

**SECTION 26 32 13
ENGINE GENERATORS**

PART 1 - GENERAL**1.1 DESCRIPTION**

- A. This section specifies the furnishing, complete installation, connection and testing of the engine generator system. This includes: air filtration, starting system, generator controls, /instrumentation, lubrication, fuel system, cooling system and exhaust system.
- B. The engine generator system shall be fully automatic and shall constitute a unified and coordinated system ready for operation.
- C. The engine generator system shall include, but not be limited to the following:
 - 1. Diesel Engine.
 - 2. Lubrication Oil System.
 - 3. Fuel Oil System.
 - 4. Cooling System.
 - 6. Intake and Exhaust Air Systems.
 - 7. Starting System.
 - 8. Generator.
 - 9. Controls, Supervision and Distribution.
 - 10. Walk-In Outdoor Generator Enclosure.
 - 11. Spare Parts.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW: Cables and Wiring.
- C. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Requirements for automatic transfer switches.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- E. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: Requirements for secondary distribution switchboards.

1.3 QUALITY ASSURANCE

- A. The supplier of the diesel-engine generator set shall be responsible for satisfactory total operation of the system and its certification. This supplier shall have had experience with three or more installations of systems of comparable size and complexity in regards to coordinating, engineering, testing and supervising. Each of these installations shall have been in successful operation for three or more years. Prior to review of submittals, the Department of Veterans Affairs reserves the right to:
1. Have the manufacturer submit a list of locations of similar installations.
 2. Inspect any of these installations and operations of engine-generator set, and question the user concerning the installations without the presence of the supplier.
- B. Factory authorized representative shall be capable of providing emergency maintenance and repairs at the project site within 4 hours maximum of notification.
- C. Engine generator and auxiliary components shall be supplied from a single manufacturer.
- D. Noise level developed by the generator set shall be as herein specified.
- E. Factory Test: The Government shall have the option of witnessing the following tests at the factory. The Government will pay all expenses for the Government representative's trip to witness these tests. Contractor shall notify the COTR 15 days prior to date of testing. Manufacturer shall furnish load banks, testing instruments and all other equipment as necessary to perform these tests.
1. Load Test: Shall include six hours of continuous operation; four hours while the set is delivering 100 percent of the specified KW and two hours while delivering 110 percent of the specified KW. During this test record the following data at 20-minute intervals:

Time	Engine RPM	Oil Temperature Out
KW	Water Temperature In	Fuel Pressure
Voltage	Water Temperature Out	Oil Pressure
Amperes	Oil Temperature In	Ambient Temperature

2. Quick Start Test: Record time required for the engine generator set to develop specified voltage, frequency and KW load from a standstill condition.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 2. Data shall be submitted in the following form:
 - a. Technical data sheets (TDS): These include published performance, rating and derating curves, published ratings, catalog cuts, pictures, manufacturer's specifications, material composition, and gauge thickness.
 - b. Description of operation (DO): Manufacturer's literatures and, if suitable, diagrams.
 - c. Calculations (CALC): Detailed engineering calculations with all equations, graphs, assumptions, and approximations shown, and data sources referenced.
 - d. Certification (CERT): Written confirmation as to the document's accuracy, and genuineness.
 - e. Shop Drawings (SD): Scaled drawings showing plan views, side views, elevations and cross sections.
 - f. Diagrams (DGM): These include control system diagrams, elementary diagrams, control sequence diagrams or table, wiring diagrams, interconnections diagrams (between local control cubicles, remote annunciator panels, remote derangement panels, remote monitoring panels, remote exercising panel and underground fuel storage tanks), wireless connection diagrams, illustrative diagrams, flow diagrams, and other like items.
 3. Prior to fabrication, submit for approval the following data for each engine-generator set, transfer device and control and supervisory equipment:
 - a. Engine generator set: TDS, SD including subtransient reactance and short-circuit current capacity.
 - b. Engine jacket water heaters: TDS
 - c. Muffler assembly: TDS, SD
 - d. Motor-operated damper assembly: TDS

- e. Day tank and pumps or integral sub-base fuel tank: TDS, CALC
 - f. Batteries, racks and charger: TDS, CALC
 - g. Torsional Vibration: CERT
 - h. Control and Supervisory Equipment: TDS, DGM, DO, SD
 - i. Performance:
 - 1) Voltage regulating equipment: TDS
 - 2) Frequency regulating equipment: TDS
 - 3) Voltage and frequency dips and recovery times due to specified motor loading: CALC
 - 4) Antifreeze derating: TDS
 - 5) Ambient derating: TDS
 - k. Fuel oil system: DGM
 - l. Cooling system: DGM
 - m. Vibration isolators: TDS, CALC
 - n. Sound power level data for the packaged outdoor generator.
 - o. Vibration isolation system performance data from no-load to full-load. This must include seismic qualification of the engine-generator mounting, base and vibration isolation.
- C. Manuals:
- 1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals of the engine generator set and auxiliaries including technical data sheets, wiring diagrams, and information, such as telephone number, fax number, and web sites, for ordering replacement parts.
 - 2. Two weeks prior to the final inspection, submit four copies of the updated maintenance and operating manual to the COTR:
 - a. Include complete "As installed" diagrams, which indicate all items of equipment and their interconnecting wiring.
 - b. Include complete diagrams of the internal wiring for each of the items of equipment, including "As installed" revisions of the diagrams.
 - c. The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation and testing.
 - d. Complete lists of spare parts and special tools recommended for two years of normal operation of the complete system.
- D. Certifications:
- 1. Prior to fabrication of the engine-generator set, submit the following for approval, to the COTR:

- a. A certification in writing that a diesel engine of the same model and configuration, with the same bore, stroke, number of cylinders, and equal or higher BMEP and RPM ratings as the proposed diesel engine has been operating satisfactorily, with connected loads of not less than 75 percent of the specified KW/KVA rating, for not less than 2,000 hours without any failure of a crankshaft, camshaft, piston, valve, injector or governor system.
 - b. A certification in writing that devices and circuits will be incorporated to protect the voltage regulator and other components of the auxiliary electrical power system during operation of the diesel engine-generator set at speeds other than the rated RPM while performing maintenance. Include thorough descriptions with submittal of any precautions, which will be necessary to protect the voltage regulator and other components of the system during operation of the diesel engine-generator set at speeds other than the rated RPM.
2. Prior to installation of the engine-generator set at the job site, submit four copies of the following to the COTR:
 - a. Certified test data, alternator temperature rise test and strip chart recordings, and photographs showing test setup and equipment.
 3. Two weeks prior to the final inspection, submit four copies of the following, to the COTR:
 - a. Certified test report by the manufacturer of the engine-generator set that the auxiliary electrical power system conforms to the requirements of the drawings and specifications.
 - b. Certified report of field tests from the contractor that the engine-generator set and major auxiliaries have been properly installed, adjusted and tested.

1.5 STORAGE AND HANDLING

- A. Equipment shall withstand the mechanical stresses caused by rough handling during shipment in addition to the electrical and mechanical stresses, which occur during operation of the system. Protect radiator core with wood sheet.
- B. Store the equipment in a location approved by the COTR.

1.6 JOB CONDITIONS

- A. Shall conform to the arrangements and details shown on the drawings. The dimensions, enclosures and arrangements of the engine-generator set shall permit the operating personnel to safely and conveniently operate and maintain the system in the space designated for installation.
- B. Unless specified otherwise, each component of the engine-generator system shall be capable of operating as specified herein at 334 meters (1000 feet) above sea level in a ventilated room which will have average ambient air temperatures ranging from a minimum of 4 degrees C (40 degrees F) in winter to maximum of 49 degrees C (120 degrees F) in summer.

