

SECTION 26 32 13.13
DIESEL ENGINE GENERATOR SET

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): A335/A335M, Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service.
2. California Air Resources Board (CARB).
3. Code of Federal Regulations (CRF): Title 40 Volume 18, Control of Emissions from New and In-Use Non- Road Compression-Ignition Engines.
4. International Organization for Standardization (DIN/ISO): 9001, Quality Management Systems—Fundamentals and Vocabulary.
5. National Electric Manufacturer's Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. MG 1, Motors and Generators.
6. National Electrical Contractors Association (NECA): 404, Recommended Practice for Installing Generator Sets.
7. National Fire Protection Association (NFPA):
 - a. 37, Installation and Use of Stationary Combustion Engines and Gas Turbines.
 - b. 70, National Electric Code.
 - c. 110, Emergency and Standby Power Systems.
8. SAE International (SAE): J1074, Engine Sound Level Measurement.
9. UL:
 - a. 508, Industrial Control Equipment.
 - b. 1236, Battery Chargers for Charging Engine-Starter Batteries.
 - c. 2200, Stationary Engine Generator.

1.02 SUBMITTALS

A. Action Submittals:

1. Dimensioned outline drawing showing plan and elevations of engine generator set and drive system.
2. Paragraph by paragraph specification compliance statement, describing differences between specified and proposed equipment.
3. Engine and generator weight, and anchoring requirements.
4. Catalog information and technical description; include materials for block, heads, valves, rings, cylinders, pistons, crankshaft, and major bearings and wear surfaces.

5. Complete list of accessories provided.
6. Performance curves showing engine efficiency (fuel consumed per kWh output), gross fuel consumption rate, and kW output at design rated output, one-half load, and one-quarter load. Account for design altitude, temperature corrections, and engine parasitic loads.
7. Transient and subtransient reactances per unit.
8. Output waveform and telephone interference factor (TIF).
9. Circuit breaker data, including make model, catalog number, settings, and time current curves and enclosure size.
10. Cable termination lug data sheets.
11. Control panel instrument identification inscriptions.
12. Sample guarantee.
13. Electrical schematic and wiring diagrams for the following:
 - a. Generator control panel.
 - b. Main generator.
 - c. Voltage regulator.
 - d. Battery charging system.
 - e. Governing system.
 - f. Interconnection wiring diagram for automatic transfer controller specified in Section 26 36 23, Automatic Transfer Controller.
 - g. Enclosed electrical components.
14. Block heater size and voltage.
15. Jacket water heater size and voltage.
16. Noise data for enclosed engine generator at 50 percent, 75 percent, and full load.
17. Exhaust system silencer pipe supports.
18. Anchorage and bracing drawings and cut sheets as required by Section 01 88 15, Anchorage and Bracing.
19. Generator enclosure building, stairs, and access platforms.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Calculations for generator enclosure building, stairs, and access platform, including gravity and lateral force resisting system and anchors.
3. Generator set manufacturer qualifications.
4. Manufacturer's Certificate of Compliance with specified EPA and CARB emissions requirements in accordance with Section 01 67 00, Product Requirements.
5. Certification, copies of analyses, or test reports demonstrating appropriate vibration analysis and design in all modes.

6. Factory Test Report.
7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
8. Description of parts and service availability.
9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 79 00, Demonstration and Training.
10. Special guarantee.
11. Air quality permit.

1.03 QUALITY ASSURANCE

- A. Provide Work in accordance with NFPA 70, National Electrical Code (NEC). Provide material and equipment labeled or listed by a nationally recognized testing laboratory or other organization to provide a basis for approval under NEC.
- B. Provide materials and equipment manufactured within the scope of standards published by UL in conformance with those standards documented with an applied UL listing mark.
- C. Manufacturer Special Requirements:
 1. Generator Set: Listed to UL 2200 or submitted to an independent third party certification process to verify compliance as installed.
 2. Generator Set Manufacturer: Certified to ISO 9001 with third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.04 AIR QUALITY PERMIT

- A. Provided by the Contracting Officer. Provide necessary information required to assist the Contracting Officer in obtaining the permit.

