SECTION 26 32 13
ENGINE-GENERATORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and testing of the low-voltage engine-generator system. This includes, but is not limited to: air filtration, starting system, generator controls, paralleling switchgear, 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.

1.2 RELATED WORK

A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.

B. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Requirements for pipe and equipment support and noise control.

C. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Requirements for hot piping and equipment insulation.

D. Section 23 10 00, FACILITY FUEL SYSTEMS: Fuel supply and storage requirements.

E. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.

G. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage conductors.

H. 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.

I. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Requirements for protective coordination of a standby and/or essential electrical system.

K. Section 26 13 13, GENERATOR PARALLELING CONTROLS: Requirements for generator paralleling.

L. Section 26 23 00, LOW-VOLTAGE SWITCHGEAR: Requirements for secondary distribution switchgear.

M. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: Requirements for secondary distribution switchboards.

N. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Requirements for automatic transfer switches for use with engine-generators.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 QUALITY ASSURANCE

A. The supplier of the engine-generator 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. Each of these installations shall have been in successful operation for three or more years. Prior to review of submittals, the Government reserves the right to:
   1. Have the manufacturer submit a list of locations with similar installations.
   2. Inspect any of these installations and question the user concerning the installations without the presence of the supplier.

B. A factory-authorized representative shall be capable of providing emergency maintenance and repairs at the project site within 2 hours maximum of notification.

C. Factory Test: The Government shall have the option of witnessing the following tests at the factory. The tests shall be performed on the specific engine-generator(s) being manufactured for this project. The Government will pay all expenses for the Government representative's trip to witness these tests. The contractor shall notify the Resident Engineer and COR 15 days prior to date of testing. The manufacturer shall furnish load banks, testing instruments, and all other equipment necessary to perform these tests.
   1. Load Test: Shall include six hours of continuous operation; four hours while the engine-generator is delivering 100% 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 to develop specified voltage, frequency, and kW load from a standstill condition.

1.5 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Shop Drawings:
Scaled drawings, showing plan views, side views, elevations, and cross-sections.

C. Diagrams:
Control system diagrams, elementary diagrams, control sequence diagrams or tables, wiring diagrams, interconnections diagrams (between local control cubicles, remote annunciator panels, remote derangement panels, remote monitoring panels, remote exercising panel, automatic transfer switches, paralleling switchgear, and fuel storage tanks, as applicable), illustrative diagrams, flow diagrams, and other like items.

D. Technical Data:
1. Published ratings, catalog cuts, pictures, and manufacturers' specifications for engine-generator, governor, voltage regulator, radiator, muffler, dampers, enclosure, pumps, fuel tank, batteries and charger, jacket heaters, torsional vibration, and control and supervisory equipment.
2. Description of operation.
3. Short-circuit current capacity and subtransient reactance.
4. Sound power level data.
5. 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.

E. Calculations:
Detailed engineering calculations with all equations, graphs, assumptions, and approximations shown and data sources referenced. Include any calculated performance derations appropriate to installed environment.

F. Manuals:
1. When submitting the shop drawings, submit complete maintenance and operating manuals of the engine-generator and auxiliaries, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
2. Two weeks prior to the final inspection, submit four copies of the updated maintenance and operating manual to the Resident Engineer and COR:

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 pieces 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. Include complete lists of spare parts and special tools recommended for two years of normal operation of the complete system.

G. Certifications:

1. Prior to fabrication of the engine-generator, submit the following to the Resident Engineer and COR for approval:
   a. 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.
   b. 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.
   c. A certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local regulations and restrictions specified. 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).
2. Prior to installation of the engine-generator at the job site, submit four copies of certified factory test data to the Resident Engineer and COR.
3. Two weeks prior to the final inspection, submit four copies of the following to the Resident Engineer and COR:

a. Certification by the engine-generator manufacturer that the equipment conforms to the requirements of the drawings and specifications.

b. A certified report of field tests from the contractor that the engine-generator has been properly installed, adjusted, and tested.

c. A certificate by the manufacturer that the engine-generator, accessories, and components will withstand the design seismic event forces and that the engine-generator will be fully operational after the design seismic event at the project site.