1.7 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American National Standards Institute (ANSI):
 - C37.50-00.....Low-Voltage AC Power Circuit Breakers used In Enclosures-Test Procedures
- C. American Society of Testing Materials (ASTM):
 - A53/A53M-04.....Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc Coated Welded and Seamless.
 - B88-03.....Specification for Seamless Copper Water Tube
 - B88M-03.....Specification for Seamless Copper water Tube (Metric)
- D. Institute of Electrical and Electronic Engineers (IEEE):
 - C37.13-95.....Low Voltage AC Power Circuit Breakers Used In Enclosures
 - C37.90.1-02.....Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- E. National Electrical Manufacturers Association (NEMA):
 - AB 1-02.....Molded Case Circuit Breakers and Molded Case Switches and Circuit Breaker Enclosures
 - ICS 6-01.....Industrial Control and Systems: Enclosures
 - ICS 4-05.....Terminal Blocks,
 - MG 1-04.....Motor and Generators
 - MG 2-01.....Safety Standard and Guide for Selection, Installation and use of Electric Motors and Generators

- PB 2-01.....Dead-Front Distribution Switchboards
- SG 3-95.....Low Voltage Power Circuit Breakers-Power
Switching Equipment
- SG 5-95.....Power Switchgear Assemblies
- 250-03.....Enclosures for Electrical Equipment (1000 Volts
Maximum)
- F. National Electrical Testing Association (NETA):
- ATS-95.....Electrical Power Distribution Equipment and
Systems
- G. National Fire Protection Association (NFPA):
- 30-03.....Flammable and Combustible Liquids Code.
- 37-02.....Installations and Use of Stationary Combustion
Engine and Gas Turbines
- 70-05.....National Electrical Code (NEC)
- 99-05.....Health Care Facilities
- 110-05.....Standard for Emergency and Standby Power
Systems.
- H. Underwriters Laboratories, Inc. (UL):
- 50-03.....Enclosures for Electrical Equipment
- 142-02.....Steel Aboveground Tanks for Flammable and
Combustible liquids
- 2085-95.....Insulated Aboveground Tanks for Flammable and
Combustible Liquids
- 2200-04.....Stationary Engine Generator Assemblies
- 1236-02.....Battery Charges for Charging Engine-Starter
Batteries
- 467-04.....Grounding and Bonding Equipment.
- 489-04.....Molded-Case Circuit Breakers, Molded-Case
Switches and Circuit-Breaker Enclosures
- 508-05.....Industrial Control Equipment
- 891-03.....Dead-Front Switchboards

PART 2 - PRODUCTS**2.1 DIESEL ENGINE-GENERATOR SET**

- A. The engine generator system shall be in accordance with NFPA, UL, NEMA and ANSI, and as specified and as shown on the drawings.
- B. Provide a factory-assembled, wired, (except for the field connections), complete, fully automatic diesel engine-generator system.
- C. Published Rating:

1. Building No. 1, Shall be not less than 1500/1875 KW/KVA (2000/2500 KW/KVA add alternate No. 2) Standby at 480/277 volts, 3 phase, 4 wire, 60 Hz and 0.80 power factor.
2. Building No. 4, Shall be not less than 350/438 KW/KVA Standby at 480/277 volts, 3 phase, 4 wire, 60 Hz and 0.80 power factor.
3. Shall be capable of operating continuously for 24 consecutive hours within any 24-hour period of operation at 110 percent of its specified rating without damage.
- D. Assemble, connect and wire the equipment at the factory so that only the external connections need to be made at the construction site.
- E. Unit shall be factory painted with manufacturer's primer and standard finishes.
- F. Coordinate the components of the system and their arrangements, electrically and mechanically.
- G. Connections between components of the system shall conform to the recommendations of the manufacturer of the diesel engine-generator set.
- H. Couplings, shafts, and other moving parts shall be enclosed and guarded. Guards shall be metal, ruggedly constructed, rigidly fastened and readily removable for convenient servicing of the equipment without disassembling any pipes and fittings.
- I. Generator set and cooling system shall be furnished with extended life antifreeze solution to protect the system from freezing at all times.
- J. Generator set shall have the following features:
 1. Factory-mounted on a common, rigid, welded, structural steel base.
 2. The maximum engine-generator set vibration in the horizontal, vertical, and axial directions shall be limited to 0.15mm with an overall velocity limit of 24 mm/sec RMS, for all speeds.
 3. The isolators shall be constrained with restraints capable of withstanding static forces in any direction equal to twice the weight of the supported equipment.
 4. Automatic start, accelerate to the specified RPM and deliver the specified KW/KVA output at 60 Hz within 10 seconds after a single pole contact closes in a remote device.
 5. Recover rapidly from instantaneous changes between no load and the specified KW/KVA rating, and the reverse changes of load, without damage.
 6. Shall be capable of operating satisfactorily as specified for not less than 10,000 hours between major overhauls.

7. Engine-generator set shall be statically and dynamically balanced at the factory in order to comply with the maximum vibration velocity specified in paragraph 3.1.D.

2.2 DIESEL ENGINE

- A. Coupled directly to a generator.
- B. Minimum 4-cylinders.
- C. Operating speed shall be 1800 RPM.
- D. BMEP for the diesel engine, while the engine-generator set is delivering 100 percent of its specified output, shall not exceed the following maximum limits:
- E. The minimum cubic inch displacement of the engine shall not be less than the value calculated from the following equation:

$$\text{Displacement} = \frac{\text{BHP} \times \text{K}}{\text{BMEP} \times \text{RPM}}$$

$$\text{Where BHP} = \frac{\text{Specified KW} + \text{R}}{0.746 \times \text{G}}$$

K = 396,000 for 2-cycle engines

K = 792,000 for 4-cycle engines

BMEP = Values specified above

RPM = 1800

G = generator efficiency expressed as a decimal

R = horsepower of radiator fan

R = 0, when electric motor driven radiator fan is herein specified

- F. The engine shall be able to start in a 4.5 degrees C (40 degrees F) ambient temperature while using No. 2 diesel fuel oil without the use of starting aids such as glow plugs and ether injections.
- G. Fuel oil consumption of the engine rate shall not exceed 0.40 pounds of fuel oil per BHP per hour when it delivers 100 percent of its specified KW/KVA rating.
- H. Equipped with electric heaters for maintaining the engine's coolant temperature in the range of 32-38 degrees C (90-100 degrees F) as recommended by the manufacturer.
 - 1. Install thermostatic controls, contactors, and circuit breaker protected circuits for the heaters.
 - 2. The heaters shall operate continuously except while the engine is operating or the water temperature is at the predetermined level.

2.3 GOVERNOR

- A. Isochronous; electronic or hydraulic type.
- B. Steady-state speed band at 60 Hz shall not exceed plus or minus 1/3 of one percent.
- C. At 60 Hz, when load changes equal to 25 percent of the specified KW/KVA rating, frequency change shall not exceed two percent and it shall recover to 60 Hz within three seconds.
- D. At 60 Hz, when load changes equal to 100 percent of the specified KW/KVA rating, frequency change shall not exceed eight percent and it shall recover to 60 Hz within five seconds.
- E. While the engine is running, manual speed adjustments may be made.

2.4 LUBRICATION OIL SYSTEM

- A. Pressurized type.
- B. Positive-displacement pump driven by engine crankshaft.
- C. Full-flow strainer and full-flow or by-pass filters.
- D. Filters shall be cleanable or replaceable type and shall remove particles as small as 3 microns without removing the additives in the oil. For by-pass filters, flow shall be diverted without flow interruption.
- E. Extend lube oil sump drain line passing out through the skid base and terminate it with a drain valve and plug.
- F. Provide a 120-volt oil heater for exterior generator set.