1.05 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

Item	Quantity
Diesel fuel line filter elements	3 complete sets per unit if required
Lubricating oil filter elements with gasket	3 complete sets per unit
Air cleaner filter element	1 complete set per unit
Cooling fan drive belt (if applicable)	2 complete sets per unit

Item	Quantity
Hydrometer	1 each
Two-pronged battery voltmeter	1 each
Spare fuses, if used in control panel	1 complete set per unit
Spare indicating lamps (if applicable)	4 each type used per unit
Touch up paint	1 quart each color used
Special tools required to maintain or dismantle engine generator set	1 complete set for each different size unit

PART 2 PRODUCTS

2.01 GENERATOR SET

A. Physical Characteristics:

1. Finishes: Manufacturer's standard.
2. Walk-In Installation: Provide engine/generator assembly and walk-in NEMA 3R enclosure with access to three sides of generator motor and engine from inside enclosure. Provide two access doors with crash hardware in enclosure for emergency egress. Include normal and battery backup lighting, electric space heaters, thermostatically controlled exhaust fans and louvers for space cooling.
3. Provide 480 volt and 120/240 volt panelboards for all loads withing generator enclosure.
4. Provide step down transformer in enclosure for generator loads.
5. Design total assembly of generator set to be lifted into place using spreader bars.

B. Functional Characteristics:

1. Engine:
 - a. 1,250 kW power rating.
 - b. Manufacturer's standard design, unless otherwise specified.
 - c. Engine parts designed with adequate strength for specified duty.
 - d. Type: Four cycle industrial spark ignited type with unit mounted radiator and fan cooling.
 - e. Starting System:
 - 1) Type: Automatic, using 12-volt or 24-volt battery-driven starter acting in response to controller.
 - 2) Starter shall be capable of three complete cranking cycles without overheating.

2. Air Intake System: Equip with dry type air cleaner with filter service (restriction) indicator.
3. Governing System:
 - a. Electro-mechanical or electro-hydraulic type.
 - b. Regulates speed as required to hold generating frequency within tolerable limits and within 5 percent of nominal design speed.
 - c. Accessories:
 - 1) Manual speed control device.
 - 2) Positive overspeed trip switch.
4. Jacket Water Cooling System:
 - a. Radiator:
 - 1) Consisting of jacket water pump, fan assembly, fan guard, and duct flange outlet.
 - 2) Cooling System: Rated for full load operation at elevation of 7,500 feet above sea level and ambient air of 40 degrees C.
 - 3) Fan: Suitable for use in a system with 0.5 in H₂O restriction.
 - 4) Sized based on a core temperature that is 20 degrees F higher than rated operation temperature.
 - b. Engine Thermostat: As recommended by manufacturer to regulate engine water temperature.
 - c. Jacket Water Heater:
 - 1) Suitable for operation on 120-volt, single-phase, 60-Hz current.
 - 2) Thermostatically controlled.
 - d. Engine Cooling Liquid: Fill cooling system with a 50/50-ethylene glycol/water mixture prior to shipping.
5. Lubrication System:
 - a. Type: Full-pressure.
 - b. Accessories:
 - 1) Pressure switch to initiate shutdown on low oil pressure.
 - 2) Oil filter with replaceable element.
 - 3) Bayonet type oil level stick.
 - 4) Valved oil drain extension.
 - c. Oil Cooling System: Water-cooled heat exchanger utilizing jacket water.
6. Alternator:
 - a. General:
 - 1) Meet requirements of NEMA MG 1.
 - 2) Synchronous type with 2/3 pitch, revolving field, drip-proof construction, air cooled by a direct drive centrifugal blower fan.
 - 3) Stator Windings:
 - a) Skewed for smooth voltage waveform.
 - b) Reconnectable, 12 lead.
 - 4) Overspeed Capability: 125 percent.

