SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. ALTERNATE No. 6: Provide Alternate price for a dual fuel Natural Gas and LP fueled standby emergency generator in lieu of the basis of design Diesel fuel generator to meet the same performance requirements included with this specifications. The alternate shall delete the UL2085 Sub-base Fuel Tank, but shall include a LP fuel storage cylinder tank on concrete pad with tie-down straps, piping, and all associated fuel system requirements to set storage tank outside of the fenced mechanical yard. The LP fuel storage tank shall be sized for minimum of 24-hours of operating time at 100% load. The LP gas piping from tank to generator shall be installed in concrete pipe trench with drain to storm water and concrete cover flush with finished grade. Provide dedicated natural gas service line tapping of high pressure line to generator location. Provide separate and dedicated natural gas regulator for the natural gas generator. Provide additional fencing with grounding to expand mechanical yard so tank area is enclosed as part of mechanical yard. Design shall meet all applicable codes and standards. Provide concrete slab inside tank area. Provide all necessary gas utility coordination and delegated design for installation of alternate. Delegated design shall include submittal drawings of alternate products, fence, tank foundations with anchors, and civil layout drawings for approval. Refer to Division 1 for additional Alternate requirements.

1.2 SUMMARY

A. This Section includes packaged engine-generator sets for emergency power supply with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Performance requirements for sensitive loads.
5. Unit mounted – radiator mounted load banks.
6. Outdoor sound attenuated enclosure.
7. Dual wall sub-base UL 2085 fuel tank with 72 hour running capacity

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Factory published specification sheet.
2. Manufacturer’s catalog cut sheets of all auxiliary components such as battery charger, control panel, enclosure, etc.
3. Dimensional elevation and layout drawings of the generator set, enclosure and transfer switchgear and related accessories.
4. Weights of all equipment.
5. Concrete pad recommendation, layout and stub-up locations of electrical and fuel systems.
6. Interconnect wiring diagram of complete emergency system, including generator, switchgear, day tank, remote pumps, battery charger, control panel, and remote alarm indications.
7. Engine mechanical data, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, fuel consumption, etc.
8. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator efficiencies, waveform distortion and telephone influence factor.
9. Generator resistances, reactances and time constants.
10. Generator locked rotor motor starting curves.
11. Thermal damage curve for generator.
12. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.

C. Source quality-control test reports.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
6. Report of exhaust emissions showing compliance with applicable regulations.

D. Submit engine generator set capacity sizing calculations for the submitted engine generator set based on the connected equipment characteristics provided in this specification section.
E. Submit a letter from the manufacturer of the engine generator set equipment stating that all submitted engine generator set equipment and all related equipment meets or exceeds all requirements of this specification section. This shall include a listing stating either compliance or non-compliance for each specification sub section item. All non-compliance items shall include a detailed explanation of why the specification sub section requirement cannot be complied with.

F. Installation, Testing, and Start-up Procedures and Instructions.

G. Submit a letter from the manufacturer of the engine generator set equipment stating that all submitted engine generator set equipment and all related equipment meets or exceeds all requirements of this specification section. This shall include a listing stating either compliance or non-compliance for each specification sub section item. All non-compliance items shall include a detailed explanation of why the specification sub section requirement cannot be complied with.

H. Qualification Data: For installer, manufacturer, manufacturer field service representative, and NETA testing agency.

I. Source quality-control test reports.
   1. Certified summary of prototype-unit test report.
   2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
   4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
   6. Report of exhaust emissions showing compliance with applicable regulations.

J. Field quality-control and manufacturer start-up test reports shall be submitted separately within five (5) business days after completion for approval.

K. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

L. Warranty: Special warranty specified in this Section. Include Contractor's, Manufacturer's, and Dealer's written warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

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

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

J. Comply with UL 2200.

K. Comply with UL 2085.

L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

M. 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.

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

B. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:

2. Heavy snow and freezing weather conditions.

1.7 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators and remote radiators mounted on grade. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate with fire alarm installer for fire alarm interconnections.

