

SECTION 263200 – PACKAGED GENERATOR ASSEMBLIES

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. Natural Gas Engine.
 - 2. Lubrication Oil System.
 - 3. Cooling System.
 - 4. Intake and Exhaust Air Systems.
 - 5. Starting System.
 - 6. Generator.
 - 7. Controls, Supervision and Distribution.
 - 8. Outdoor Generator Enclosure.
 - 9. Spare Parts.

1.2 QUALITY ASSURANCE

- A. Equipment shall be furnished by a dealer with service facilities and spare parts stock, as approved by Engineer, within 4 hours' time of the job site by normal ground transportation. In addition, the dealer shall be able to demonstrate, in the judgment of the Engineer, adequate experience in the installation/service of standby power equipment of equivalent size and type specified herein
- B. The equipment supplied and installed shall meet the requirements of the NEC and all applicable local codes and regulations. All equipment shall be of new and current production by a manufacturer who has 10 years of experience building this type of equipment. Manufacturer shall be ISO9001 certified. There shall be one source responsibility for warranty; parts and service through a local representative with factory trained service personnel.

Automatic Transfer Switch

Automatic transfer switch(es) specified in another section shall be supplied by the generator set manufacturer in order to establish and maintain a single source of system responsibility and coordination.

- C. Two Year Standby (ISO 8528-1: ESP) Generator Set Warranty
The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor. Submittals received without written warranties as specified will be rejected in their entirety

Standby Generator Set Extended Warranty Coverage

Extended Warranty Coverage shall be provided for a period of 5 years, and shall include no deductible. Extended Warranty Coverage provides for 100 percent of usual and customary parts and labor costs for failures due to defects in materials and workmanship to the “as shipped consist” from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches. Coverage provides for a rental power unit due to unscheduled failures causing unexpected downtime to the customer in excess of 48 hours from the time of diagnoses. All repairs will be performed by factory trained dealer service personnel, and allows for repairer travel for all repairs up to 8 hours per incident.

Parts and Service Qualifications

1. Service Facility

The engine-generator supplier shall maintain 24-hour parts and service capability within 4 hours' time of the job site by normal ground transportation. The distributor shall stock parts as needed to support the generator set package for this specific project. The supplier must carry sufficient inventory to cover no less than 80% parts service within 24hrs and 95% within 48 hours.

2. Service Personnel

The dealer shall maintain qualified factory trained service personnel with experience on specified equipment within 4 hours' time of job site by normal ground transportation.

- D. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 2. Full load run.
 3. Maximum power.
 4. Voltage regulation.
 5. Transient and steady-state governing.
 6. Single-step load pickup.
 7. Safety shutdown.
 8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
 9. Report factory test results within 10 days of completion of test.

1.3 SUBMITTALS

- A. Refer to specification section 260510

1.4 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.

1.5 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.

1.6 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)
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 Stationery 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

PART 2 - PRODUCTS

2.1 GENERATOR SET

- A. The generator set shall be by one of the following:
 - 1. Caterpillar
 - 2. Cummins
 - 3. MTU
- B. The engine generator system shall be in accordance with NFPA, UL, NEMA and ANSI.
- C. Provide a factory-assembled, wired, (except for the field connections), complete, fully automatic natural gas engine-generator system.
- D. Published Rating:
 - 1. Shall be Standby 480/277 volts, 3-phase, 4-wire, 60 Hz and 0.80 power factor.
 - 2. Shall be capable of operating continuously for 24 consecutive hours within any 24-hour period of operation at 100 percent of its specified rating without damage.
- E. Assemble, connect and wire the equipment at the factory so that only the external connections need to be made at the construction site.
- F. Unit shall be factory painted with manufacturer's primer and standard finishes.
- G. Coordinate the components of the system and their arrangements, electrically and mechanically.
- H. Connections between components of the system shall conform to the recommendations of the manufacturer of the generator set.
- I. 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.
- J. Generator set and cooling system shall be furnished with extended life antifreeze solution to protect the system from freezing at all times.
- K. 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.

2.2 NATURAL GAS ENGINE

- A. Coupled directly to a generator.
- B. Minimum 4-cylinders.
- C. Operating speed shall be 1800 RPM.
- D. The engine shall be able to start in a 40 degrees F ambient temperature while using natural gas without the use of starting aids such as glow plugs and ether injections.
- E. Equipped with electric heaters for maintaining the engine's coolant temperature in the range of 90-100 degrees 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 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 ENGINE COOLING SYSTEM

- A. Liquid-cooled, closed loop, with radiator mounted on the engine generator set and integral engine driven circulating pump.