- 5) Waveform Deviation from Sine Wave: 5 percent maximum.
- 6) Total Harmonic Current and Voltage Distortion: 5 percent maximum, measured at generator main circuit breaker.
- b. Insulation System:
 - 1) Class F, with a maximum rise of 105 degrees C over 40 degree C ambient in accordance with NEMA MG 1.
 - 2) Vacuum pressure impregnated (VPI), fungus resistant in accordance with MIL E-4970A.
- c. Excitation System:
 - 1) Field brushless type or permanent magnet generator (PMG) exciter.
 - 2) PMG and Controls: Capable of providing regulated current, at a rate of 300 percent of nameplate current, to a single-phase or three-phase fault for 10 seconds.
- d. Voltage Regulation:
 - 1) Solid state, three-phase sensing type.
 - 2) Adjustable output voltage level to plus or minus 5 percent.
 - 3) Provisions for proper voltage regulation for existing or future adjustable frequency drives as part of generator load.
- e. Voltage and Frequency Regulation Performance:
 - 1) Steady State Voltage Regulation: Less than plus or minus 1 percent from no load to continuous rating point.
 - 2) NEMA MG 1 Defined Transient Voltage Dip:
 - a) Less than 15 percent at rapid application of rated load.
 - b) Recovery to rated voltage and frequency within 2 seconds following initial load application.
 - 3) Steady State Frequency Regulation: Plus, or minus 1.5-Hz overload range.
- f. Short Circuit Capabilities: Sustain 300 percent of rated current for 10 seconds for external three-phase bolted fault without exceeding rated temperatures.
- g. Main Circuit Breaker:
 - 1) Type: Molded case.
 - 2) Current Rating: As recommended by generator manufacturer.
 - 3) Interrupt Rating: 25,000 amps RMS symmetrical at 480 volts.
 - 4) Trips: Thermal-magnetic with inverse time characteristics and adjustable magnetic pickup.
 - 5) Enclosure:
 - a) Rating: NEMA 250, Type 1.
 - b) Mounted with vibration isolation from engine generator set.
 - 6) Surge Protective Devices: Three-phase capacitors and arresters mounted in terminal compartment.

7. Control Panel:
 - a. Rating: NEMA 250, Type 12.
 - b. Material: Steel.
 - c. Instrument Identification: Face label or engraved, black, laminated plastic nameplate with white 1/4-inch-high letters, attached with Type 422 stainless steel screws.
 - d. UL 508 listed.
 - e. Tested to meet or exceed IEEE 587 requirements for voltage surge resistance.
 - f. Controls shall be solid-state, microprocessor based. Control panel shall be designed and built by generator manufacturer and shall provide operating, monitoring, and control functions for generator set.
8. Instrumentation:
 - a. Type: Suitable for engine-mounted vibration environment.
 - b. Mounting: Nonshock mounted.
 - c. Alarm and Signal Contacts: Rated 5 amps at 120V ac, dry.
 - d. Fault Indication Lamps: Push-to-test type.
 - e. Meters: Digital with analog display, plus or minus 2 percent accuracy.
9. Operator Controls and Indication:
 - a. STOP/AUTO/ENGINE TEST selector switch.
 - b. Generator voltage adjustment.
 - c. Voltmeter PHASE SELECTOR switch.
 - d. Ammeter PHASE SELECTOR switch.
 - e. Voltmeter.
 - f. Ammeter.
 - g. Kilo-Watts (kW).
 - h. Percent kW.
 - i. Power Factor.
 - j. FREQUENCY meter.
 - k. Engine OIL PRESSURE indicator.
 - l. Engine jacket WATER TEMPERATURE indicator.
 - m. Engine SPEED indicator (RPM).
 - n. Engine OIL TEMPERATURE indicator.
 - o. RUNNING TIME indicator.
 - p. DC battery voltage.
 - q. Emergency STOP button.
10. Alarm Indicators with Manual Pushbutton RESET:
 - a. Low oil pressure.
 - b. High jacket water temperature.
 - c. Engine overspeed.
 - d. Engine overcrank.
 - e. Low/high dc voltage.

11. External Interfaces:
 - a. Provide Ethernet/IP connection for external controls and data exchange.
 - b. Furnish a single, common DPDT relay output upon occurrence of alarm condition.
 - c. Status Output Contacts:
 - 1) Dry contacts rated 5 amps at 120V ac for following status indications at remote PLC panel:
 - a) Generator in HAND mode.
 - b) Generator in AUTO mode.
 - c) Generator OUT OF SERVICE.
 - d) Generator in FAULT/TROUBLE.
 - e) Generator RUNNING.
 - d. Accept remote dry start contact closure from automatic transfer switch, rated 10 amps at 32V dc.
12. Functional Requirements:
 - a. LCD text display of alarm/event descriptions.
 - b. Recracking Lockout: When engine fires, starting control shall automatically disconnect cranking control to prevent recracking for a preset period after engine stop.
 - c. Overcranking Lockout: Initiate after four cranking cycles of 10 seconds on and 10 seconds off or provide continuous cranking cycle with crank time limiter.
 - d. Cool-down Timer: Adjustable from 5 minutes to 60 minutes.
 - e. Alarms:
 - 1) Low coolant level.
 - 2) Low fuel level.
 - 3) Low battery voltage.
 - 4) High battery voltage.
 - 5) Battery charger failure.
 - f. Engine shutdown upon any of the following conditions:
 - 1) Engine overspeed.
 - 2) Emergency stop button depressed.
 - 3) High jacket water.
 - 4) Low oil pressure.
 - g. Air Inlet Damper Opening:
 - 1) Upon engine start sequence initiation, a normally closed, dry contact, rated 5 amps at 120V ac, from engine start circuit shall open to provide a signal to open air inlet dampers.
 - 2) Air inlet dampers shall fail open.
13. Baseplate:
 - a. Mount engine generator set on a rigid common steel base frame.
 - b. Base frame shall be stiffened to minimize deflections.