C. Coordinate with Automatic Temperature Control installation for Building Automation System interconnections.

D. Coordinate with Owner, Owner’s Representatives, and Commissioning Agent for installation, testing, start-up, warranty, operation and maintenance manuals, demonstration and training and post construction activities during warranty period.

1.8 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of initial start-up of the system.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months’ full maintenance by skilled employees of manufacturer’s designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
1.11 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
2. Field test and manufacturer start-up test reports.

1.12 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
2. Filters: One set each of lubricating oil and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Caterpillar; Engine Div.
2. Kohler Co.; Generator Division.
4. MTU.

B. The kW size of the drawing listed on the drawings is based on a Kohler generator selection provided by their generator selection software and establishes a basis of design size of the generator, feeder, and generator distribution panel. Manufacturers are allowed to submit other sized generators as long as the performance requirement listed in this spec are met and proven by calculations submitted with the shop drawings. Loads, Steps, maximum frequency and voltage dips are listed in this specification to establish the performance requirements. The oversizing of the alternator to maximize SkVA starting capability and reducing kW size of engine is acceptable.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

C. Capacities and Characteristics:
1. Power Output Ratings: Nominal ratings as indicated.
2. Output Connections: 208Y/120V, 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. Step and Load Requirements for Submittal Calculations:

1. The following load and step table shall be used for submittal sizing calculations and submittal comparison of submitted manufacturer. Performance of the generator under these steps and load shall be required to be demonstrated by calculations.
2. Generator Load Steps:
   a. Step 1: ATS-1 Loads
   b. Step 2: ATS-2 Loads
   c. Step 3: ATS-3 Loads.

3. Table of Generator Load and Steps.

<table>
<thead>
<tr>
<th>Load Step</th>
<th>Equipment Designation</th>
<th>Load Type</th>
<th>Load</th>
<th>Permitted Voltage Dip During Starting</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exterior Lighting</td>
<td>LED Lighting</td>
<td>2kVA</td>
<td>30% Continuous</td>
<td>Continuous</td>
</tr>
<tr>
<td>1</td>
<td>Interior Lighting</td>
<td>LED Lighting</td>
<td>5kVA</td>
<td>30% Continuous</td>
<td>Continuous</td>
</tr>
<tr>
<td>1</td>
<td>Fire Alarm and LS Equip</td>
<td>UPS/ small battery chargers</td>
<td>2kVA</td>
<td>30% Continuous</td>
<td>Continuous</td>
</tr>
<tr>
<td>1</td>
<td>Receptacle Load</td>
<td>Resistive</td>
<td>35kVA</td>
<td>30% Intermittent</td>
<td>Intermittent</td>
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<tr>
<td>1</td>
<td>IT Rack Mtd UPS Loads</td>
<td>1 Phase UPS</td>
<td>3 @ 5.5kVA</td>
<td>30% Continuous</td>
<td>Continuous</td>
</tr>
<tr>
<td>1</td>
<td>Misc. Exhaust Fans</td>
<td>Multiple 120V- 1 Phase fractional HP Motors</td>
<td>0.18kW</td>
<td>30% Intermittent</td>
<td>Intermittent</td>
</tr>
<tr>
<td>1</td>
<td>Site Gates</td>
<td>3 Phase Motors</td>
<td>2 @ 0.75HP</td>
<td>30% Continuous</td>
<td>Continuous</td>
</tr>
<tr>
<td>2</td>
<td>EF-1</td>
<td>3 Phase Motors</td>
<td>0.75HP</td>
<td>30% Continuous</td>
<td>Continuous</td>
</tr>
<tr>
<td>2</td>
<td>Pumps</td>
<td>3 Phase Motor</td>
<td>4 @ 1HP</td>
<td>30% Intermittent</td>
<td>Intermittent</td>
</tr>
<tr>
<td>2</td>
<td>AHU-1 Return Fan</td>
<td>3 Phase Motor</td>
<td>3HP</td>
<td>30% Intermittent</td>
<td>Intermittent</td>
</tr>
<tr>
<td>2</td>
<td>AHU-1 Supply Fan</td>
<td>3 Phase Motor</td>
<td>7.5HP</td>
<td>30% Intermittent</td>
<td>Intermittent</td>
</tr>
<tr>
<td>2</td>
<td>Boilers</td>
<td>4 @ 0.75HP</td>
<td>0.75HP</td>
<td>30% Intermittent</td>
<td>Intermittent</td>
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<tr>
<td>3</td>
<td>ACC Units</td>
<td>1 Phase</td>
<td>3 @ 3</td>
<td>30% Intermittent</td>
<td>Intermittent</td>
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<td></td>
<td>Refrigerant Compressor</td>
<td>Tons</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----------------------</td>
<td>------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>FCU-1</td>
<td>1 Phase Refrigerant Compressor</td>
<td>5.4 FLA 30% Intermittent</td>
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<tr>
<td>3</td>
<td>ACC-1</td>
<td>3 Phase Refrigerant Compressor</td>
<td>15 Tons 30% Intermittent</td>
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</tbody>
</table>

E. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

F. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is not permissible to meet specified performance.
2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 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: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
   
   a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:
   
   1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
   3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:
   
   2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
   
   1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

   a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
   b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.

1. Configuration: Horizontal air discharge.
2. Radiator Core Tubes: Aluminum.
3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
5. Fan: Driven by totally enclosed electric motor with sealed bearings.
6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

J. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

K. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

L. Starting System: 24-V electric, with negative ground.

1. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
2. Cranking Cycle: As required by NFPA 110 for system level specified.
3. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
4. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
5. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to
maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.


7. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
   a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   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 installed in generator enclosure.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Comply with UL 2085, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
   1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
      a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
   2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of 72 hours' operation at 100 percent of rated power output of engine-generator system without being refilled. Maximum of 2000 gallons.
   3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
   4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
   5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.

8. Vandal-resistant fill cap.

9. Tank level indicator.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Controls – Generator Set Mounted: Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls.

1. Environmental: The generator set control shall be tested and certified to the following environmental conditions.

   a. -40°C to +70°C Operating Range
   b. 95% humidity non-condensing, 30°C to 60°C
   c. IP22 protection
   d. 5% salt spray, 48 hours, +38°C, 36.8V system voltage
   e. Sinusoidal vibration 4.3G’s RMS, 24-1000Hz
   g. Shock: withstand 15G
2. Functional Requirements: The following functionally shall be integral to the control panel.
   a. The control shall include a 33 x 132 pixel, 24mm x 95mm, positive image, transflective LCD display with text based alarm/event descriptions.
   b. Audible horn for alarm and shutdown with horn silence switch.
   c. Standard ISO labeling
   d. Multiple language capability
   e. Remote start/stop control
   f. Local run/off/auto control integral to system microprocessor
   g. Cool down timer
   h. Speed adjust
   i. Lamp test
   j. Push button emergency stop button
   k. Voltage adjust
   l. Voltage regulator V/Hz slope – adjustable
   m. Password protected system programming

3. Digital Monitoring Capability: The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units.
   a. Engine
      1) Engine oil pressure
      2) Engine oil temperature
      3) Engine coolant temperature
      4) Engine RPM
      5) Battery volts
   b. Generator
      1) Generator AC volts (Line to Line, Line to Neutral and Average)
      2) Generator AC current (Avg. and Per Phase)
      3) Generator AC Frequency
      4) Generator kW (Total and Per Phase)
      5) Generator kVA (Total and Per Phase)
      6) Generator kVAR (Total and Per Phase)
      7) Power Factor (Avg. and Per Phase)
      8) Total kW-hr
      9) Total kVAR-hr
      10) % kW
      11) % kVA
      12) % kVAR
   c. Voltage Regulation
      1) Excitation voltage
      2) Excitation current