2.5 FUEL OIL SYSTEM

- A. Shall comply with NFPA 37 and NFPA 30, and have the following features:
 - 1. Injection pump(s) and nozzles.
 - 2. Plungers shall be carefully lapped for precision fit and shall not require any packing.
 - 3. Filters or screens, which require cleaning or replacement, will not be permitted in the injection system assemblies.
 - 4. Return surplus oil from the injectors to the main storage tank by gravity or a pump.
 - 5. Filter System:
 - a. Dual primary filters shall be located between the main fuel oil storage and day tank.
 - b. Secondary filters (engine mounted) shall be located so the oil will be thoroughly filtered before it reaches the injection system assemblies.

- c. Filters shall be cleanable or replaceable type and shall entrap and remove water from oil as recommended by the engine manufacturer.

B. Day Tank:

1. Capacity of the day tank shall be not less than:
 - a. 75 gallons for generator sets specified from 201 KW to 300 KW.
 - b. 4 hours fuel consumption based on 100% load for generator sets specified over 300 KW.
2. Shall be welded steel, UL approved.
3. Secure, pipe and connect the tank adequately for maximum protection from fire hazards, including oil leaks.
4. Incorporate a vent, drain cock, shutoff cocks and gauge glass. Terminate the vent piping outdoors with mushroom vent cap.
5. Incorporate a float switch on the day tank to control the fuel oil transfer pump and to actuate an alarm in the engine generator control cubicle when the oil level in the tank drops below the level at which the transfer pump should start to refill the tank.
 - a. The float switch contacts, which control the fuel oil transfer pump, shall be set to energize the pump when the liquid level in the tank reaches 1/3 of the total volume of the tank.
 - b. The float switch contacts, which actuate the low fuel oil day tank alarm device, shall be set to alarm and energize the second fuel transfer pump when the liquid level in the tank reaches 1/4 of the total volume of the tank.
6. Day tank and engine supply line elevations shall be below the elevation of the injector return outlet on the engine.
7. Provide a packaged design fuel oil day tank for prime mover. Day tank shall be complete in all respects in order to provide the prime mover with a reliable, local source of fuel. Day tank shall be for use with main tank and remote fuel delivery system described elsewhere in order to provide an automatic, self-refilling fuel supply system.
8. The day tank shall be designed and supplied as an engineered system by the manufacturer. The tank shall be of packaged design to include all inlet flow control devices, other valves, level controls, remote pump activation, indicators, alarms and all other devices as required to form an integrated, functional system such that field installation is restricted largely to external piping, wiring and such intermediate devices that are required by code and/or good

engineering practice to interconnect the bulk source of supply to the day tank, the day tank to the prime mover and to provide for external vents as per local codes and UL142, NFPA31 and NFPA37.

- i. The system shall be for use with fuel oil as described by NFPA321, "Basic Classification of Flammable and Combustible Liquids". As defined by this standard, the fuel supply system shall be for use with "combustible liquids", those having a flash point at or above 100°F and further defined as class II or class III liquids. In no case shall a liquid defined as "flammable", or as "class I" or as having a flash point less than 100°F be used. In every case, the system shall not be used or applied at a temperature in excess of the flash point of the contents. Electrical equipment used in the system shall be in accordance with NFPA30, section 5-7, wherein it states "For areas where class II or class III liquids only are stored or handled at a temperature below their flash points, the electrical equipment may be installed in accordance with provisions of NFPA70, National Electric Code, for ordinary locations..."
 - ii. The system shall be designed and installed in accordance with applicable sections of NFPA30, NFPA31, NFPA37, UL80 and UL142. The day tank shall bear the label of Underwriters Laboratories standard 142 and UL508.
9. The day tank shall be installed adjacent to the prime mover, on the same grade. Install as shown on the plan drawings, on a housekeeping pad adjacent to the prime mover. Anchor tank to the pad. Provide weather proof enclosure.
10. Provide schedule 40, ASTM A 53, black iron pipe connections to the day tank. Make all connections to fixed installed pipe with pipe unions to facilitate tank service/removal.
- i. Supply to Day-tank from remote pumps
 - ii. Day tank overflow to bulk supply
 - iii. Supply and return to prime mover, as recommended by manufacturer
 - iv. Vent sizes shall be as shown and as required by local codes and by UL 142, NFPA31 and NFPA37 specification
11. Day tank ratings
- i. Capacity: 325 gallons

- ii. Power requirements: 208 VAC, 3-phase, 60Hertz, 15A dedicated branch circuit
 - iii. Day tank construction
 - a. All welded steel atmospheric tank of rectangular construction built in accordance with codes and standards noted above for outdoor use with fuel oil
 - b. Pipe thread connections shall be provided for:
 - Fuel oil supply from remote pump set, 1-1/4 inch
 - Supply to prime mover, 1.0 inch
 - Return from prime mover, 1.0 inch
 - Supply to overflow return pump, 1.0 inch
 - Vent, 2.0 inch
 - Emergency vent, 4.0 inch - (1) for 50 & 75-gallons, (2) for 100 gallon tanks & larger
 - Drain, 0.75 inch, with drain valve
 - c. An inspection port in the top shall be provided
 - d. The tank shall be equipped with a welded steel channel base suitable for bolt attachment to a concrete pad
 - e. The tank shall have interior corrosion protection
 - f. The exterior of the day tank shall receive a heavy duty industrial anti-corrosion coating and be finish painted
 - g. All day tank system components shall be protected by a removable steel equipment cover.
 - h. Day tank shall be factory leak tested at 3PSI.
 - i. The tank shall be steel double-wall construction bearing the UL 142 label and having a containment rating of 110% of the primary day tank. The containment shall be equipped with a leak detector that shall activate the "rupture" alarm described below. A drain with rated ball valve is to be supplied. The containment shall be equipped with a separate e-vent as required by UL 142.
12. Fuel delivery systems
- i. The day tank shall be fed from a remote pump set described elsewhere.
 - ii. Provide the following inlet devices:
 - Inlet Back-Siphon Prevention Check Valve

13. Day tank level controller. A UL Listed, integrated design PLC level controller w/Modbus Communication shall be supplied which provides differential level control for activation of supply pump, tank level indication, leak indication, system alarms and manual operating controls. Level controller shall be self-contained as a unit within a Type 3R box suitable for mounting on or on top of the day tank. The controller shall utilize discrete level sensors and circuit paths for level alarms and fill pump control. Failure in one sensor or circuit path shall not necessarily disable the entire controller. All indicators are to be long life light emitting diodes.

- i. The level controller shall provide the following

Control functions

- Isolated "Auto-off-manual" pump control mode switch
- "Press to test" pump push-button
- Pump start-stop automatic level control
- Pump overflow control backup

Indication Functions

- Fuel level
- Power available
- Switch not in auto
- Pump running
- Low level alarm
- High level alarm
- Overflow alarm/pump control backup activated
- Day Tank leak

Outputs

- Pump running
- Low level alarm (60W)
- High level alarm (60W)
- Day tank leak

- a. The level controller shall have an intrinsic overflow cutout backup control which, upon sensing an overflow, will stop the pump, activate an alarm and cause the controller to revert to an emergency backup level control mode which

allows the tank to continue operating automatically but which inhibits overflow.