1.6 STORAGE AND HANDLING

A. Equipment 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 equipment in a location approved by the Resident Engineer and COR.

1.7 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):

C37.50-00.....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-07.....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)

D975-09b.....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. National Electrical Manufacturers Association (NEMA):
ICS 6-06.....Enclosures
ICS 4-05.....Terminal Blocks
MG 1-07.....Motor and Generators
MG 2-01.....Safety Standard and Guide for Selection, Installation and Use of Electric Motors and Generators
PB 2-06.....Dead-Front Distribution Switchboards
250-08.....Enclosures for Electrical Equipment (1000 Volts Maximum)

F. National Fire Protection Association (NFPA):
30-08.....Flammable and Combustible Liquids Code
37-06.....Installations and Use of Stationary Combustion Engine and Gas Turbines
70-08.....National Electrical Code (NEC)
99-05.....Health Care Facilities
110-10.....Standard for Emergency and Standby Power Systems

G. Underwriters Laboratories, Inc. (UL):
50-95.....Enclosures for Electrical Equipment
142-06.....Steel Aboveground Tanks for Flammable and Combustible Liquids
2200-98.....Stationery Engine Generator Assemblies
1236-06.....Battery Chargers for Charging Engine-Starter Batteries
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

PART 2 - PRODUCTS

2.1 ENGINE-GENERATOR

A. The engine-generator system shall be in accordance with NFPA, UL, NEMA and ANSI, and as specified herein. All information required by these specifications shall shown on the drawings.

B. Provide a factory-assembled, wired (except for field connections), complete, fully automatic engine-generator system.

C. Engine-Generator Parameter Schedule: The system will be designed as (3) 750kW/937.5kVA generators
Power Rating: Emergency Standby
Voltage: 277/480V
Power Factor: 0.8 lagging
Engine-Generator Application: parallel with other engine-generators on an isolated bus
Fuel: diesel
Maximum Speed: 1800 RPM
Frequency Bandwidth (steady state): + 0.25 %
Voltage Regulation: + 2% (maximum) (No Load to Full Load) (standalone applications)
Voltage Bandwidth: + 2% (steady state)
Frequency: 60 Hz
Phases: 3 Phase, Wye
Max Time to Start and be Ready to Assume Life safety Load: 10 seconds

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. 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 0.0059 in [0.15 mm], with an overall velocity limit of 0.866 in/sec [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. Shall be capable of operating satisfactorily as specified for not fewer than 10,000 hours between major overhauls.

I. Each engine-generator specified for parallel operation shall be configured for automatic parallel operation. Each engine-generator shall be capable of parallel operation with one or more engine-generators on an isolated bus.

J. Each engine-generator specified for parallel operation shall be configured to automatically load-share with other engine-generators by proportional loading. Proportional loading shall load each engine-generator to within 5% of its fair share. A fair share is its nameplate-rated capacity times the total load, divided by the sum of all nameplate-rated capacities of on-line engine-generators. Load sharing shall incorporate both the real and reactive components of the load.

2.2 ENGINE

A. Coupled directly to a generator.

B. Minimum four cylinders.

C. The engine shall be able to start in a 40˚ F [4.5˚ C] ambient temperature while using No. 2 diesel fuel oil without the use of starting aids such as glow plugs and ether injections.

D. Fuel oil consumption of the engine rate shall not exceed the following values:

Size Range Net kW	% of Rated Output **capacity**	Fuel Usage kg/kWH (lbs/kWH)
100 -299	75 and 100	0.272 (0.600)
	50	0.292 (0.643)
300 -999	75 and 100	0.261 (0.575)
	50	0.272 (0.600)
1000 -2500	75 and 100	0.243 (0.536)
	50	0.260 (0.573)

E. Equipped with electric heater for maintaining the coolant temperature between 90-100˚ F [32-38˚ C]), 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 one-third of 1%.