14. Vibration Isolators:
 - a. Provide vibration isolators, spring/pad type.
 - b. Include seismic restraints if required by Site location.
 15. Automatic Load Transfer Control: Automatic run controls shall be suitable for remote interface and control by automatic transfer switch, provided by others. Engine generator set shall start and run upon closure of a remote dry contact.
- C. Performance Characteristics:
1. Service Conditions:
 - a. Elevation: 7,500 feet above sea level.
 - b. Ambient Temperature at Engine Generator Set: 104 degrees F maximum.
 2. Ratings:
 - a. Operate at 1,800 rpm.
 - b. Rated as shown on the Drawings, based on specified service conditions.
 - c. Voltage: 480Y/277 volts, three-phase, three-wire, 60-Hz.
 - d. Rated based on standby service.
 3. Emissions: Engines shall meet US EPA standard emission requirements specified in 40 CFR Chapter I, Parts 60, 1048.
 4. Vibration Design: Engine and generator, individually, shall not exhibit vibration in any plane exceeding 10 mils at continuous rating point, when measured at attachment points to common steel subbase.

2.02 EXHAUST SYSTEM

- A. Physical Characteristics:
1. Exhaust Silencer:
 - a. Provide silencer suitable to be suspended from roof rafters by threaded rod.
 - b. Provide a weather-tight wall thimble for the exhaust piping and terminate with a rain cap.
 - c. Exhaust connections to generator set shall be through seamless flexible connections.
- B. Functional Characteristics:
1. Wrap exposed length of exhaust pipe and silencer with thermal insulating wrap.
 2. Exhaust Pipe: ASTM A335, Grade P11, standard wall, with fittings selected to match piping materials.
 3. Pipe Connections: Welded.

4. Engine Connection: Flanged, flexible, corrugated, Type 321 stainless steel expansion fitting, specifically suited for diesel exhaust service.
5. Length as required for flexibility and expansion in piping.

C. Performance Characteristics:

1. Silencer: Rated as “critical grade,” with exhaust noise reduction of 25 dBA to 32 dBA.

2.03 STARTING BATTERY

A. Physical Characteristics: None.

B. Functional Characteristics:

1. Batteries:
 - a. Lead-acid type.
 - b. Sized as recommended by engine manufacturer.
 - c. Capable of providing 15 seconds minimum of cranking current at 0 degree C and three complete 15-second cranking cycles at 40 degrees C.
 - d. Housed in acid-resistant frame isolated from engine generator main frame.
 - e. Located such that maintenance and inspection of engine is not hindered.
 - f. Complete with battery cables and connectors.
 - g. Provide electric battery warmer plate.

C. Performance Characteristics: None.

2.04 BATTERY CHARGER

A. Physical Characteristics: None.

B. Functional Characteristics:

1. UL 1236 listed and labeled.
2. 10-amp automatic float, taper and equalize charge type, with plus or minus 1 percent voltage regulation over a plus or minus 10 percent input voltage variation.
3. Temperature compensated to operate over an ambient range of minus 30 degrees C to 50 degrees C.
4. Locate charger in generator control panel, or wall mounted in generator enclosure. Generator manufacturer shall coordinate location.
5. Include:
 - a. Ammeter and voltmeter.
 - b. Fused ac input and dc output.

- c. Power ON pilot light.
- d. AC failure relay and light.
- e. Low and high dc voltage alarm relay and light.
- f. Alarm relay dry contacts rated 4 amps at 120V ac.
- g. Wire battery charger status and alarm contacts back to generator control panel, terminate and identify contacts.

