

SECTION 26 32 13
ENGINE GENERATORS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of the low-voltage/ engine generators.
- B. Provide diesel generator in sound attenuated weather resistant enclosure with sub-base diesel tank with capacity for 96 hours of generator running at full capacity as manufactured by Cummins or equal.

1.2 RELATED WORK

- A. Section 03 30 00, CAST-IN-PLACE CONCRETE: Requirements for concrete equipment pads.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- 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 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Requirements for pipe and equipment support and noise control.
- F. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit and coordination study, and requirements for a coordinated electrical system.
- G. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Requirements for hot piping and equipment insulation.
- H. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Requirements for automatic transfer switches for use with engine generators.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. A factory-authorized representative shall be capable of providing emergency maintenance and repairs at the project site within 4 hours maximum of notification.

1.4 FACTORY TESTS

- A. Factory Tests shall be performed in the factory by the equipment manufacturer. Factory Tests shall comply with all Factory Tests requirements stated in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the requirements stated in this section.
- B. Load Test: Shall include two hours while the engine generator is delivering 100% of the specified kW, and four hours while the engine generator is delivering 80% 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

- C. Cold Start Test: Record time required for the engine generator to develop specified voltage, frequency, and kW load from a standstill condition with engine at ambient temperature.
- D. The manufacturer shall furnish fuel, load banks, testing instruments, and all other equipment necessary to perform these tests.

1.5 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:

- a. Submit sufficient information to demonstrate compliance with drawings and specifications.
- b. Scaled drawings, showing plan views, side views, elevations, and cross-sections.

2. Diagrams:

- a. Control system diagrams, control sequence diagrams or tables, wiring diagrams, interconnections diagrams (between engine generators, automatic transfer switches, paralleling switchgear, local control cubicles, remote annunciator panels, and fuel storage tanks, as applicable), and other like items.

3. Technical Data:

- a. Published ratings, catalog cuts, pictures, and manufacturer's specifications for engine generator, governor, voltage regulator, radiator, muffler, dampers, day tank, pumps, fuel tank, batteries

- and charger, jacket heaters, torsional vibration, and control and supervisory equipment.
 - b. Description of operation.
 - c. Short-circuit current capacity and subtransient reactance.
 - d. Sound power level data.
4. Calculations:
- a. Calculated performance derations appropriate to installed environment.
5. Manuals:
- a. When submitting the shop drawings, submit complete maintenance and operating manuals, to include the following:
 - 1) Technical data sheets.
 - 2) Wiring diagrams.
 - 3) Include information for testing, repair, troubleshooting, and factory recommended periodic maintenance procedures and frequency.
 - 4) Provide a replacement and spare parts list. Include a list of tools and instruments for testing and maintenance purposes.
 - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
6. Test Reports:
- a. Submit certified factory test reports for approval.
 - b. Submit field test reports two weeks prior to the final inspection.
7. Certifications:
- a. Prior to fabrication of the engine generator, submit the following for approval:
 - 1) A certification in writing that an engine generator of the same model and configuration, with the same bore, stroke, number of cylinders, and equal or higher kW/kVA ratings as the proposed engine generator, has been operating satisfactorily with connected loads of not less than 75% of the specified kW/kVA rating, for not fewer than 2,000 hours without any failure of a crankshaft, camshaft, piston, valve, injector, or governor system.

- 2) A certification in writing that devices and circuits will be incorporated to protect the voltage regulator and other components of the engine generator during operation at speeds other than the rated RPM while performing maintenance. Submit thorough descriptions of any precautions necessary to protect the voltage regulator and other components of the system during operation of the engine generator at speeds other than the rated RPM.
- 3) A certification from the engine manufacturer stating that the engine exhaust emissions meet the applicable federal, state, and local regulations and restrictions. At a minimum, this certification shall include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and hazardous air pollutants (HPAs).
- b. Prior to installation of the engine generator at the job site, submit certified factory test data.
- c. Two weeks prior to the final inspection, submit the following.
 - 1) Certification by the manufacturer that the engine generators conform to the requirements of the drawings and specifications.
 - 2) Certification by the Contractor that the engine generators have been properly installed, adjusted, and tested.