C. 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 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. Main fuel storage tank(s) shall comply with the requirements of Section 23 10 00, FACILITY FUEL SYSTEMS.

B. 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.

C. Piping System: Black steel standard weight ASTM A-53 pipe and necessary valves and pressure gauges between:

1. The engine and the base tank, and from fuel conditioning to base tank, as shown on the drawings.

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 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% ethylene glycol and 50% soft water, with corrosion inhibitor additive as recommended by the manufacturer.

E. Fan shall be driven by belts from engine shaft.

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.

H. Motor-Operated Dampers:

1. Dampers, which are provided under Section 23 31 00, HVAC DUCTS AND CASINGS, shall be two-position, electric motor-operated.
2. Dampers shall open simultaneously with the starting of the diesel engine and shall close simultaneously with the stopping of the diesel engine.

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:

1. Where turbo-charges are required, they shall be engine-mounted, driven by the engine gases, securely braced against vibration and adequately lubricated by the engine's filtered lubrication 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 3 in [75 mm] 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 0.016 in [0.4 mm] thick. The jacket is to be held in place by bands of 0.015 in [0.38 mm] thick by 0.5 in [15 mm] wide aluminum.
4. Insulation and jacket are not required on flexible exhaust sections.

F. Roof Sleeves: Pipe sleeves (thimble) shall be Schedule 40 standard weight steel pipe. Flash exhaust pipe thimble through roof with 16 oz soft sheet copper, flanged, and made watertight under built-up roofing and extended up around pipe thimble. The exhaust pipe shall be positioned within the thimble by four 6 in [150 mm] wide spiders welded to the exhaust pipe.

G. Exhaust piping termination shall be provided with a hinged, gravity-operated, self-closing rain cover.

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 (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 10second 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 HEATERS

Provide a thermostatically-controlled electric heater to automatically maintain the oil temperature within plus or minus 3˚ F [1.7˚ C] of the control temperature.

2.10 JACKET COOLANT HEATERS

Provide a thermostatically-controlled electric heater mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 3˚ F [1.7˚ C] 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 125% of the RPM specified for the engine-generator without damage.
F. Telephone influence factor shall conform to NEMA Standards.
G. Furnished with brushless excitation system or static-exciter-regulator assembly.
H. 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.
I. The grounded (neutral) conductor shall be electrically isolated from equipment ground and terminated in the same junction box as the phase conductors.
J. Provide "Remote Annunciator Panel" for each generator to be located in the boiler plant control room.
K. Provide Remote Derangement Panel for each generator. Locate at a 24-hour monitored location.
L. Provide "Remote Monitoring Panel" for each generator. Locate at the Boiler Plant Control Room.

2.12 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator circuit breaker shall be insulated-case, electronic-trip type; 100 percent rated; complying with UL 489. Tripping characteristics shall be adjustable long-time and short-time delay and instantaneous. Provide shunt trip to trip breaker when engine-generator is shut down by other protective devices.

B. Integrate ground-fault indication with other engine-generator alarm indications.

2.13 CONTROLS

A. Shall include Engine Generator Control Cubicle(s) Remote Annunciator Panel, Remote Derangement Panel and Remote Monitoring Panel.

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. All controls to existing transfer switches shall be extended to start generators
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 labelled.
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.
10. NOT USED.
11. The manufacturer shall coordinate the interfacing of the control systems with all related equipment supplied in accordance with other sections of the project specification.

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 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 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 10˚ F [-12˚ C].

4) Permanently indicate the temperature settings near the associated signal light.