C. Performance Characteristics: None.

2.05 FUEL SYSTEM

A. Physical Characteristics:

- 1. UL 142 compliant.
- 2. Sub-base double wall steel. Tank shall be constructed of commercial or structural grade carbon steel in accordance with:
 - a. Specification for Carbon Structural Steel, ASTM A36M; or Specification for Steel, Sheet and Strip, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy and HighStrength Low-Alloy with Improved Formability, ASTM A1011/A1011M; or Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled, ASTM A635/A635M.
- 3. Finish: Manufacturers standard color.
- 4. Sized for 24 hours of operation at 75 percent rated load.

B. Functional Characteristics:

- 1. Diesel.
- 2. Storage tank designed and manufactured for installation and use in accordance with the Flammable and Combustible Liquids Code, NFPA 30; the Standard for Installation of Oil-Burning Equipment, NFPA 31; the Motor Fuel Dispensing Facilities and Repair Garages, NFPA 30A; the Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, NFPA 37; the Uniform Fire Code, NFPA 1; and the International Fire Code published by the International Code Council.
- 3. In addition to vent openings, tank shall be provided with fittings to accommodate filling, inventory control and product withdrawal.
- 4. Complete engine fuel system including all pressure regulators, strainers, and control valves. The fuel system shall be plumbed to generator skid for ease of Site connections.
- 5. Fuel Connections to Engine: Flexible hose, suitable for application.
- 6. Diesel Fuel: Provide Fuel for testing and a full fuel tank after testing is complete.

C. Performance Characteristics: None.

2.06 FACTORY FINISHING

- A. Engine Generator Set and Instrument Panel: Factory-applied primer and two finish coats of manufacturer's standard heat-resistant engine paint.

2.07 FACTORY TESTS

- A. General: Conform to NFPA 110.
- B. Steady Load Test: Test engine generator set at steady load run of 60 minutes minimum duration at 100 percent full-rated load.
- C. Transient Load Test: Conduct transient load test to demonstrate ability to meet load pickup and load release requirements specified.
- D. Harmonic Test: Conduct at full load conditions on the actual unit or one of the same model and size.
- E. Record and Report:
 - 1. Strip chart recording and full harmonic analysis measuring up to 50th harmonic for both voltage and current and three phases simultaneously.
 - 2. Transient response.
 - 3. Load/speed stability.
 - 4. Engine fuel consumption.
 - 5. Power output.
 - 6. Harmonic analysis.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Level and securely mount engine generator set in accordance with manufacturer's recommendations.
- B. Install in accordance with NECA 404.
- C. Where applicable, mount engine generator set on vibration isolators in accordance with isolator manufacturer's recommendations.

3.02 FIELD FINISHING

- A. Touch up damaged coating with paint system compatible to existing.

3.03 FIELD TESTS BY GENERATOR MANUFACTURER

A. General:

1. Conform to NFPA 110.
2. Fuel provided by Contractor.
3. Top off fuel after testing.

B. Performance Test:

1. Perform upon completion of installation.
2. Operate 2 hours minimum, 1 hour at 50 percent load and 1 hour at full load.
 - a. Manufacture shall provide a resistive load bank, and all required connecting materials for the load testing.
3. Manufacturer's representative shall make necessary adjustments.
4. Demonstrate ability of engine generator set to carry specified loads.
5. Demonstrate engine generator set safety shutdowns.

C. Test Report:

1. Record and report the following:
 - a. Electric load on generator.
 - b. Fuel consumption.
 - c. Exhaust temperature.
 - d. Ambient air temperature.
 - e. Safety shutdown performance results.
 - f. Noise levels at meters.

D. Post-test Requirements:

1. Make final adjustments.
2. Replace fuel and oil filters.
3. Check belt drive tensions.
4. Demonstrate proper operation of equipment, including automatic operation with control from automatic transfer switch to Contracting Officer.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative:

1. Present at Site or classroom designated by Contracting Officer for minimum person-days listed below, travel time excluded:
 - a. 2 person-days for installation assistance and inspection.
 - b. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

- c. 1/2 person-day for prestartup classroom or Site training.
- d. 1/2 person-day for facility startup.
- e. 1/2 person-day for post-startup training. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Contacting Officer.

B. See Section 01 79 00, Demonstration and Training.

END OF SECTION