1.6 STORAGE AND HANDLING

- A. Engine generators shall withstand shipping and handling stresses in addition to the electrical and mechanical stresses which occur during operation of the system. Protect radiator core with wood sheet.
- B. Store the engine generators in a location approved by the COR.

1.7 JOB CONDITIONS

- A. Job conditions shall conform to the arrangements and details shown on the drawings. The dimensions, enclosures, and arrangements of the engine generator system shall permit the operating personnel to safely and conveniently operate and maintain the system in the space designated for installation.

1.8 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):

C37.50-07.....Low-Voltage AC Power Circuit Breakers Used In
Enclosures-Test Procedures

C39.1-81 (R1992)Requirements for Electrical Analog Indicating
Instruments

C. American Society of Testing Materials (ASTM):

A53/A53M-10.....Standard Specification for Pipe, Steel, Black,
and Hot-Dipped, Zinc Coated Welded and Seamless

B88-09.....Specification for Seamless Copper Water Tube

B88M-11.....Specification for Seamless Copper water Tube
(Metric)

D975-11b.....Diesel Fuel Oils

D. Institute of Electrical and Electronic Engineers (IEEE):

C37.13-08.....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. International Code Council (ICC):

IBC-12.....International Building Code

F. National Electrical Manufacturers Association (NEMA):

ICS 6-06.....Enclosures

ICS 4-10.....Application Guideline for Terminal Blocks

MG 1-11.....Motor and Generators

MG 2-07.....Safety Standard and Guide for Selection,
Installation and Use of Electric Motors and
Generators

PB 2-11.....Dead-Front Distribution Switchboards

250-08.....Enclosures for Electrical Equipment (1000 Volts
Maximum)

G. National Fire Protection Association (NFPA):

30-12.....Flammable and Combustible Liquids Code

37-10.....Installations and Use of Stationary Combustion
Engine and Gas Turbines

70-11.....National Electrical Code (NEC)

99-12.....Health Care Facilities

110-10.....Standard for Emergency and Standby Power
Systems

H. Underwriters Laboratories, Inc. (UL):

50-07.....Enclosures for Electrical Equipment

142-06.....Steel Aboveground Tanks for Flammable and
Combustible Liquids

467-07.....Grounding and Bonding Equipment

489-09.....Molded-Case Circuit Breakers, Molded-Case
Switches and Circuit-Breaker Enclosures

508-99.....Industrial Control Equipment

891-05.....Switchboards

1236-06.....Battery Chargers for Charging Engine-Starter
Batteries

2085-97.....Insulated Aboveground Tanks for Flammable and
Combustible Liquids

2200-98.....Stationary Engine Generator Assemblies

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The engine generator system shall be in accordance with NFPA, UL, NEMA and ANSI, and as specified herein.

B. Provide a modular generator set in weather resistant and sound

attenuated enclosure factory-assembled, wired (except for field connections), complete, fully automatic engine generator system, as well as all associate equipment and devices intended for the operating, control, monitoring, and remote manual stop functions. General system shall be manufactured by Cummins or equal.

BRAND NAME OR EQUAL PRODUCTS

In accordance with VAAR 811.104-71 (b), based on the inclusion of FAR 52.211-6, Brand Name or Equal (AUG 1999) and VAAR 852.211-73, Brand Name or Equal (JAN 2008), bidders proposing to furnish an "equal product other than referenced in the solicitation, shall insert the following description for each equal product (See also VAAR 852.211-73 (c)(1) and (c)(2)).

Bidding On:

Manufacturer's Name: _____.

Brand: _____.

No.: _____.

Specification Section and Page Number: _____.

C. Engine Generator Parameter Schedule:

1. Power Rating: Emergency Standby
2. Voltage: 120/208V
3. Rated Power: 80 kW (80 kVA continuous)
4. Power Factor: 0.8 lagging
5. Engine Generator Application: stand-aloneparallel with utility source
6. Fuel: diesel
7. Voltage Regulation: + 2% (maximum) (No Load to Full Load)
(standalone applications)
8. Phases: 3 Phase, Wye
9. Each component of the engine generator system shall be capable of operating at 1000 feet above sea level in a weather resistant outdoor enclosure which will have average ambient air temperature ranging from a minimum of -30°F in winter to maximum of 100°F in summer.