5) When the coolant temperature drops to below 70˚ F [21˚ C], 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 - 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.

g. 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 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 Resident Engineer and COR. The audible alarm shall be rated for 85 dB at 10 ft [3 M].

i. Generator Breaker Signal Light:
1) A flashing green light shall be energized when the 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. 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: 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 ANNUNCIATOR PANEL

A. A remote annunciator panel shall be installed per direction of COR.
B. The annunciator shall indicate alarm conditions of the engine-generator as follows:
   1. Individual visual signals shall indicate generator run.
   2. Individual visual signals plus a common audible alarm shall warn of the following:

a. LOW LUBRICATING OIL PRESSURE
b. LOW COOLANT
c. HIGH COOLANT TEMPERATURE
d. LOW FUEL - DAY TANK
e. LOW FUEL – MAIN TANK
f. FAILURE TO START
g. OVERSPEED

C. The annunciator shall also have the following features:
1. Lamp test momentary contact switch which will momentarily actuate the alarm buzzer and all 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 push-button 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.

D. Include control wiring between the remote annunciator panel and the engine-generator. Wiring shall be as required by the manufacturer.

2.15 REMOTE DERANGEMENT PANEL

A. Incorporate an engine running light (red), trouble light (amber), generator breaker open or tripped (green flashing), and a buzzer with a momentary-contact silencing switch or push-button in a suitable metal enclosure.
B. The light and buzzer shall be energized whenever a trouble light and audible alarm is energized at the engine-generator control cubicle.
C. Install the panel at the location shown on the drawings.
D. Permanently attach an identification sign to the enclosure. The sign read "GENERATOR DERANGEMENT PANEL" and shall be laminated red phenolic resin with a white core and engraved lettering not less than 0.1875 in [4.7 mm] high.
E. Include control wiring between the remote derangement panel and the engine-generator. Wiring shall be as required by the manufacturer

2.16 REMOTE MONITORING PANEL

A. Shall have duplicates of the voltmeter, ammeter, and engine running light (red). Panel shall be located in location determined by owner.
B. Include control wiring between the remote derangement panel and the engine-generator. Wiring shall be as required by the manufacturer.

2.17 **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.

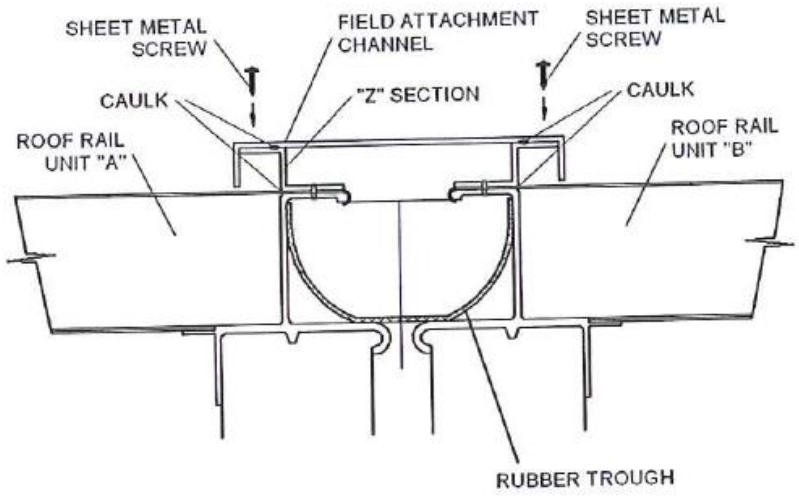
C. Enclosure shall be walk-in type and sound-attenuated (maximum 85 dBA at 5 ft [1525 mm] from any side, top and bottom to no more than 75 dBA when measured at 50 ft [15 m] horizontally from any part of the enclosure or appendage on the enclosure. Sound ratings shall be based on full-load condition of engine-generator in a single unit operation condition.

D. Airflow configuration shall be intake through rear of unit, and discharge air vertically up. Enclosure shall be suitable for winds up to 120 mph [193 kmh] roof load shall be equal to or greater than 40 lbs/sq ft [200 kg/sq m]. Non-distributed loading as required.