- 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.
- C. Water circulating pumps shall be the centrifugal type driven by engine. Incorporate pressure relief devices, where required, to prevent excessive pressure increase after the engine stops.
- 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. Coolant hoses shall be flexible per manufacturer's recommendation.
- G. Self-contained thermostatic-control valve shall modulate coolant flow to maintain optimum constant coolant temperature as recommended by the engine manufacturer.

2.6 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:
 - 1. 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

- 2. 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.
- 3. 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.
- 4. 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, shall support the pipe.
- E. Insulation for Exhaust Pipe and Muffler:
 - 1. Calcium silicate minimum 3 inches thick.

2. The installed insulation shall be covered with aluminum jacket 0.016 inch thick. The jacket is to be held in place by bands of 0.015 inch thick by 0.5 inch wide aluminum.
3. Insulation and jacket are not required on flexible exhaust sections.

2.7 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
 1. Battery: Nickel-cadmium high discharge rate type. Battery voltage shall be compatible with the starting system. Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
 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.
 7. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
- 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 -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. AC power failure alarm light.
 - c. High DC voltage alarm light.
 - d. DC voltmeter – 5 percent accuracy.
 - e. DC Ammeter – 5 percent accuracy.

2.8 GENERATOR

- A. Synchronous, amortisseur windings, bracket-bearing, self-venting, rotating-field type connected directly to the engine.
- B. Integral poles and spider, or individual poles dove-tailed to the spider.
- C. Designed for sustained short circuit currents in conformance with NEMA Standards.
- D. Designed for sustained operation at 125 percent of the RPM specified for the generator set without damage.
- E. Telephone influence factor shall conform to NEMA Standards.
- F. Furnished with brushless excitation system or static-exciter-regulator assembly.
- G. 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.
- H. At full load, the efficiency shall be not less than:
 1. 92 percent for sets specified over 175 KW.
- I. The neutral shall be electrically isolated from equipment ground and terminated in same junction box as the phase conductors.
- J. The alternator shall not be oversized more than one size.
- K. Each step load shall have a maximum of 15% voltage and frequency dip upon starting.

2.9 GENERATOR CONTROL PANEL

- A. Controls – Generator Set Mounted
 1. Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls via SAE J1939.
- B. Environmental
 1. The generator set control shall be tested and certified to the following environmental conditions:
 - a. –40°C to +70°C Operating Range
 - b. 100% condensing humidity, 30°C to 60°C

- c. IP22 protection for rear of controller; IP55 when installed in control panel
- d. 5% salt spray, 48 hours, +38°C, 36.8V system voltage
- e. Sinusoidal vibration 4.3G's RMS, 24-1000Hz
- f. Electromagnetic Capability (89/336/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC, BS EN 50081-2, 50082-2)
- g. Shock: withstand 15G

C. Functional Requirements

- 1. The following functionality shall be integral to the control panel.
 - a. The control shall include a minimum 33 x 132 pixel, 24mm x 95mm, positive image, transfective LCD display with text based alarm/event descriptions.
 - b. The control shall include a minimum of 3-line data display
 - c. Audible horn for alarm and shutdown with horn silence switch
 - d. Standard ISO labeling
 - e. Multiple language capability
 - f. Remote start/stop control
 - g. Local run/off/auto control integral to system microprocessor
 - h. Cooldown timer
 - i. Speed adjust
 - j. Lamp test
 - k. Emergency stop push button
 - l. Voltage adjust
 - m. Voltage regulator V/Hz slope - adjustable
 - n. Password protected system programming

D. Digital Monitoring Capability

- 1. The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units
 - a. Engine
 - Engine oil pressure
 - Engine oil temperature
 - Engine coolant temperature
 - Engine RPM
 - Battery volts
 - Engine hours
 - Engine crank attempt counter
 - Engine successful start counter
 - Service maintenance interval
 - Real time clock
 - Engine exhaust stack temperature
 - Engine main bearing temperature
 - b. Generator
 - Generator AC volts (Line to Line, Line to Neutral and Average)
 - Generator AC current (Avg and Per Phase)
 - Generator AC Frequency
 - Generator kW (Total and Per Phase)
 - Generator kVA (Total and Per Phase)

Generator kVAR (Total and Per Phase)
Power Factor (Avg and Per Phase)
Total kW-hr
Total kVAR-hr
% kW
% kVA
% kVAR
Generator bearing temperature
Generator stator winding temperature