- b. Mode control switch: "Manual - OFF - Auto"
 - c. Pump running indicator
 - d. Control power transformer
 - e. Programmed for operation as detailed above and to include MODBUS Communication protocol and communication port for remote monitoring capability.
 - f. Provide daytank control panel anti-condensation heater.
14. Overflow-return pump: Provide a day tank mounted overflow-return pump with controller:
- i. 1-HP, 17 GPM at 50 PSI at 1725 rpm, when operating with fuel oil having a viscosity of 50SSU.
 - ii. Direct drive, motor driven pump coupled via flexible coupling.
 - iii. Motors to be open drip proof construction, 1.0 HP, NEMA type B, continuous duty at 40°C, 1725 RPM, 208 VAC, 3-phase, 60 hertz, 1.15 service factor.
 - iv. Pumps to be directly driven, positive displacement, internal gear type with mechanical shaft seal. Pump shall be a high pressure, hydraulic type consisting of two intermeshing, hardened steel, precision ground gear assemblies enclosed by a high strength, die cast aluminum housing, hardened drive shaft, pressure loaded mechanical shaft seal.
 - v. Provide check valve on pump outlet
 - Provide overflow-return pump controller
 - Arm pump at 70% day tank level
 - Activate pump at 95% day tank level and pump down to 70% level.
 - Lock-out fill system when overflow-return pump is activated
 - Provide alarm when overflow-return pump is activated
 - Provide test push-button, running and armed indicators
 - vi. Provide a day-tank mounted submersible oil heater with adjustable thermostat and low level cut-out. Sized as required for the volume of day-tank being used. Powered from separate power supply.
15. Provide a manufacturers two-year parts and labor warranty.
16. Day tank testing
- i. The day tank shall be supplied with manufacturers test certificates as below

- Tank test: pressure test, leak proof test and structural integrity/appearance test
- Level controller: operational test with liquid of level sensors, level indicator, level control, alarms, backup devices
- Pump: vacuum test, flow test, pressure test, leak proof test, ampere/voltage test, load test, overload test.

17. Day tank manual

- i. The day tank shall be supplied with an illustrated manufacturers manual that includes the following:

- Registration certificate
- Glossary
- Equipment list
- Detailed description of operation
- Pump specifications
- Installation instructions
- Troubleshooting instructions
- Maintenance instructions
- Piping diagram
- Electrical drawing
- Exploded view parts drawing/parts list
- Dimensional drawing
- Warranty card

18. The day tank system, shall be designed and manufactured by a single supplier and be a standard product in serial production. The manufacturer shall have at least 10 years experience in the design and manufacture of these products.

C. Fuel Oil Transfer Pump-Main Storage Tank to Day Tank(s).

1. Electric motor-driven, duplex arrangement, close-coupled, single-stage, positive-displacement type with built-in pressure relief valves. When the fuel is used for cooling components of the fuel injection system, the engine's fuel return line shall be returned to the main storage tank, rather than the day tank.
2. Include a heavy-duty automatic alternator and H-0-A switch to alternate sequence of pumps and allow maintenance. Pumps shall be controlled with the float switch on the day tank and H-0-A selector

- switch so the day tank will be refilled automatically when the oil level lowers to the low limit for the float switch. The H-0-A selector switches shall enable the pumps to be operated manually at any time.
3. For all engines, each transfer pump and its electrical and plumbing connections shall be sized to provide a flow rate of at least four times the engines' fuel pumping rate.
 4. Provide a manually operated, rotary-type, transfer pump connected in parallel with the electric motor-driven transfer pumps so that oil can be pumped to the day tank while the electric motor-driven pumps are inoperative.
- D. Fuel Supply Pump System: Provide a packaged, skid style, fuel oil pump set and pump controller for supply of fuel to generator injector inlets. Pump set shall be of low/medium pressure design in order to supply a day-tank located at 30-feet total dynamic head above the level of the pumps. The system shall be complete in all respects in order to draw fuel from an adjacent main storage tank and supply fuel to the remote day-tank.
- E. Pump set construction
1. The pump set shall consist of rigid, 7-gauge steel, all welded skid which shall maintain alignment of pumps, piping and all mechanical components. The skid shall include a drip pan/containment with raised 3-inch lip to contain any leakage or spills.
 2. The drip pan/containment shall be equipped with a leak sensor to detect leakage of fuel. This sensor shall activate an alarm on the pump set control panel.
 3. Piping shall be schedule 40 seamless steel with threaded or flanged fittings. Flexible hoses shall not be allowed.
 4. The pump set shall include a 1-1/4-inch fuel supply manifold, 1-1/4 inch fuel outlet manifold and 1-inch fuel return manifold. 1-inch pipe flange connections shall be supplied on each end of the manifolds. A main 1-inch, ball type, 600PSI, bronze construction shutoff valve shall be provided at the inlet and outlet connection.
 5. The pump set controller shall be installed upon risers welded to the pump set skid. The pump set controller shall be housed within a Type1 enclosure.
 6. The entire pump set skid/controller shall be painted in fuel oil resistant white industrial enamel.

F. Duplex pumps:

1. 1/2 HP, 7 GPM at 50 PSI at 1725 rpm, when operating with fuel oil having a viscosity of 50SSU.
2. Direct drive, motor driven pump coupled via flexible coupling.
3. Motors to be open drip proof construction, .50 HP, NEMA type B, continuous duty at 40°C, 1725 RPM, 208 V AC, 3-phase, 60 hertz, 1.15 service factor
4. Pumps to be directly driven, positive displacement, internal gear type with mechanical shaft seal. Pump shall be a high pressure, hydraulic type consisting of two intermeshing, hardened steel, precision ground gear assemblies enclosed by a high strength, cast aluminum housing, hardened drive shaft, pressure loaded mechanical shaft seal. Pump shall have PSI capability as dictated on the equipment schedule.
5. Pump pressure relief valve, for each pump, adjustable type, 50-400 PSI, set at 65-PSI, bronze construction with stainless steel spring. To be connected to pressure relief return manifold for return to main tank. The pressure relief valve shall be installed on the outlet of the pump prior to the pump check valve.
6. Shutoff ball valves, installed as below, bronze construction, stainless steel ball, Teflon seal, 600PSI.
 - Main pump set inlet valve, prior to duplex strainer
 - Pump inlet shutoff valves, after strainer and prior to flow switch: each pump
 - Pump outlet shutoff valves, after check valve and prior to main shutoff valve: each pump
 - Main pump set outlet valve, after pump shutoffs
7. Pump check valve, swing-type, each pump, bronze construction, 600PSI. The check valve shall be installed on the outlet side of the pump after the pressure relief valve and prior to the pump outlet shutoff valve.

G. Duplex strainer:

1. One duplex fuel oil strainer on the pump suction sized to produce no more than ½"Hg pressure drop through a clean strainer with both pumps operating. Strainer shall allow flow transfer between baskets without interruption of flow. Strainer body shall be cast iron with yoke type, quick opening covers. Strainer shall be fitted with threaded drain plug and suitable for 200PSI operating pressure. Baskets shall

be stainless steel with 40-mesh screens. Equip strainer with differential pressure switch and panel alarm indicator to check strainer when dirty.

H. Fuel oil gauges:

1. 2-inch dial pressure gauge installed on the outlet of each pump.

Gauge construction shall be brass socket, stainless steel case, copper alloy bourdon tube, brass movement, polycarbonate window, white enameled aluminum dial with black scale, black enameled aluminum pointer. Gauge shall be filled with liquid glycerin to dampen vibrations. 270°-scale shall be 0-500PSI. Gauge shall be installed with isolation ball valve.

2. 2-inch dial vacuum gauges, installed on the inlet to each pump after the strainer and on the inlet to the duplex strainer. Gauge construction as above.