- D. Assemble, connect, and wire the engine generator at the factory so that only the external connections need to be made at the construction site.
- E. Engine Generator Unit shall be factory-painted with manufacturer's primer and standard finishes.
- F. Connections between components of the system shall conform to the recommendations of the manufacturer.
- G. 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.
- H. Engine generator shall have the following features:
 - 1. Factory-mounted on a common, rigid, welded, structural steel base.
 - 2. Engine generator shall be statically and dynamically balanced so that the maximum vibration in the horizontal, vertical, and axial directions shall be limited to 0.15 mm (0.0059 inch), with an overall velocity limit of 24 mm/sec (0.866 inch per second) 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. Shall be capable of operating satisfactorily as specified for not fewer than 10,000 hours between major overhauls.

2.2 ENGINE

- A. The engine shall be coupled directly to a generator.
- B. Minimum four cylinders.
- C. The engine shall be able to start in a 4.5 °C (40 °F) ambient temperature while using No. 2 diesel fuel oil without the use of starting aids such as glow plugs and ether injections.
- D. The engine shall be equipped with electric heater for maintaining the coolant temperature between 32-38 °C (90-100 °F), or 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 type.
- B. Steady-state speed band at 60 Hz shall not exceed plus or minus 0.33%.

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 out through the skid base and terminate it with a drain valve and plug.
- F. Provide a 120-volt oil heater for exterior engine generator.

2.5 FUEL 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 that require periodic cleaning or replacement shall 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 such that 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. Each engine generator shall be provided with a welded steel integral day tank with double-wall fuel containment.
2. Each day tank shall have capacity to supply fuel to the engine for a 72-hour period at 100% rated load without being refilled, including fuel that is returned to the main fuel storage tank. The calculation of the capacity of each day tank shall incorporate the requirement to stop the supply of fuel into the day tank at 90% of the ultimate volume of the tank.
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 controlling the fuel oil transfer pump shall be set to energize the pump when the liquid level in the tank reaches one-third of the total volume of the tank.
 - b. The float switch contacts that 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 one-quarter 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.

2.6 COOLING SYSTEM

- A. Liquid-cooled, closed loop, with fin-tube radiator mounted on the engine generator, and integral engine driven circulating pump.
- B. Cooling capacity shall not be less than the cooling requirements of the engine generator and its lubricating oil while operating continuously at 100% of its specified rating.
- C. Coolant shall be extended-life antifreeze solution, 50% ethylene glycol and 50% soft water, with corrosion inhibitor additive as recommended by the manufacturer.
- D. Fan shall be driven by a totally enclosed electric motor.
- E. Coolant hoses shall be flexible, per manufacturer's recommendation.

- f. Self-contained thermostatic-control valve shall modulate coolant flow to maintain optimum constant coolant temperature, as recommended by the engine manufacturer.

2.7 AIR INTAKE AND EXHAUST SYSTEMS

A. Air Intake:

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

B. Exhaust System:

2. Exhaust Muffler:

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 while it is delivering 100% 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.

E. Insulation for Exhaust Pipe and Muffler:

1. Calcium silicate minimum 75 mm (3 inches) thick.
2. Insulation shall be as specified in Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
3. The installed insulation shall be covered with aluminum jacket 0.4 mm (0.016 inch) thick. The jacket is to be held in place by bands of 0.38 mm (0.015 inch) thick by 15 mm (0.5 inch) wide aluminum.
4. Insulation and jacket are not required on flexible exhaust sections.

F. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing rain cover.

2.8 ENGINE STARTING SYSTEM

A. The engine starting system 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 (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).

