SECTION 26 32 13.13

DIESEL ENGINE ELECTRICAL GENERATOR SET

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included:

1. Furnish diesel engine electrical generator set system. The system shall include skid-mounted diesel engine generator set, external sub-base fuel tank, control panel, low voltage distribution circuit breakers, generator starting batteries, battery charger, sound attenuation weather-proof outdoor enclosure, wiring and conduit, cooling and ventilation equipment, exhaust components, and appurtenances as specified herein.

2. Provide factory performance tests results of the generator being supplied.

3. Provide manufacturer field (on-site) services including startup, commissioning, testing support, and equipment training.

4. Provide extended warranty for generator maintenance inspection and service after acceptance.

1.2 DEFINITIONS

A. DISTRICT shall be the East Bay Municipal Utility District.

B. SUPPLIER shall be defined as the authorized agent, dealer, or distributor of the diesel engine electrical generator system.

1.3 JOB CONDITIONS

A. The operating environment of the diesel engine electrical generator set shall be:

1. Altitude: Approximately 5 feet above Mean Sea Level.

2. Outside temperature, maximum: 130 degrees F.

3. Outside temperature, minimum: 25 degrees F.

4. Exposure: Outdoors, uncovered, within 1 mile from marine environment

B. Operating hours: Standby-duty, 24 continuous hours per day, 7 days a week.

1.4 REFERENCES

A. California Code of Regulations:

1. Title 17, §93115 - Airborne Toxic Control Measures for Stationary CI Engines.

2. Title 24, Part 3 – California Electrical Code (CEC).

B. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE 446 - Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

C. International Electrotechnical Commission (IEC):

1. IEC 8528 part 4, Control Systems for Generator Sets.

2. IEC 61000-2 and 61000-3 for susceptibility, 61000-6 radiated and conducted electromagnetic emissions.

D. National Electrical Manufacturers Association (NEMA) Publications:

1. MG 1 Motors and Generators.

E. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code

2. NFPA 110 – Standard for Emergency and Standby Power Systems.

F. Underwriters Laboratories (UL):

1. UL 2200 – Standard for Stationary Engine Generator Assemblies.

1.5 QUALITY ASSURANCE

A. The engine, generator, and all major items of auxiliary equipment shall be manufactured in the U.S. by manufacturers currently engaged in the production of such equipment. The generator set shall be factory assembled and tested, and shipped to the certified dealer facility where parts and services are performed. The performance of the diesel engine generator set and all associated equipment shall be certified as functional with stability to the full power rating and exhibits voltage and frequency regulation.

B. The generator set shall be produced by a manufacturer who has produced this type of equipment for a period of at least 10 years.

C. The SUPPLIER shall have at least 10 years of experience in the sales and service of the equipment with service personnel trained and certified by the generator set manufacturer.

D. All equipment and products specified herein shall be the responsibility of one SUPPLIER.

E. Before the generator set is shipped from the factory to the site, an unwitnessed factory certified test of the generator set running for a minimum of 1-hour, running at 100 percent load for 1/2 –hour continuously shall be performed.

1.6 QUALITY CONTROL

A. Generator shall be factory tested. All tested data shall be submitted to the District for review prior to shipping to the job site.

1.7 REGULATORY REQUIREMENTS

A. Generator engine shall meet or exceed the emissions requirements per Title 17, CCR 93115.6 for new stationary emergency standby diesel fueled compression ignition engines.

B. Equipment furnished shall meet the requirements of the California Electrical Code (CEC) and all applicable local codes and regulations.

C. Generator engine shall meet local air permit requirements (e.g. Bay Area Air Quality Management District (BAAQMD) Best Available Control Technologies (BACT) for I.C. Engine – Compressed Ignition, Emergency, >50hp and <1,000hp (revised 12/20/2020). Final purchase of the engine shall be contingent on the District receiving the Authority to Construct from BAAQMD and passing the Health Risk Assessment completed prior to issuance of the Authority to Construct.

1.8 SUBMITTALS

A. Submit the product data of the complete and assembled system specified herein. Product data shall clearly highlight: fuel consumption, rated horsepower output, and emissions rates for NOx, CO, non-methane hydrocarbons (NMHC+NOx), and particulates (PM10).

B. Submitted data shall be fully sufficient in detail for determination of compliance with the provisions and intent of this Proposal, and for coordination of all connections for installation by others.

C. Submit technical information for engine on Data Form ICE from the BAAQMD, which can be obtained from their web site at: http://www.baaqmd.gov and https://www.baaqmd.gov/permits/apply-for-a-permit/engine-permits.

1. The information shall be sufficient to complete:

a. Form P-101B.

b. Form ICE.

c. Form HRA.

D. Submit in print and a photo the nameplate for the generator to satisfy permitting requirements.

E. Within 10 days of contract award, provide submittals including the following:

1. Model number of the diesel engine generator set and all associated equipment.

2. Material List - A breakdown of all components and options, including quantity, description, manufacturer, and model number.