I. Flow switches, one each installed on the inlet of each pump. Switches shall be used to sense for proper pump operation as required by control system described below. Switches shall be bronze construction, shuttle/reed switch type, 400PSI rated. Switch shall be installed after strainer and prior to pump

J. Pump controller, for activation by remote daytank "Call for Fuel" contacts.

- 1.6.1 Function: PLC w/ Modbus Automatic duplex pump controller to provide lead-lag operation with automatic alternation of pumps on successive starts and automatic lag pump back-up. With control switch in "automatic" position, upon closure of remote control contacts, lead pump starts and runs. Upon time-out of flow switch delay, pump failure circuit is armed and monitors for proper pump flow. Upon sensing of loss of flow, lag pump is started and runs continuously until manually reset, alarm is activated to manual reset. In normal operation, upon subsequent closure of remote control contacts, pumps alternate operation.

- Pump motor starter, full voltage type, non-reversing, with overload relay, circuit breaker and disconnect switch with lockable, externally operable, weatherproof handle mechanism.

- Mode control switch per each pump: "automatic" - "off"- "pump run"
- Pump running indicators
- Pump failure indicators
- Pump set leak indicator

- Audible alarm horn with reset push-button
 - Alarm reset push-button
 - All wiring within shall be run in raceways, terminated at numbered terminal blocks and shall be color-coded and numbered at each end per the as-built drawings supplied with the system.
 - Power inlet to the Fuel Supply Center shall be made to a door mounted main disconnect switch that is mechanically interlocked with the door such that power must be disconnected prior to opening the enclosure.
 - The system shall be supplied with an isolation type control power transformer with fused primary. Control power circuits shall be subdivided into discrete fused branches such that critical circuits are isolated among each other and from non-critical circuits.
- K. Provide fusible link, automatic closing, cast iron construction fire valve on the supply to pump set.
- L. Piping System: Black steel, standard weight, ASTM A-53 pipe and necessary valves and pressure gages between:
1. The engine and the day tank as shown on the drawings.
 2. The day tank and the supply and return connections at the underground storage tank as shown on the drawings. Connections at the engine shall be made with flexible piping suitable for the fuel furnished.
 3. See fuel oil piping diagram on the drawings.

2.6 ENGINE COOLING SYSTEM

- A. Liquid-cooled, closed loop, with radiator mounted on the engine generator set and integral engine driven circulating pump as shown on the drawings.
- B. Cooling capacity shall not be less than the cooling requirements of the engine-generator set and its lubricating oil while operating continuously at 110 percent of its specified rating.
- D. Coolant shall be extended life antifreeze solution, 50 percent ethylene and 50 percent soft water, with corrosion inhibitor additive as recommended by the manufacturer
- E. Radiator core tubes material shall be as recommended by the engine manufacturer.
- F. Fan shall be driven by multiple belts from engine shaft

2.7 AIR INTAKE AND EXHAUST SYSTEMS**A. Air Intake:**

Provide an engine-mounted air cleaner with replaceable dry filter and dirty filter indicator.

B. Exhaust System:**2. Exhaust Muffler:**

- a. Shall be Critical grade type and capable of the following noise attenuation:

Octave Band Hertz (Mid Frequency)	Minimum db Attenuation (.0002 Microbar Reference)
31	5
63	10
125	27
500	37
1000	31
2000	26
4000	25
8000	26

3. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine-generator set while it is delivering 110 percent of its specified rating.
4. Exhaust pipe size, from the engine to the muffler, shall be as recommended by the engine manufacturer. Pipe size from muffler to air discharge shall be two-pipe sizes larger than engine exhaust pipe.
5. Connections at the engine exhaust outlet shall be made with a flexible exhaust pipe. Provide bolted type pipe flanges welded to each end of the flexible section.

C. Condensate drain at muffler shall be made with schedule 40 black steel pipe through a petcock.**D. Exhaust Piping and Supports:** Black steel pipe, ASTM A-53 standard weight with welded fittings. Spring type hangers, as specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT, shall support the pipe.**2.8 ENGINE STARTING SYSTEM****A. Shall start the engine at any position of the flywheel.****B. Electric cranking motor:**

1. Shall be engine-mounted.
 2. Shall crank the engine via a gear drive.
 3. Rating shall be adequate for cranking the cold engine at the voltage provided by the battery system, and at the required RPM during five consecutive starting attempts of 10 seconds cranking each at 10 second intervals, for a total of 50 seconds of actual cranking without damage.
- C. Batteries: 24 volt electric with the following features:
1. Batteries shall be nickel-cadmium high discharge rate type.
 2. Each battery cell shall have minimum and maximum electrolyte level indicators, and flip top flame arrestor vent cap.
 3. Batteries shall have connector covers for protection against external short circuits.
 4. With the charger disconnected, the batteries shall have sufficient capacity so that the total system voltage does not fall below 85 percent of the nominal system voltage with the following demands:
 - a. Five consecutive starting attempts of 10 seconds cranking at 10 second intervals for a total of 50 seconds of actual cranking (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).
 5. Battery racks shall be metal with an alkali resistant finish and thermal insulation, and secured to the floor.
 6. Battery shall operate continuously for 12 hours and be able to provide the cranking power described in 2.8.B.3 without charging.
- D. Battery Charger:
1. The charger shall maintain one percent voltage regulation from no load to full load for line voltage variation of 10 percent and frequency variation of ± 3 Hz from 60 Hz.
 2. The charger shall maintain a nominal float voltage of 1.4 vdc and a nominal equalizing voltage of 1.6 vdc.
 3. The charger shall be capable of continuous operation in an ambient temperature of -20 to 60 degrees C (-30 to 104 degrees F) without derating. The charger shall be convection cooled and housed in a NEMA 250, Type 1 enclosure. The charger shall have a hinged front door and all components shall be accessible from the front.
 4. Provide both AC and DC transient protection. Charger shall be able to recharge a fully discharged battery without tripping AC protective

- devices. AC circuit breaker shall not trip under any DC load condition including short circuit on output terminals.
5. The charger shall be capable of recharging the fully discharged battery in 12 hours and simultaneously power the Supervisory and Control panel.
 6. The charger shall have fused AC input and DC output protection, and shall not discharge the batteries when AC power fails.
 7. The charger shall have the following accessories:
 - a. On-Off control switch with pilot light.
 - b. Hand adjustable 0 to 24 hour equalize charge timer.
 - c. AC power failure alarm light.
 - d. High DC voltage alarm light.
 - e. DC voltmeter - 5 percent accuracy.
 - f. DC Ammeter - 5 percent accuracy.

2.9 GENERATOR

- A. Synchronous, amortisseur windings, bracket-bearing, self-venting, rotating-field type connected directly to the engine.
- B. Lifting lugs designed for convenient connection to and removal from the engine at the construction site.
- C. Integral poles and spider, or individual poles dove-tailed to the spider.
- D. Insulation shall be as required for the ambient temperature and other requirements designated in the paragraph, DIESEL ENGINE-GENERATOR SET, in this section.
- E. Designed for sustained short circuit currents in conformance with NEMA Standards.
- F. Designed for sustained operation at 125 percent of the RPM specified for the generator set without damage.
- G. Telephone influence factor shall conform to NEMA Standards.
- H. Furnished with brushless excitation system or static-exciter-regulator assembly.
- I. Nameplates attached to the generator and exciter shall show the manufacturer's name, equipment identification, serial number, voltage ratings, field current ratings, KW/KVA output ratings, power factor rating, time rating, temperature rise ratings, RPM ratings, full load current rating, number of phases and frequency, and date of manufacture.
- J. At full load, the efficiency shall be not less than:
 1. 89 percent for sets specified from 60 KW to 175 KW.