C. Batteries shall be nickel-cadmium high discharge rate type.

1. Each battery cell shall have minimum and maximum electrolyte level indicators and a flip-top flame arrestor vent cap.
2. Batteries shall have connector covers for protection against external short circuits.
3. With the charger disconnected, the batteries shall have sufficient capacity so that the total system voltage does not fall below 85% of the nominal system voltage with the following demands:
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).

4. Battery racks shall be metal with an alkali-resistant finish and thermal insulation, and secured to the floor.

D. Battery Charger:

1. A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize-charging rate for recharging fully depleted batteries within 24 hours and a floating charge rate for maintaining the batteries at fully charged condition.
2. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage.

2.9 LUBRICATING OIL HEATER

- A. Provide a thermostatically-controlled electric heater to automatically maintain the oil temperature within plus or minus 1.7 °C (3 °F) of the control temperature.

2.10 JACKET COOLANT HEATER

- A. Provide a thermostatically-controlled electric heater mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 1.7 °C (3 °F) of the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

2.11 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.
- C. Integral poles and spider, or individual poles dove-tailed to the spider.
- D. Designed for sustained short-circuit currents in conformance with NEMA Standards.
- E. Designed for sustained operation at 100% of the RPM specified for the engine generator without damage.
- F. Telephone influence factor shall conform to NEMA MG 1.
- G. Furnished with brushless excitation system or static-exciter-regulator assembly.
- H. Nameplates attached to the generator 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.

- I. The grounded (neutral) conductor shall be electrically isolated from equipment ground and terminated in the same junction box as the phase conductors.

2.12 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator circuit breaker shall be molded case type. Molded case circuit breaker shall have automatic, trip free, non-adjustable, inverse time and instantaneous magnetic trips for 400 A frame size or less. Magnetic trip shall be adjustable from 5x to 10x for breakers with 400 A frame size and higher. Factory setting shall be LOW unless otherwise noted. Provide shunt trip to trip breaker when engine generator is shut down by other protective devices.
- B. Overcurrent protective device cubicle shall contain terminations for neutral and equipment grounding conductors as necessary.

2.13 CONTROLS

- A. Shall include Engine Generator Control Cubicle(s).
- B. General:
 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. Coordinate controls with the automatic transfer switches shown on the drawings so that the systems will operate as specified.
 5. Cubicles:
 - a. Code gauge steel: manufacturer's recommended heavy gauge steel with factory primer and light gray finish.
 - b. Doors shall be gasketed, 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. Door locks for panels and cubicles shall be keyed identically to operate from a single key.
 6. Wiring: Insulated, rated at 600 V.
 - a. Install the wiring in vertical and horizontal runs, neatly harnessed.

- b. Terminate all external wiring at heavy duty, pressure-type, terminal blocks.
 - 7. The equipment, wiring terminals, and wires shall be clearly and permanently labeled.
 - 8. The appropriate wiring diagrams shall be laminated or mounted under plexiglass within the frame on the inside of the cubicles and panels.
 - 9. All indicating lamps and switches shall be accessible and mounted on the cubicle doors.
 - 11. The manufacturer shall coordinate the interconnection and programming of the generator controls with all related equipment, including automatic transfer switches and generator paralleling controls as applicable, specified in other sections.
- C. 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 push-button 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% 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, in the 0 to 15 minute range, shall cause the engine generator 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 shall stop.
 - d. Selector switch in OFF position shall prevent the engine from starting either automatically or manually. Selector switch in MANUAL position shall also cause the engine to start when the manual start push-button is depressed momentarily.
 - e. With selector switch is in MANUAL position, depressing the MANUAL STOP push-button momentarily shall stop the engine after a cool-down period.

- f. A maintained-contact, red mushroom-head push-button 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 a timer that will be independent of the battery voltage fluctuations.
 - b. The controls shall crank the engine through one complete cranking cycle, consisting of four starting attempts of 10 seconds each with 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 that 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) The difference between the first and second stage temperature settings shall be approximately -12 °C (10 °F).