E. The enclosure shall meet the following requirements:

1. Radiator exhaust outlet shall be ducted out through 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.
   a) Weatherproof walk-in style enclosures.
   b) 36” aisles at control panel end of gensets.
   c) Minimum 60” aisle between gensets after final assembly of combined enclosures.
   d) Reduces noise radiated from installed equipment by 25dB(A) @ 1 Meter
   e) Distributed floor load to 200 lbs/ft^2
   f) Rain test equal to 4 inches/hour.
   g) Basic structure shall meet all seismic requirements of Zone 4 or equivalent.
6. The enclosure system will consist of several enclosures with a roof, two end walls, and side walls as required to offer a common generator room and connected separate switchgear room with door access to the common generator room. Incorporate prepainted aluminum stressed-skin semi-monocoque construction and application-specific acoustic insulation, lining and air handling equipment designed to provide the specified level of sound attenuation.

7. Provide a flawless field joining kit for installation between enclosures to offer a weather tight seal, walls and the critical roofline. Enclosure shall include a rubber trough element, z channels and a weather channel cap completely covering the seam area. Roof end caps, factory installed rubber seams between enclosure walls and wall adjoining covers shall be supplied for complete closure and clean finish. All field joining shall be completed jointly by electrical contractor and generator supplier oversight. Full instructions, sketches and pictures shall be supplied to insure a proper installation. Alternate systems than described above and depicted below will require pre-approval by engineer to insure integrity of seams.



8. The roof shall incorporate a positive camber and be comprised of a mill-finish 6063-T6 extruded aluminum perimeter channel or “roof rail” with 16 gauge (minimum) roll-formed galvanized cross-members or “roof bows” mechanically fastened to the roof rails.

9. The roof skin shall be a nominal 0.040-inch thick 3003-H16 or 3105-H14 mill-finish aluminum sheet and fastened to the roof bows and roof rails. The top skin shall be rolled over the perimeter of the roof rails so as to provide additional weather protection. A weatherproof mastic/sealant shall be used at the perimeter, as well as any joints required in the roof skin. The top skin shall be comprised of separate sheets of roof skin joined with lock-seam construction.

This joint(s) shall include a high performance mastic tape or sealant for both joint structural integrity and weather protection.

10. The walls shall be manufactured utilizing mill-prepainted 0.040 inch thick (nominal) 3004-H36 aluminum panels hard-riveted to fabricated aluminized steel "Z" section wall posts located on 24 inch (maximum) centers. The enclosure walls shall incorporate an extruded structural "panel-cap" of mill finish extruded 6063-T6 aluminum.

11. The panel-cap will interlock into the adjoining roofrail for a weatherproof structural connection between the roof and sidewalls. The bottom exterior of the sidewalls will incorporate a mill finish extruded 6063-T6 aluminum "rubrail" for a structural connection of the sidewalls to the base perimeter.

12. Corner posts shall be pairs of mating/interlocking mill finish 6063-T6 aluminum extrusions with one-half of each pair attached to the end of the wall. The halves will interlock upon assembly forming a structural, weatherproof corner.

13. End walls shall be of a removable type retained with 0.250-inch stainless steel thread-forming hardware to facilitate equipment installation and maintenance.

14. Thermo-acoustic insulation or a thermo-acoustic composite material shall be installed on the interior roof and wall panels of a weight and thickness consistent with the specified level of noise reduction. The insulation shall be covered with mill finish 0.032-inch thick (nominal) perforated aluminum interior lining for the purpose of protecting the insulating medium as well as allowing noise to permeate the absorptive material.

15. The floor structure shall be rated for a minimum distributed load of 200 lbs./ft2 and reinforced as required to support prevailing point-loading. The floor and underframe assembly shall consist of fabricated steel or structural steel welded to form the outer perimeter. This perimeter shall be combined with formed structural steel cross-members (nominal 16-inch centers) so as to create a welded steel support structure for the installed power generation

equipment. Steel channels shall be incorporated into the floor structure for adequate structural support and attachment of the generator set and vibration isolators. Provide access doors as required to access all piping connections, sensor ports, and any other point requiring access and maintenance.