2. 92 percent for sets specified over 175 KW.

- K. The neutral shall be electrically isolated from equipment ground and terminated in same junction box as the phase conductors.

2.10 EQUIPMENT FOR CONTROLS, SUPERVISION AND DISTRIBUTION

- A. Shall include Engine Generator Control Cubicle(s) Master Control Cubicle Remote Annunciator Panel Remote Monitoring Panel Exercising Control Panel.

1. Control Equipment shall be in accordance with UL 508, NEMA ICS-4, ICS-6 and ANSI C37.90.1.

2. Panels shall be in accordance with UL 50.

3. Cubicles shall be in accordance with UL 891.

4. Incorporate all of the items required to fulfill the requirements in the specifications and on the drawings.

5. Components:

- a. Shall be heavy duty, industrial type.
- b. Electrical contacts shall be precious metal surfaced.
- c. Only heavy duty solid-state components will be accepted.

6. Coordinate controls with the automatic transfer devices shown on the drawings, so that the systems will operate as specified.

7. Cubicles and Panels:

- a. Code gauge steel; manufacturer's recommended heavy gauge steel with factory primer and light gray finish.
- b. Doors shall be gasketed and be attached with concealed or semi-concealed hinges, and shall have a permanent means of latching in closed position.
- c. Panels shall be wall mounted or incorporated in other equipment as indicated on the drawings or as specified.
- d. Cubicle design shall be of frame construction free standing sheet metal cabinet, floor supported with front and rear access openings for air circulation.
- e. Door locks for panels and cubicles shall have identical keying to operate from a single key.
- f. Panel installation shall be suitable for convenient maintenance and operation. Overall heights of the cubicles shall not exceed 2.5 meters (90 inches).

8. Wiring: Insulated, rated at 600 volts, UL approved.

- a. Install the wiring in vertical and horizontal runs, neatly harnessed.

- b. Terminate all external wiring at heavy duty, pressure type, terminal blocks.
9. Clearly and permanently label the equipment, wiring terminals and wires.
10. Laminate or mount under plexiglas appropriate wiring diagrams and mount them within the frame on the inside of the cubicles and panels.
11. The system shall be designed and manufactured employing the most modern technology to insure maximum reliability and longevity.
13. All indicating lamps and switches shall be accessible and mounted on the cubicle doors.
14. Electronic governor control panel, voltage regulator, control panel, motorized voltage adjusting potentiometer, and associated components shall be shipped to the generator control switchboard manufacturer for assembly, mounting and/or interwiring in the switchboard. Detailed drawings outlining proper interconnection and physical mounting data shall also be furnished to the generator switchboard manufacturer to facilitate proper design and interfacing. The engine generator set supplier shall furnish these items as soon as possible.
15. All meters shall be solid-state switchboard type, 112 mm (4-1/2 inches), 1 percent accuracy transformer rated for 600 volt service. Ammeters and voltmeters shall be furnished with phase selector switches. Metering shall include necessary current and potential transformers and instrument fuses.
16. The repetitive accuracy of the monitors shall be as stated over an environmental temperature range of 0 to 45 degrees C (32 to 113 degrees F) and voltage range of 70 to 110 percent of nominal. The accuracy shall not exceed the following limits:

Voltage Monitors	+ 2 percent of set point
Current Monitors	+ 3 percent of set point
Frequency Monitors	+ 0.2 Hz.
Power Monitors	+ 3 percent of set point

17. The manufacturer shall coordinate the interfacing of the control systems with all related equipment supplied in accordance with other sections of the project specification.
- B. Engine Generator Control Cubicle
1. Starting and Stopping Controls:

- a. A three-position, maintained-contact type selector switch with positions marked "AUTOMATIC", "OFF" and "MANUAL". Provide flashing amber light for "OFF" and "MANUAL" positions.
 - b. A momentary contact pushbutton switch with positions marked "MANUAL START" and "MANUAL STOP".
 - c. Selector switch in "AUTOMATIC" position shall cause the engine to start automatically when a single pole contact in a remote device closes. When the generator's output voltage increases to not less than 90 percent of its rated voltage, and its frequency increases to not less than 58 Hz, the remote devices shall transfer the load to the generator. An adjustable time delay relay, 0 to 15 minute range, shall cause the engine generator set to continue operating without any load after completion of the period of operation with load. Upon completion of the additional 0 to 15 minute (adjustable) period, the engine generator set shall stop.
 - d. Selector switch in "OFF" position shall prevent the engine from starting either automatically or manually. Selector switch in "MANUAL" position shall cause the engine to start when the manual start pushbutton is also depressed momentarily.
 - e. With selector switch in "MANUAL" position, depressing the "MANUAL STOP" pushbutton momentarily shall stop the engine after a cool down period.
 - f. A maintained contact, red mushroom head pushbutton switch marked "EMERGENCY STOP" will cause the engine to stop without a cool down period independent of the position of the selector switch.
2. Engine Cranking Controls:
- a. The cranking cycles shall be controlled by timer that will be independent of the battery voltage fluctuations.
 - b. Shall crank the engine through one complete cranking cycle, consisting of four starting attempts of 10 seconds each and 10 seconds between each attempt.
 - c. Total actual cranking time for the complete cranking cycle shall be 40 seconds during a 70 second interval.
 - d. Cranking shall terminate when the engine starts so the starting system will not be damaged. Termination of the cranking shall be controlled by self-contained, speed-sensitive switch. The switch shall prevent re-cranking of the engine until after the engine stops.

e. After the engine has stopped the cranking control shall reset.

3. Supervisory Controls:

a. Overcrank:

- 1) When the cranking control system completes one cranking cycle, four starting attempts, without starting the engine, the "OVERCRANK" signal light and the audible alarm shall be energized.
- 2) The cranking control system shall lock-out, and shall require a manual reset.

b. Coolant Temperature:

- 1) When the temperature rises to the predetermined first stage level, the "HIGH COOLANT TEMPERATURE - FIRST STAGE" signal light and the audible alarm shall be energized.
- 2) When the temperature rises to the predetermined second stage level, which shall be low enough to prevent any damage to the engine and high enough to avoid unnecessary engine shutdowns, the "HIGH COOLANT TEMPERATURE - SECOND STAGE" signal light and the audible alarm shall be energized and the engine shall stop.
- 3) Difference between the first and second stage temperature settings shall be approximately -12 degrees C (10 degrees F).
- 4) Permanently indicate the temperature settings near the associated signal light.
- 5) When the coolant temperature drops to below 21 degrees C (70 degrees F), the "LOW COOLANT TEMPERATURE" signal light and the audible alarm shall be energized.

c. Low Coolant Level: When the coolant level falls below the minimum level recommended by the manufacturer, the "LOW COOLANT LEVEL" signal light and audible alarm shall be energized.

d. Lubricating Oil Pressure:

- 1) When the pressure falls to the predetermined first stage level, the "OIL PRESSURE - FIRST STAGE" signal light and the audible alarm shall be energized.
- 2) When the pressure falls to the predetermined second stage level, which shall be high enough to prevent damage to the engine and low enough to avoid unnecessary engine shutdowns, the "OIL PRESSURE - SECOND STAGE" signal light and the audible alarm shall be energized and the engine shall stop.