- 4) Permanently indicate the temperature settings near the associated signal light.
 - 5) When the coolant temperature drops to below 21 °C (70 °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) The difference between the first and second stage pressure settings shall be approximately 15% of the oil pressure.
 - 4) The pressure settings near the associated signal light shall be permanently displayed so that the running oil pressure can be compared to the target (setpoint) value.
- 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:
- 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:
- When the fuel oil level in the storage tank decreases to less than one-third 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 push-button shall silence the audible alarm by using relays or 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 alarm 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 engine generator room in a location as directed by the Resident Engineer COR. The audible alarm shall be rated for 85 dB at 3 M (10 feet).

i. Generator Breaker Signal Light:

- 1) A flashing green light shall be energized when the engine generator circuit breaker is in the OPEN or TRIPPED position.
- 2) 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 fewer than 9,999 hours, and an electric type tachometer.
- c. A voltmeter, ammeter, 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. Visual Indications:
 - 1) OVERCRANK
 - 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: The LAMP TEST momentary contact switch shall momentarily actuate the alarm buzzer and all the indicating lamps.

5. Automatic Voltage Regulator:

- a. Shall correct voltage fluctuations rapidly and restore the output voltage to the predetermined level with a minimum amount of hunting.
- b. Shall include voltage level rheostat located inside the control cubicle.
- c. Provide a 3-phase automatic voltage regulator immune to waveform distortion.

2.14 REMOTE MANUAL STOP STATION

- A. Shall be provided per NFPA 101, and shall be a red mushroom-head push-button switch.
- B. Shall be connected to the main generator control panel to provide emergency shutdown of the generator.
- C. Shall be located outside the room housing the generator.
- D. Shall have permanent label reading "EMERGENCY STOP".

2.15 REMOTE ANNUNCIATOR PANEL

- A. A remote annunciator panel shall be installed at location as shown on the drawings.
- B. The annunciator shall indicate alarm conditions as required by NFPA 99 and 110.
- C. Include control wiring between the remote annunciator panel and the engine generator. Wiring shall be as required by the manufacturer.

2.16 SOUND-ATTENUATED ENCLOSURE

- A. The engine generator and related equipment shall be housed in an outdoor weatherproof enclosure.
- B. The enclosure shall be provided with a factory-installed and factory-wired panelboard, 20A 120V receptacles, and compact fluorescent light fixtures with guards and switches.
- C. Enclosure shall be weatherproof and sound-attenuated (maximum 85 dBA at 1525 mm (5 feet) from any side, top and bottom to no more than 75 dBA when measured at 15 M (50 feet) horizontally from any part of the

enclosure). Sound ratings shall be based on full load condition of engine generator in a single unit operation condition.

- D. Airflow configuration shall be intake through rear of unit, and discharge air vertically up. Enclosure shall be suitable for winds up to 193 kmh (120 miles per hour) roof load shall be equal to or greater than 200 kg/sq m (40 pounds per square foot) Non-distributed loading as required.
- E. The enclosure shall meet the following requirements:
 - 1. Radiator exhaust outlet shall be ducted through the end of the enclosure.
 - 2. All exterior surfaces shall be factory-painted with industrial enamel.
 - 3. Unit shall have sufficient guards to prevent entrance by small animals.
 - 4. Batteries shall fit inside enclosure and alongside the engine generator. Batteries under the generator are not acceptable.
 - 5. The muffler shall be mounted and thermally-insulated inside the enclosure.

2.17 SPARE PARTS

- A. For each engine generator:
 - 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.
- C. For each control panel:
 - 1. Three complete sets of fuses, if applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install concrete bases of dimensions shown on the drawings.
- B. Installation of the engine generator shall comply with manufacturer's written instructions and with NFPA 110.
- C. Mounting:
 - 1. Support the base of engine generator on vibration isolators, each isolator bolted to the floor (pad), and the generator base bolted to isolator.

2. Install sufficient 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's base.
4. Locate isolators for approximately equal load distribution and deflection per isolator. The base of the engine generator shall be drilled at the factory for the isolator bolts.
5. Isolators shall be shipped loose with the engine generator.
6. All connections between the engine generator 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.

E. Connect all components of the generator system so that they will continue to be energized during failure of the normal electrical power supply system.