3. Technical Data - Manufacturer produced specifications or datasheets for diesel engine generator supplied, including the following tabular data:

a. Engine type, aspiration, compression ratio, and combustion cycle, bore, stroke, displacement, and number of cylinders.

b. Power rating at 0.8 power factor with and without fan.

c. Engine lubricating oil capacity.

d. Engine coolant capacity without radiator.

e. Engine coolant capacity with radiator.

f. Coolant pump external resistance (maximum).

g. Coolant pump flow at maximum resistance.

h. Fuel consumption: 50, 75, and 100 percent standby load (gallons per hour).

i. Maximum continuous duty horsepower with fan.

j. Total operating weight including all coolant, engine oil, fuel, diesel exhaust fluid, and all other material necessary for operation.

k. Generator:

1) Ratings, prime and standby power kW.

2) Line to Line Voltage.

3) Phases.

4) Connections.

5) Frame number.

6) Insulation class.

7) Number of leads.

8) Total weight.

9) Rotor weight.

10) Air flow required.

11) Fuel to line and generator efficiency at 0.8 power factor for 25, 50, 75, and 100 percent load.

12) Time constants, short circuit transient (T'D).

13) Time constants, armature short circuit (TA).

14) Reactance, subtransient - direct axis (X"D).

15) Reactance, transient - saturated (X'D).

16) Reactance, synchronous - direct axis (XD).

17) Reactance, negative sequence (X2).

18) Reactance, zero sequence (X0).

19) Reactance, fault current, 3 phase symmetrical.

l. Radiator:

1) Fan drive ratio.

2) Fan power.

3) Air flow and maximum external pressure differential.

4) Radiator coolant capacity and protection level in degrees F.

m. Engine-generator Set:

1) Dimensions: Length, width, height, access clearances.

2) Sound level.

3) Total weight.

4) Mounting bolt pattern.

n. Exhaust silencer:

1) Dimensions: Length, width, height.

2) Weight (pounds).

3) Inlet and outlet sizes (inches).

4) Attenuation (db vs. frequency).

5) Pressure loss.

o. Sound-attenuating weatherproof enclosure:

1) Dimensions: Length, width, height.

2) Weight (pounds).

3) Enclosure and insulation material, thickness, flame rating

4) Attenuation (db vs. frequency).

5) Nominal (free-field) exterior sound level at 23 feet.

6) Configuration and size of: access doors; control panels; fluid connections, fill ports, and drains; electrical connections; air inlet and discharge; exhaust discharge.

7) Mounting details.

p. Sub-base Fuel Tank:

1) Dimensions: Length, width, height.

2) Materials of construction.

3) Size (Gallons).

4) Double wall containment volume (Gallons).

q. Lube oil sump capacity.

r. Vibration Isolators:

1) Load ratings.

2) Dimensions: Length, width, height.

s. High Temperature Insulation Blankets:

1) Materials of construction and dimension details.

2) R-factor and personnel protection capability; touch temperature.

t. Generator Distribution Circuit Breakers and Control Panels:

1) Distribution Circuit Breakers Rated Maximum Voltage.

2) Distribution Circuit Breakers Operating Voltage.

3) Distribution Circuit Breaker Continuous current and short circuit ratings.

4) Distribution circuit breaker types.

5) Current transformer type, ratings, and accuracy.

6) Potential transformer type, ratings, and accuracy.

7) Control power transformer type and capacity.

8) Internal control wiring conductor and insulation information.

9) Instruments, human machine interface (HMI) display, meters, protective relays, circuit breaker control switches, alarms and indicating lights.

10) Terminal blocks.

11) Nameplates.

12) Enclosure NEMA rating and materials type.

u. Starting Batteries:

1) Type.

2) Dimensions.

3) Weight.

4) Volume.

5) Number of plates.

6) Ratings.

7) Battery sizing calculations.

8) Battery container information.

v. Battery Charger:

1) Nominal voltage and current ratings.

2) Adjustable float and equalizes voltages.

3) Recommended float voltages.

4) Voltage regulation.

5) Input voltage.

6) Weight.

7) Dimensions.

8) Ambient temperature ratings.

9) Enclosure NEMA rating.

w. Distribution circuit breakers.

x. Light fixtures, switches, and convenience receptacles.

y. Nameplates.

4. Certification that the engine generator meets the specified emissions standards. Air emission compliance certification including, but not limited to:

a. Manufacturer data on air emissions
b. Stack height and diameter

5. Complete specifications, outline dimensional drawings, and descriptive literature.

6. General assembly drawings.

7. Front, side, and section views.

8. Three-line and control schematic (elementary) diagrams in ladder type format for the entire system.

9. Complete schematic, wiring, and interconnection diagrams showing all terminal and destination markings for all equipment, as well as the functional relationship between all electrical components.

10. Anchorage, seismic, and vibration info including typical mounting details drawings for installation.

11. Warranty Statements: Warranty verification published by the manufacturers of the components and the generator set.

F. Unwitnessed Factory Test Report: Prior to shipping to the job site submit unwitnessed factory quality test reports to District for review and approve.