16. The cross-members shall be overlaid with a composite of 0.72-inch thick (nominal) oriented strand board (OSB) covered by 14 gauge (minimum) diamond plate steel for the purpose of load distribution, vibration isolation and sound attenuation. The steel sheet shall be coated with a wear-resistant, high quality anti-corrosive material. Truss head screws shall be inserted in optimal locations through the diamond plate sheets to establish a ground connection to the underframe cross-members.

17. The fuel base tank capacity shall be sized for 96 hours at full load, and it shall be installed beneath the floor and shall be listed as a "primary containment aboveground tank for flammable and combustible liquids" in accordance with UL Standard No. 142 and mounted within a combined rupture basin/floor/underframe. The interstitial space between the tank and basin shall be monitored to indicate a rupture condition. Fuel tank shall connections shall include drainage plumbing, supply/return lines, fuel conditioning system supply and return, fuel level monitoring, fuel level indication, and fill/supply valve.

18. Provide the base day tank complete in all respects in order to provide the prime mover with a reliable, local source of fuel. Provide the base tank and fuel delivery system described above in order to provide an automatic Fuel Supply System.

19. Include an adequate pump based on full load engine fuel consumption driven by an 115V AC, single-phase, 60 Hertz, motor.

20. Pipe thread connections shall be provided for, but not limited to, fuel oil supply/fill, supply to prime mover, return from prime mover, vent, emergency vent, fuel level monitoring, fuel level indication, fuel conditioning system supply and return, and drain with ball valve. The drain will penetrate the containment described below.

21. Include inlet solenoid valve, LED lamp indicators for power available, fill control not in auto, tank filling, low level alarm, high level alarm, tank rupture. Include output dry contacts for low fuel, tank rupture, and high level. Digital control of this fuel delivery system is desired including a level gauge.

ELECTRICAL PACKAGE

Enclosure manufacturer furnished and wired in genset enclosures:

Shelter-To-Shelter Interconnection/Junction Box(interconnection in field by electrical contractor) Quantities as shown on drawings.

- Fused disconnect
- 100A, 3PH, 120/208V 30 Space Panelboard W/Main
- Empty Conduit - Stub-Up to Load Center
- Fluor. Vaportight Light 4ft 2 Tube w/elec.ballast
- Light Switches (3-Way)
- Receptacle (GFCI, Interior, 125V, 20A, Duplex)
- Dual Head Emergency Light
- 100W Exterior LED Light W/Photocell
- Digital Fuel Monitor w/Low, High, Rupture
- Contacts for Duplex Pumps & Return Pump
- Connection Box for Pump Controls or Tank Alarms
- Heater W/Thermostat & Cut-Out Relay: 208V 3 Ph
- 16" Roof Exhaust Fan W/Thermostat & Motor-operated Damper
- Battery Pad Heater W/Thermostat
- Include bird/rodent screen on air inlet and discharge openings.
  - Inlet Damper Wired to Load Center/Panelboard/J-Box and shall be wired for power close/spring open.
  - Discharge Damper Wired to Load Center/Panelboard

Generator manufacturer furnished, enclosure manufacturer installed and wired

Battery Charger A.C. and D.C.

Battery Charger Alarms to J-Box OR Genset

Generator Strip Heater

Jacket Water Heater

Enclosure manufacturer furnished equipment and services:

Silencer, 12" Low Profile Critical Cool (Silex PK-CI-12, See notes)
Silencer Drain Petcock
Exhaust Flex
Insulation Blanket for Exhaust Flex
Exhaust Elbow with companion flange for exhaust extension by mechanical contractor
Insulation Blanket For Exhaust Elbow
Extend Coolant Drain to Exterior
Extend Crankcase Breather Tube to Duct Adapter
Extend Lube Oil Drain to Exterior
Extend Fuel Overflow from Base Tank to Exterior
Extend Fuel Supply for Base Tank to Exterior
Racor Fuel Filter/Water Separator - 75/1000 FHX30 (Duplex)-Valved-change on fly

Generator manufacturer furnished, enclosure manufacturer installed

- Genset
- Vibration Isolators/Pads
- Batteries, Rack, and Cables-Starting and switchgear station batteries
- Battery Charger
- Mechanical Installation of Switchgear
-Removable Access Panel(s) Behind Switchgear

2.18 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:
   Three complete sets of fuses.
C. For each control panel:
   Three complete sets of fuses.