F. Install piping between engine generator 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-oz neoprene-coated fiberglass fabric approximately 150 mm (6 inches) wide.
2. Crimp and fasten the fabric to the sheet metal with screws 50 mm (2 inches) 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 °C (2000 °F) insulating cement before applying the outer covering.
3. The installation shall be clean and free of debris, thermally and structurally tight without sag, neatly finished at all hangers or other penetrations, and shall provide a smooth finished 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 ACCEPTANCE CHECKS AND TESTS

- A. Provide the services of a factory-authorized, factory-trained representative of the engine generator manufacturer to inspect field-assembled components and equipment installation, and to supervise the field tests.
- B. When the complete engine generator system has been installed and prior to the final inspection, test all components of the system in the presence of the Resident Engineer COR 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, rust-inhibitor, and load bank for testing of the engine generator.
- D. Visual Inspection: Visually verify proper installation of engine generator and all components per manufacturer's pre-functional installation checklist.
- E. Set engine generator circuit breaker protective functions per Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY.
- F. Field Tests:
 1. Perform manufacturer's after-starting checks and inspections.
 2. Test the engine generator for six hours of continuous operation as follows:
 - a. Two hours while delivering 100% of the specified kW.
 - b. Four hours while the engine generator is delivering 80% of its specified kW rating.
 - c. If during the 6-hour continuous test, an engine generator failure occurs or the engine generator cannot maintain specified power output, the test(s) are null and void. After repair and/or

adjustments, the test(s) shall be repeated at no additional cost to the Government until satisfactory results are attained.

3. Record the following test data at 30-minute intervals:
 - a. Time of day, as well as reading of running time indicator.
 - b. kW.
 - c. Voltage on each phase.
 - d. Amperes on each phase.
 - e. Engine RPM.
 - f. Frequency.
 - g. Coolant water temperature.
 - h. Fuel pressure.
 - i. Oil pressure.
 - j. Outdoor temperature.
 - k. Average ambient temperature in the vicinity of the engine generator.
4. Demonstrate that the engine generator will attain proper voltage and frequency within the specified time limit from a cold start after the closing of a single contact.
5. Furnish a resistance-type load for the testing of the engine generator. 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 shall not be less than 100% of the specified kW rating of the engine generator.

G. Starting System Test:

1. Demonstrate that the batteries and cranking motor are capable of five starting attempts of 10 seconds cranking each at 10-second intervals with the battery charger turned off.

H. Remote Annunciator Panel and Remote Manual Stop Tests:

Simulate conditions to verify proper operation of each visual or audible indication, interconnecting hardware and software, and reset button. Simulate emergency stop of the generator by initiating the remote manual stop station, while the generator is in operation.

I. Fuel systems shall be flushed and tested.

J. Automatic Operation Tests:

Test the engine generator and associated automatic transfer switches to demonstrate automatic starting, loading and unloading. The load for this test shall be the actual connected loads. Initiate loss of normal

source and verify the specified sequence of operation. Restore the normal power source and verify the specified sequence of operation. Verify resetting of controls to normal.

- K. At the completion of the field tests, fill the main storage tank and day tank with fuel of grade and quality as recommended by the manufacturer of the engine. Fill all engine fluids to levels as recommended by manufacturer.
- L. When any defects are detected during the tests, correct all the deficiencies and repeat all or part of the 6-hour continuous test as requested by the Resident Engineer COR, at no additional cost to the Government.
- M. Provide test and inspection results in writing to the Resident Engineer COR.

3.3 FOLLOW-UP VERIFICATION

- A. After completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the engine generator(s) and control and annunciation components are in good operating condition and properly performing the intended function.

3.4 INSTRUCTIONS AND FINAL INSPECTIONS

- A. Laminate or mount under acrylic resin a set of operating instructions for the system and install instructions within a frame mounted on the wall near the engine generator at a location per the Resident Engineer COR.
- B. Furnish the services of a competent and factory-trained technician for one 4-hour period for instructions to VA personnel in operation and maintenance of the equipment, on the date requested by the Resident Engineer COR.

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