- 3) Difference between the first and second stage pressure settings shall be approximately 15 percent of the oil pressure.
 - 4) Permanently indicate the pressure settings near the associated signal light.
- e. Overspeed:
- 1) When the engine RPM exceeds the maximum RPM recommended by the manufacturer of the engine, the engine shall stop.
 - 2) Simultaneously, the "OVERSPEED" signal light and the audible alarm shall be energized.
- f. Low Fuel - Day Tank:
- 1) When the fuel oil level in the day tank decreases to less than the level at which the fuel oil transfer pump should start to refill the tank, the "LOW FUEL DAY TANK" light and the audible alarm shall be energized.
- g. Low Fuel - Main Storage Tank:
- 1) When the fuel oil level in the storage tank decreases to less than 1/3 of total tank capacity, the "LOW FUEL-MAIN STORAGE TANK" signal light and audible alarm shall be energized.
- h. Reset Alarms and Signals: Overcrank, Coolant Temperature, Coolant Level, Oil Pressure, Overspeed, and Low Fuel signal lights and the associated audible alarms shall require manual reset. A momentary-contact silencing switch and pushbutton shall silence the audible alarm by using relays of solid state devices to seal-in the audible alarm in the de-energized condition. Elimination of the alarm condition shall automatically release the sealed-in circuit for the audible so that it will be automatically energized again when the next alarm condition occurs. The signal lights shall require manual reset after elimination of the condition, which caused them to be energized. Install the audible alarm just outside the generator room in a location as directed by the COTR. The audible alarm shall be rated for 85 dB at 3 meter (10 feet).
- i. Generator Breaker Signal Light:
- 1) Molded case circuit breaker and contactor: A flashing green light shall be energized when the generator circuit breaker is in either the "OPEN" or "TRIPPED" position.

- 2) Power circuit breaker: A flashing green light shall be energized when the generator circuit breaker is in the "OPEN" or "TRIPPED" position.
 - 3) Simultaneously, the audible alarm shall be energized.
4. Monitoring Devices:
- a. Electric type gauges for the cooling water temperatures and lubricating oil pressures. These gauges may be engine mounted with proper vibration isolation.
 - b. A running time indicator, totalizing not less than a 9,999 hour, heavy duty and an electric type tachometer.
 - c. Voltmeter, ammeter, and their selector switches, frequency meter, kilowatt meter, manual adjusting knob for the output voltage and the other items shown on the drawings shall be mounted on the front of the generator control panels.
 - d. Install potential and current transformers as required.
 - e. Individual signal lights:
 - 1) OVER-CRANK
 - 2) HIGH COOLANT TEMPERATURE - FIRST STAGE
 - 3) HIGH COOLANT TEMPERATURE - SECOND STAGE
 - 4) LOW COOLANT TEMPERATURE
 - 5) OIL PRESSURE - FIRST STAGE
 - 6) OIL PRESSURE - SECOND STAGE
 - 7) LOW COOLANT LEVEL
 - 8) GENERATOR BREAKER
 - 9) OVERSPEED
 - 10) LOW FUEL - DAY TANK
 - 11) LOW FUEL - MAIN STORAGE TANK
 - f. Lamp Test: "Lamp Test" momentary contact switch shall momentarily actuate the alarm buzzer and all the indicating lamps.
5. Power switching and overcurrent protection shall be accomplished with molded case circuit breakers
- a. Molded Case Circuit Breakers shall have the following features:
 - 1) Solid state adjustable trip type circuit breakers.
 - 2) Shall be in accordance with UL 489 and NEMA AB-1.
 - 3) Trip units shall have field adjustable tripping characteristics as follows:
 - a) Ampere setting (continuous).
 - b) Long time band.

- c) Short time trip point.
- d) Short time delay.
- e) Instantaneous trip point.
- f) Ground fault system for circuit breakers rated 480 volt, equal to or greater than 1000 amperes. The system shall alarm but not trip the circuit breaker.
- 4) Trip setting shall be as shown on the electrical system protective device study.
- 5) Shall be 100 percent rated.
- 6) Electrically and mechanically trip free.
- 7) Manual operating handle with lock-open padlocking provisions, and position indicators on the front of the breaker.
- 8) Rear stud connection for both line and load sides.
- 9) Shall include type "a" and "b" auxiliary contacts for interfacing with controls.
- 6. Automatic Voltage Regulator:
 - a. Shall maintain the generator's output voltage within plus or minus one percent for load variations between no load and full load.
 - b. Shall correct voltage fluctuations rapidly and restore the output voltage to the predetermined level with a minimum amount of hunting.
 - c. Shall include voltage level rheostat located inside the control cubicle.

2.13 REMOTE ANNUNCIATOR PANEL

- A. Remote annunciator panel shall be installed at the Engineering Control Center.
- B. The annunciator shall indicate alarm conditions of the emergency or auxiliary power source as follows:
 - 1. Individual visual signals shall indicate:
 - a. When generator is operating to supply power to load?
 - b. When battery charger is malfunctioning?
 - c. When main storage tank is low.
 - 2. Individual visual signals plus a common audible alarm shall warn of the following:
 - a. "LOW LUBRICATING OIL PRESSURE - FIRST STAGE."
 - b. "LOW COOLANT."
 - c. "EXCESSIVE COOLANT TEMPERATURE - FIRST STAGE."
 - d. LOW FUEL - DAY TANK."

- e. "OVERCRANK" (failure to start).
 - f. "OVERSPEED."
- C. The annunciator shall also have the following features:
- 1. One pushbutton momentary contact switch. Label switch "LAMP - TEST".
Initiating this switch shall momentarily actuate the alarm buzzer and all the indicating lamps.
 - 2. Audible Alarm: There shall be an audible alarm, rated for 85 dB at 10 feet, which shall become actuated whenever an alarm condition occurs. A momentary-contact acknowledge pushbutton shall silence the audible alarm, but not clear the alarm lamp. Elimination of the alarm condition shall automatically release the seal-in circuit for the audible alarm and extinguish the alarm lamp.

2.16 EXERCISING CONTROL PANEL

- A. Incorporate exercising controls so as to allow testing of each remotely located transfer switch from the Engine-Generator Control Cubicle.
- 1. For each transfer switch, incorporate red and green lamps, indicating the position of the transfer switch.
 - 2. For each transfer switch, incorporate a two position contact switch.
Label switch position: "Test and "Automatic". The "Test" position shall simulate an outage of normal power at the transfer switch. The "Automatic" position shall place the transfer switch in normal operation.

2.17 SOUND ATTENUATED ENCLOSURE

- A. The emergency generator set and related equipment shall be housed in a walk-in outdoor weatherproof enclosure. The generator will function properly without overheating in the ambient conditions specified. Enclosure shall be weatherproof and sound attenuated (maximum 85 dBA at 1525 mm (five feet) from any side, top and bottom to no more than 75 dBA when measured at 15 meters (50 feet) horizontally from any part of the enclosure) Enclosure shall be walk-in type and sound attenuated (maximum 85 dBA at 1525 mm (five feet) from any side, top and bottom to no more than 75 dBA when measured at 15 meters (50 feet) horizontally from any part of the enclosure or appendage on the enclosure.) Sound ratings shall be based on full load condition of engine/generator in a single unit operation condition. Airflow configuration of the unit will be intake through rear of unit and discharge air vertically up. Enclosure shall be suitable for winds up to 193 kmh (120 mph); roof load shall be

equal to or greater than 200 kg/sq m (40 lbs per sq. ft). Non-distributed loading as required. Enclosure shall be furnished with lights, gfci receptacles, exhaust fan, space heater, panelboard with all supporting circuit breakers for enclosure and generator peripheral devices completely wired. The enclosure shall be completely factory-assembled and wired so that only external circuit connections are required in the field.