4. Alarms and Shutdowns: The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence:
a. Engine Alarm/Shutdown

1) Low oil pressure alarm/shutdown
2) High coolant temperature alarm/shutdown
3) Loss of coolant shutdown
4) Overspeed shutdown
5) Overcrank shutdown
6) Low coolant level alarm
7) Low fuel pressure alarm
8) Emergency stop depressed shutdown
9) Low coolant temperature alarm
10) Low battery voltage alarm
11) High battery voltage alarm
12) Control switch not in auto position alarm
13) Battery charger failure alarm

b. Generator Alarm/Shutdown

1) Generator Over Voltage
2) Generator Under Voltage
3) Generator Over Frequency
4) Generator Under Frequency
5) Generator Reverse Power
6) Generator Overcurrent

c. Voltage Regulation

1) Loss of excitation alarm/shutdown
2) Instantaneous over excitation alarm/shutdown
3) Time over excitation alarm/shutdown
4) Rotating diode failure
5) Loss of sensing
6) Loss of PMG

5. Inputs and Outputs

a. Programmable Digital Inputs: The Controller shall include the ability to accept six (6) digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.

b. Digital Outputs: The control shall include the ability to operate six (6) programmable relay output signals, integral to the controller. The output relays shall be rated for 2A @ 30VDC and consist of six (6) Form A (Normally Open) contacts and two (2) Form C (Normally Open & Normally Closed) contacts.

c. Discrete Outputs: The control shall include the ability to operate one (1) discrete outputs, integral to the controller, which are capable of sinking up to 300mA.

6. Maintenance: All engine, voltage regulator, control panel and accessory units shall be accessible through a single electronic service tool. The following maintenance functionality shall be integral to the generator set control:

a. Engine running hours display
b. Service maintenance interval (running hours or calendar days)
c. Engine crank attempt counter
d. Engine successful starts counter
e. 20 events are stored in control panel memory
f. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 14 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:

1) Day of week
2) Time of day to start
3) Duration of cycle

7. Building Automation System (BAS) Interface: The controller shall include Bacnet communications Interface:

a. Provide the following Alarm or Status outputs to the BAS system:
   1) Generator Running
   2) Generator Trouble
   3) Engine Alarm/Shutdown
   4) Alternator Alarm/Shutdown
   5) Voltage Regulation Alarm/Shutdown
   6) Battery Charger Fault/Alarm
   7) Battery System Low Voltage Alarm

8. Local Control Panel Annunciation

a. Provide a local, control panel mounted, annunciator to meet the requirements of NFPA 110, Level 1.

1) Annunciators shall be networked directly to the generator set control.
2) Local Annunciator shall include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton.
3) Provide the following individual light indications for protection and diagnostics:

   a) Overcrank
   b) Low coolant temperature
   c) High coolant temperature warning
   d) High coolant temperature shutdown
   e) Low oil pressure warning
   f) Low oil pressure shutdown
   g) Overspeed
   h) Low coolant level
   i) EPS supplying load
   j) Control switch not in auto
   k) High battery voltage
   l) Low battery voltage
   m) Battery charger AC failure
   n) Emergency stop
   o) Spare
   p) Spare
E. Remote Alarm Annunciator: An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are flush-mounted type to suit mounting conditions indicated.

1. Provide a remote annunciator to meet and comply with the requirements of NFPA 110, Level 1 systems. Included the necessary contacts and terminals in control and monitoring panel.
   a. The annunciator shall provide remote annunciation of all points stated above and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn.
   b. Ability to be located up to 800 ft from the generator set.

F. Building Automation System (BAS) Interface:

1. Provide the following Alarm or Status outputs to the BAS system:
   a. Generator Running
   b. Generator Trouble
   c. Engine Alarm/Shutdown
   d. Alternator Alarm/Shutdown
   e. Voltage Regulation Alarm/Shutdown
   f. Battery Charger Fault/Alarm
   g. Battery System Low Voltage Alarm

G. Fire Alarm System Interface:

1. Provide the following Status outputs to the Fire Alarm System:
   a. Generator Running
   b. Generator Trouble
   c. Generator Fault

H. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

I. 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.

J. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
   2. Trip Settings: Selected to coordinate with generator thermal damage curve.
   3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
   4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator circuit breaker shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
   1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
   2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
   3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
   4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class F, 130 degree Celsius rated.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.
G. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
   1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

2.8 LOAD BANK

A. Description: Permanent, outdoor, weatherproof, radiator mounted, remote-controlled, forced-air-cooled, resistive and reactive unit capable of providing a balanced 3-phase, delta-connected load to generator set at 100 percent rated-system capacity, at 100 percent power factor, lagging. Unit may be composed of separate resistive and reactive load banks controlled by a common control panel. Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.

B. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases.

C. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.

D. Load Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.

E. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.

F. Load-Bank Enclosures: NEMA 250, Type 3R, complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with 1/2-inch- (13-mm-) square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge.

G. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor
shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.

H. Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.

I. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising. Control panel shall maintain minimum 35% total load on generator to avoid wet stacking the generator.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Prefabricated and preengineered enclosure with the following features:

2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
3. Space Heater: Thermostatically controlled and sized to prevent condensation.
4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
8. Muffler Location: External to enclosure.
9. Physical Size Restrictions: Due to the restrictive location and required working clearances the full width of the enclosure shall not exceed dimensions shown on drawings.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

C. Interior Lights with Switch: Factory-wired, vapor-proof LED type, UL listed for Wet Locations fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.

D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.
2.10 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

3. Number of Layers: Two.

2.11 FINISHES

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

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.


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.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 PERMITTING

A. Secure MDE air quality permit to construct in accordance with COMAR 25.11.02, if manufacturer selected break horsepower exceeds exemption limit required by law.
3.2 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.3 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

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

C. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

E. Provide full levels of fuel and all fluids for testing and start up and at Owner acceptance system after approval of field testing and successful completion of all start up, testing, and functional demonstration.

3.4 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Division 23 Section "Facility Fuel-Oil Piping."
2. Alternate: Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23 Section "Facility Natural-Gas Piping."

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

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

H. Make connections to Building Automation System and functionally test all control and indication prior to field quality control testing and demonstration and training.

I. Make connections to Fire Alarm System and functionally test all control and indication prior to field quality control testing and demonstration and training.

3.5 IDENTIFICATION

A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports by NETA ATS generator and circuit breaker sections. Optional NETA ATS tests are not required.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing. Report results in writing. Factory authorized service representative shall perform all required inspection and testing work except work required by NETA ATS unless noted otherwise.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, perform manufacturer recommended tests, inspections, and start-up and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. 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.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.

7. Exhaust Emissions Test: Comply with applicable government test criteria.

8. Load Bank Test: Functional test radiator mounted load bank to demonstrate stepping of load through full range and also demonstrate load bank can hold 30 percent, 50 percent, and 75 percent load for 15-minute duration. Perform manufacturer recommended start up testing.

9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

10. 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.

11. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line and compare measured levels with required values.

E. Coordinate tests with tests for transfer switches and run them concurrently.

F. Test instruments shall have been calibrated within the 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.

G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

M. Program automatic steps of load bank to maintain minimum of 50 percent load on the generator.

N. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

A. Adjust all circuit breakers, switches, access doors, and operating handles for free mechanical and/or electrical operation as described in manufacturer's instructions.

B. Set field-adjustable, protective-relay trip characteristics according to results in Section 260573 "Overcurrent Protection Device Coordination Study."

3.8 CLEANING

A. Clean interiors of generator enclosure remove construction debris, dirt, shipping materials. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

B. Whip interior vertical and horizontal surfaces with manufacturer approved cleaning solution and clean clothes.

C. Repaint scratched or marred exterior surfaces to match original finish.

D. Clean generator area and staging area.

3.9 COMMISSIONING

A. Coordinate with Commissioning Agent and Owner for all startup, testing, and demonstration. Provide minimum 14 days written notification for startup, testing, and demonstration activities to allow for witness of same. Contractor shall include project management and site supervisor attendance during all startup and testing.
3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 263213