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:

The vibration velocity in the horizontal, vertical, and axial directions shall not exceed 0.65 in [16.25 mm] 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 6 in [150 mm] wide.
2. Crimp and fasten the fabric to the sheet metal with screws 2 in [50 mm] 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˚ F [1093˚ C] 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 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 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 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 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, and 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-start installation checklist.

E. Set relays per this specification. Set engine-generator circuit breaker protective functions per Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.

F. Field Tests:
   1. Perform manufacturer’s after-starting checks and inspections.
   2. Test the engine-generator for eight hours of continuous operation as follows:
      a. First six hours while the engine-generator is delivering 100% of its specified kW rating.
      b. Last two hours while the engine-generator is delivering 100% 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 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. Engine 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, frequency, and will accept the specified block load 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 Monitoring Panel Tests:
Simulate conditions to verify proper operation of each indicating lamp, alarm device, meter, interconnecting hardware and software, and reset button.

I. Fuel systems shall be flushed and tested per Section 23 10 00, FACILITY FUEL SYSTEMS: Fuel supply and storage requirements.

J. Automatic Operation Tests:

Test the engine-generator to demonstrate automatic starting, loading and unloading. The load for this test shall utilize both load banks and actual loads to be served. 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. Parallel Operation Test:
   1. Test the capability of each engine-generator to parallel and share load with other engine-generators, individually and in all combinations. During operations, record load-sharing characteristics of each engine-generator in parallel operation. Record the following data:
      a. Ambient temperature (at 15-minute intervals).
      b. Generator output current (before and after load changes).
      c. Generator output voltage (before and after load changes).
      d. Power division and exchange between engine-generators.
      e. Real power (watts) and reactive power (vars) on each engine-generator.
   2. Connect each engine-generator, while operating at no load, in parallel with one other engine-generator in the system, operating at service load, until all possible two-unit-in-parallel combinations have been tested. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive loads. Document stabilization of voltage, frequency within specified bandwidth, the active power division, active power exchange, reactive power division, and voltage and frequency stability, and transient response in the following steps for each combination.
      a. Divide the load proportionally between the engine-generators and operate in parallel for 15 minutes.
      b. Increase the load in steps until each engine-generator is loaded to its service load.
      c. Decrease the load in steps until each engine-generator is loaded to approximately 25% of its service load.
      d. Increase the load in steps until each engine-generator is loaded to approximately 50% of its service load. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive load.

e. Reduce the sum of the loads on all engine-generators to the output rating of one engine-generator.

f. Transfer a load equal to the output rating of one engine-generator to and from each engine-generator. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive load.

3. Connect each engine-generator, while operating at no load, in parallel with all multiple combinations of all other engine-generators in the system, while operating at service load, until all multiple combinations of parallel operations have been achieved.

4. Connect each engine-generator in parallel with the commercial power source. Operate in parallel for 15 minutes. Verify stabilization of voltage and frequency within specified bandwidths. Record the output voltage, frequency, and loading to demonstrate ability to synchronize with the commercial power source.

L. 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.

M. 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 Resident Engineer and COR, at no additional cost to the Government.

N. Provide test and inspection results in writing to the Resident Engineer and COR.

3.3 FOLLOW-UP VERIFICATION

Upon 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 and COR.

B. Furnish the services of a competent, factory-trained technician for three 4-hour periods for instructions to VA personnel in operation and maintenance of the equipment, on the dates requested by the Resident Engineer and COR.

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