B. The enclosure shall meet the following requirements:

1. The exterior finish shall be guaranteed for a period of 10 years to be free from any defects when properly maintained.
2. Enclosure shall be of sufficient size allowing for code clearances and proper servicing isles without removal or opening of enclosure panels.
3. Radiator exhaust outlet shall be ducted through the end of the enclosure.
4. All exterior surfaces shall be factory painted with industrial enamel.
5. Unit shall have sufficient guards to prevent entrance by small animals.
6. Batteries to fit inside enclosure and along side the engine provide protective shield. (Batteries under the generator are not acceptable.)
7. Exhaust System: The silencer shall be critical grade, mounted and thermally insulated inside the enclosure. Insulation must be provided for the silencer, flex and all discharge piping. The weight of the silencer shall not be supported by engine. The exhaust pipe size shall be sufficient to insure that exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer. The exhaust silencer outlet roof penetration shall be sealed to prevent the entrance of rain, snow and sleet. A stainless steel bellowed flex shall be provided.

2.18 SPARE PARTS

A. For each engine-generator set:

1. Six lubricating oil filters.
2. Six primary fuel oil filters.
3. Six secondary fuel oil filters.
4. Six intake air filters.

- B. For each battery charger:
 - 1. Three complete sets of fuses.
 - 2. One complete set of indicating lamps.
- C. For each control and supervisory panel:
 - 1. Three complete sets of fuses.
 - 2. One complete set of indicating lamps.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install concrete bases of dimensions shown on the drawings for packaged engine-generator sets.
- B. Installation of the engine generator set shall comply with manufacturer's written instructions and with NFPA 110.
- C. Mounting
 - 1. Support the base of engine-generator set on vibration isolators, each isolator bolted to the floor (pad), generator base bolted to isolator.
 - 2. Install sufficient number of isolators so that the floor (pad) bearing pressure under each isolator is within the floor (pad) loading specification.
 - 3. Install equal number of isolators on each side of the engine-generator set's base.
 - 4. Locate isolators for approximately equal load distribution and deflection per isolator. Base of the engine-generator set shall be drilled at the factory for the isolator bolts.
 - 5. Isolators shall be shipped loose with the engine-generator set.
 - 6. All connections between the engine-generator set and exterior systems, such as fuel lines, electrical connections, and engine exhaust system and air exhaust shroud, shall be flexible.
- D. Balance:
 - 1. The vibration velocity in the horizontal, vertical, and axial directions shall not exceed 16.25 mm (0.65 inch) per second peak at any specific frequency. These limits apply to main structural components such as the engine block and the generator frame at the bearings.
 - 2. Balance the engine-generator set statically and dynamically at the factory in order to comply with the maximum specified vibration velocity.

- E. Connect all components of the essential electrical power system so that they will continue to be energized by the auxiliary electrical power system during failures of the normal electrical power supply system.
- F. Install piping between diesel engine and remote components of cooling, fuel and exhaust systems.
- G. Flexible connection between radiator and exhaust shroud at the wall damper:
 - 1. Install noncombustible flexible connections made of 20-ounce neoprene-coated fiberglass fabric approximately 150 mm (six inches) wide.
 - 2. Crimp and fasten the fabric to the sheet metal with screws 50 mm (two inch) on center. The fabric shall not be stressed, except by the air pressure.
- H. Exhaust System Insulation:
 - 1. Adhesive and insulation materials shall be applied on clean, dry surfaces from which loose scale, and construction debris has been removed by wire brushing.
 - 2. Fill all cracks, voids and joints of applied insulation material with high temperature 1093 degrees C (2000 degrees F) insulating cement before applying the outer covering.
 - 3. The installation shall be neat, thermally and structurally tight without sag, neatly finished at all hangers or other penetrations and shall provide a smooth finish surface.
 - 4. Insulation and jacket shall terminate hard and tight at all anchor points.
 - 5. Insulate completely from engine exhaust flexible connection through roof or wall construction, including muffler.

3.2 START UP AND TESTING

- A. Provide the services of a factory-authorized, factory-trained representative of the diesel engine-generator set manufacturer to inspect field-assembled components, and equipment installation and supervise the field tests
- B. When the complete auxiliary electrical power system has been installed and prior to the final inspection, tests all components of the system in the presence of the COTR for proper operation of the individual components and the complete system and to eliminate electrical and mechanical defects.

- C. Furnish fuel oil, lubricating oil, anti-freeze liquid, water treatment and rust inhibitor and load bank for testing of the diesel engine-generator set.
- D. Field Tests for the Diesel Engine-Generator Set:
1. Test the engine generator set for eight hours of continuous operation as follows:
 - a. First six hours while the set is delivering 100 percent of its specified KW rating.
 - b. Last two hours while the set is delivering 110 percent of its specified KW rating.
 - c. If during the 8-hour continuous test a failure occurs, either the diesel engine shuts down or the full KW rating of the load bank is not achieved, the test is null and void. The test(s) shall be repeated until the satisfactory results are attained at no additional cost to the government.
 2. Record the following test data at 30-minute intervals:
 - a. Time of day, also reading of running time indicator.
 - b. KW.
 - c. Voltage on each phase.
 - d. Amperes on each phase.
 - e. Engine RPM.
 - f. Frequency.
 - g. Engine water temperature.
 - h. Fuel pressure
 - i. Oil pressure.
 - j. Outdoor temperature
 - k. Average ambient temperature in the vicinity of the diesel engine.
 - l. Average ambient temperature in the vicinity of the starting batteries.
 3. Demonstrate that the generator set will attain proper voltage, frequency and will accept 100 percent block load within 10 seconds from a cold start after the closing of a single contact.
 4. Furnish a resistance type load for the testing of the generator:
 - a. When approved in writing by the COTR prior to the testing, the Contractor may use connected loads in the building (resistant plus other types) as part of the test load provided the Contractor assumes complete responsibility for the use of the connected loads, including personnel injuries and property damage.

- b. Test loads shall always include adequate resistance to assure stability of the loads and equipment during all of the testing operations. The test load KW rating:
 - 1) Shall not be less than 110 percent of the specified KW rating of the largest generator set.
 - 2) Shall not be less than 35 percent of the sum of the specified KW ratings of the all generator sets in a paralleling system.
- E. Battery and Starting System Test:
 - 1. Demonstrate that the batteries and cranking motor are capable of 5 starting attempts of 10 second cranking each at 10 second intervals with the battery charger turned off.
- F. Test local and remote panels: Simulate engine failures while checking for proper operation of each indicating lamp, alarm device and reset button. (It is recommended that one VA inspector be located in the generator room and another at the site of remote panels. By means of telephone or walkie-talkies, the inspectors should be assured of proper operation and coordination of these panels.)
- G. At the completion of the field tests, fill the underground storage tank with fuel of grade and quality as recommended by the manufacturer of the engine.
- H. When any defects are detected during the tests, correct all the deficiencies and repeat all or part of the 8-hour continuous test as requested by the COTR, at no additional cost to the Government.
- I. Provide test and inspection results in writing to the COTR.

3.3 INSTRUCTIONS AND FINAL INSPECTIONS

- A. Laminate or mount under Plexiglas a set of operating instructions for the system and install instructions within a frame mounted on the wall near the diesel engine-generator set as requested by the COTR.
- B. At the final inspection in the presence of a VA representative, demonstrate that the complete auxiliary electrical power system operates properly in every respect.
- C. Furnish the services of a competent, factory-trained engineer or technician for five, 4-hour periods for instructions to VA personnel in operation and maintenance of the equipment, on the dates requested by the COTR.

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