- c. Voltage Regulation
 - Excitation voltage
 - Excitation current

E. Alarms and Shutdowns

- 1. The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence:
 - a. Engine Alarm/Shutdown
 - Low oil pressure alarm/shutdown
 - High coolant temperature alarm/shutdown
 - Loss of coolant shutdown
 - Overspeed shutdown
 - Overcrank shutdown
 - Emergency stop shutdown
 - Low coolant temperature alarm
 - Low battery voltage alarm
 - High battery voltage alarm
 - Control switch not in auto position alarm
 - Battery charger failure alarm
 - b. Generator Alarm/Shutdown
 - Generator phase sequence
 - Generator over voltage
 - Generator under voltage
 - Generator over frequency
 - Generator under frequency
 - Generator reverse power (real and reactive)
 - Generator overcurrent
 - c. Voltage Regulator Alarm/Shutdown
 - Loss of excitation alarm/shutdown
 - Instantaneous over excitation alarm/shutdown
 - Time over excitation alarm/shutdown
 - Rotating diode failure
 - Loss of sensing
 - Loss of PMG

F. Inputs and Outputs

- 1. Programmable Digital Inputs

- a. The Controller shall include the ability to accept programmable digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.
 - 2. Programmable Relay Outputs
 - a. The control shall include the ability to operate programmable relay output signals, integral to the controller. The output relays shall be rated for 2A @ 30VDC and consist of six (6) Form A (Normally Open) contacts and two (2) Form C (Normally Open & Normally Closed) contacts.
 - 3. Programmable Discrete Outputs
 - a. The control shall include the ability to operate two (2) discrete outputs, integral to the controller, which are capable of sinking up to 300mA.
 - 4. Provide a cell phone auto dialer to report trouble and alarm conditions.
- G. Maintenance
- 1. All engine, voltage regulator, control panel and accessory units shall be accessible through a single electronic service tool. The following maintenance functionality shall be integral to the generator set control
 - a. Engine running hours display
 - b. Service maintenance interval (running hours or calendar days)
 - c. Engine crank attempt counter
 - d. Engine successful starts counter
 - e. 40 events are stored in control panel memory
 - f. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 7 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:
 - Day of week
 - Time of day to start
 - Duration of cycle
- H. Remote Communications
- 1. The control shall include Modbus RTU communications as standard via RS-485 half duplex with configurable baud rates from 2.4k to 57.6k.
- I. Remote Monitoring Software
- 1. The control shall provide Monitoring Software with the following functionality
 - a. Monitor up to eight (8) generator sets, plus ATS and UPS.
 - b. Provide access to all data and events on generator set communications network
 - c. Provide remote control capability for the generator set(s)
 - d. Ability to communicate via Modbus RTU or remote modem
 - e. Provide a cell phone auto dialer to report trouble and alarm conditions.
- J. Local Annunciator (NFPA 99/110, CSA 282)
- 1. Provide a local, control panel mounted, annunciator to meet the requirements of NFPA 110, Level 1.
 - a. Annunciators shall be networked directly to the generator set control

- b. Local Annunciator shall include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton
- c. Provide the following individual light indications for protection and diagnostics
 - Overcrank
 - Low coolant temperature
 - High coolant temperature warning
 - High coolant temperature shutdown
 - Low oil pressure warning
 - Low oil pressure shutdown
 - Overspeed
 - Low coolant level
 - EPS supplying load
 - Control switch not in auto
 - High battery voltage
 - Low battery voltage
 - Battery charger AC failure
 - Emergency stop
 - Spare
 - Spare

K. Remote Annunciator (NFPA 99/110, CSA 282)

- 1. Provide a remote annunciator to meet the requirements of NFPA 110, Level 1.
 - a. The annunciator shall provide remote annunciation of all points stated above and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn.
 - b. Ability to be located up to 4000 ft from the generator set Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.10 SOUND ATTENUATED ENCLOSURE

- A. The emergency generator set and related equipment shall be housed in an outdoor weatherproof enclosure. The generator will function properly without overheating in the ambient conditions specified. Enclosure shall be weatherproof and sound attenuated at a maximum 75 dBA at 7 meters. 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.
- 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.

2.11 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, per the seismic requirements for the site.
- 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 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 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 six inches wide.
 - 2. Crimp and fasten the fabric to the sheet metal with screws 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 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 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 Resident Engineer for proper operation of the individual components and the complete system and to eliminate electrical and mechanical defects.
- C. Field Tests for the 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. If during the 6-hour continuous test a failure occurs, either the 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 owner.
 - c. Provide a portable load bank test for the generator.
 - 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 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. Demonstrate a functional performance test with a simulated loss of normal power to the building. The Engineer and commissioning agent shall witness test. (use the building load)
 5. Demonstrate a functional performance test to the AHJ. (use the building load)
- D. 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.
- E. Test local and remote panels: Simulate engine failures while checking for proper operation of each indicating lamp, alarm device and reset button.
- F. 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 owner, at no additional cost.
- G. Provide test and inspection results in writing to the engineer.

END OF SECTION 263200