operating band.

## 2.8 OUTDOOR GENERATOR SET ENCLOSURE

- A. Description: Weatherproof steel housing. Multiple panels lockable with adequate access to components requiring maintenance. Panels removable by one person without tools. Instruments and control mounted within enclosure.
1. The enclosures shall allow the generator set to operate at full load in an ambient of 40°C - 45°C with no additional derating of the electrical output.
  2. The enclosure roof shall be pitched to prevent accumulation of water.
  3. The complete exhaust system shall be internal to the enclosure.
  4. A duct between the radiator and air outlet shall be provided to prevent re-circulation of hot air.
  5. All acoustical insulation shall be fixed to the mounting surface with pressure sensitive adhesive or mechanically fastened. In addition, all acoustical insulation mounted on a horizontal plane shall be mechanically fastened. The acoustical insulation shall be flame retardant meeting UL 94 HF1 classification.
  6. The enclosures shall include an exhaust scoop to direct the cooling air in a vertical direction.
  7. Muffler Location: Within enclosure.
  8. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 72 dBA measured at any location 23 feet from the engine generator in a free field environment.

- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
  - 1. Louvers: Fixed engine, cooling air inlet and discharge. Storm proof and drainable louvers to prevent entry of rain and snow.

## 2.9 VIBRATION ISOLATION DEVICES

- A. Generator set shall be seismic certified from factory without additional elastomeric isolator pads or spring isolators.

## 2.10 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard color finish over corrosion resistant pretreatment and compatible primer.

## 2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
- B. Project Specific Equipment Tests: Before shipment, factory test engine generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
  - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
  - 2. Full load run.
  - 3. Maximum power.
  - 4. Voltage regulation.
  - 5. Transient and steady-state governing.
  - 6. Single-step load pickup.
  - 7. Safety shutdown.
  - 8. Sound generation.
  - 9. Provide 14 days' advance notice of tests and opportunity for observation of tests by the Owner's representative.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions as satisfactory.

### 3.2 PREPARATION

- A. Field Measurements: Field verify locations of new and existing work prior to commencing work of this section.
- B. Protection: Protect surrounding areas and surfaces to preclude damage from work of this section.

3.3 INSTALLATION, APPLICATION, ERECTION, AND PERFORMANCE

- A. General: Install, apply, erect, and perform the work in accordance with Article "Quality Assurance" provisions, specifications, and manufacturer's installation instructions and directions. Where these may be in conflict, the more stringent requirements govern.

3.4 PACKAGED ENGINE GENERATOR INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access without removing connections or accessories, for periodic maintenance.
- C. Secure packaged engine generator sets to anchor bolts installed in concrete bases. Comply with requirements in Section 260510 for concrete bases and Section 260548 for seismic restraints.
- D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.5 CONNECTIONS

- A. Piping installation requirements are specified in Division 26 Sections.
- B. Connect fuel, cooling system, and exhaust system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Ground equipment according to Section 260526.
- D. Connect wiring according to Section 260519.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Comply with requirements in Section 260810.
  - 2. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  - 3. Test the complete engine generator system at manufacturer's factory:
    - a. At full load and rated power factor with a reactive load.
    - b. Tests shall include and be documented:
      - 1) Radiator.
      - 2) Engine control panel.
      - 3) Single-step load pickup.
      - 4) Transient and steady-state governing.
      - 5) Safety shutdown device testing.
      - 6) Rated power.
      - 7) Maximum power.

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4. Provide full load test utilizing portable test bank as required by NFPA 110. Simulate power failure including operation of transfer switch, and return to normal.
  5. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  6. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified in this section including, but not limited to, single step full load pickup test.
  7. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages for the following.
    - 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 connectors. Perform integrity load test and capacity load test for battery.
    - c. Verify acceptance of charge for each element of battery after discharge.
    - d. Verify that measurements are within manufacturer's specifications.
  8. Battery Charger Tests: Verify specified rates of charge for both equalizing and float charging conditions.
  9. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
  10. Exhaust System Back Pressure Test: Verify that back pressure at full rated load is within manufacturer's written allowable limits for engine.
  11. Exhaust Emissions Test: Comply with applicable government test criteria.
  12. Voltage and Frequency Transient Stability Tests: Measure voltage and frequency transients for 50 and 100 percent step load increases and decreases and verify that performance is as specified.
  13. 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.
  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 4 locations on the property line, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches specified in Section 263600 and run them concurrently.
- D. Test instruments shall have been calibrated within last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- H. Repair malfunctioning unit on site with factory-authorized service technicians, or remove malfunctioning units and provide new. Retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach label or tag to each tested component indicating satisfactory completion of tests.
- K. Infrared Scanning: After date of Substantial Completion, but not more than 60 days after final acceptance, perform infrared scan of each power wiring termination and each bus connection. Remove access panels so terminations and connections are accessible to portable scanner.
  - 1. Follow-up Infrared Scanning: Perform additional follow-up infrared scan 11 months after date of Substantial Completion.
  - 2. Instrument: Use 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 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.
- L. Include copy of test reports in the Operation and Maintenance Manual.

### 3.7 DEMONSTRATION

- A. Demonstrate proper system operation to the A/E and Owner utilizing factory-trained field service personnel.

### 3.8 TRAINING

- A. Conduct one 2 hour training session for Owner's representatives at project site. Include training on installed equipment, system operation, emergency procedures, and maintenance. Training conducted by factory-trained service personnel.

### 3.9 FUEL FILL

- A. Fill fuel storage system(s), including remote bulk storage tank(s), with fuel after tests and demonstrations have been completed.

END OF SECTION 263213