G. Prior to contract closeout:

1. Operating, maintenance, and testing manuals for all equipment, including, but not limited to the following:

    a. Engine.

    b. Generator.

    c. Voltage Regulator.

    d. Electronic Governor.

    e. Distribution Circuit Breakers and Control Panels.

    f. Batteries.

    g. Battery Charger.

    h. Coolant or block heaters.

    i. Silencer.

2. Recommended spare parts and current price list.

3. The name, address, and phone number of the local sales representative and technical assistance for each piece of equipment.

4. The name, address, and phone number of the local parts distributor for each piece of equipment.

5. Certification shall be supplied with each system that verifies the torsional vibration compatibility of the rotating element of the prime movers and generators for the intended use.

6. O&M Manuals shall be made in 3-ring bound hard copy and electronic PDF on a CD-ROM. Provide four (4) hard copies and two (2) electronic CD-ROM copies.

    a. Include all final factory test reports to be inserted after testing completed.

    b. Any modifications made to equipment shall be documented in the O&M manuals.

7. Letter or certification of three (3) years extended warranty that includes parts, labor, and travel.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Ship equipment, material, and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

B. All mechanical and electrical equipment shall be coated, wrapped, and otherwise protected from snow, rain, drippings of any sort, dust, dirt, mud, flood and condensed water vapor during shipment and while stored. The protective coverings shall remain in place until the work areas are substantially free of all construction dust, dirt, mud, accumulated water, moisture, and debris.

C. Unload equipment from the transport vehicle(s) per manufacturer's instructions.

D. Ship generator to 2020 Wake Avenue, Oakland, CA 94607, U.S.A.

1.10 MANUFACTURER'S FIELD SERVICES

A. Field services including startup, commissioning, testing support, and training shall be provided.

B. Certified factory-trained manufacturer's representative shall be present at the site or classroom designated by the District for the minimum person-days listed, travel time excluded.

Person-Days	Manufacturer's Services
2	Field commissioning, startup, testing support
1	Training of District personnel (person-days listed is total training days): • 2 training sessions of 4 hours with no more than 10 persons maximum per session, schedule to be determined. • Provide all training and presentation materials.

C. Training shall include operations of the diesel engine electrical generator and the associated equipment, function of each component, alarms and control logic, principles of power generation, startup and shutdown procedures, safety precautions, emergency and lockout procedures, interconnections, procedures for contacting manufacturer's representative for field service, discussion of warranty, and basic troubleshooting and preventative maintenance.

1.11 WARRANTY

A. The manufacturer of the diesel engine electrical generator set and all the associated equipment shall have an authorized dealer within a one hundred (100) mile radius of the project site who can provide factory-trained servicemen, the

required stock of replacement parts, technical assistance, and warranty administration. Standard service and replacement parts shall be available within 24 hours of service call.

B. Warranty shall be manufacturer's standard, but in no event be for a period of less than two (2) years with 400 runtime hours, whichever comes first. In the first year of the warranty, runtime hours are unlimited.

C. Provide extended warranty coverage for a period of three (3) years after the end of the manufacturer's standard warranty. The extended warranty shall be equivalent in coverage to the manufacturer's standard warranty. The extended warranty shall include parts, labor, and travel.

D. Warranty shall include repair labor, travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair.

E. Warranty date and runtime shall start from the date of acceptance of the system. Runtime incurred during startup and testing does not count.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise noted, all products shall be factory installed into an integrated, skid-mounted, UL 2200 listed enclosed diesel engine electrical generator set system.

B. The system shall meet or exceed NFPA 110 requirements for providing Level 1, Type 10 life safety emergency power.

C. The diesel engine electrical generator set shall meet or exceed the State of California emission requirements for stationary compression ignition engines.

D. The generator set system shall be new.

E. The generator set and associated equipment shall be suitable for the job conditions as specified and outdoor rated.

F. Acceptable manufacturers for diesel engine electric generator set system:

1. Cummins,

2. Caterpillar,

3. Or equal.

2.2 DIESEL ENGINE

A. The engine shall be liquid cooled, four-cycle design, turbocharged, compression ignition diesel design. Continuous rated standby power of a minimum of 275kw (344kVA) when operating at 277/480 volts wye connected, three-phrase, 60 Hz, 0.80 power factor, when driving a synchronous generator at a speed not to exceed 1,800 RPM. The engine shall be designed to use ultra-low sulfur diesel fuel.

B. The engine shall be equipped with air filters, fuel filters, pressure gauge, water pump, temperature gauge, fuel level gauge, battery voltage gauge, and service hour meter.

C. The engine shall be provided with a full pressure lubricating oil system arranged to distribute oil to all moving parts of the engine and to cool the pistons. The system shall include pressure regulating valves, oil filter, oil strainer, oil cooler, oil level indicator, low oil pressure shutdown, crankcase ventilator, and necessary piping and fittings.

D. Provide lubricating oil filters of the full-flow type, capable of filtering the full rate of oil flow of the oil pump at maximum engine speed. The filter shall provide a means of automatically bypassing lubricating oil if the condition of the filter so requires.

E. Lubricating oil strainer and filter shall be cleanable, or replaceable, without disconnecting any piping.

F. The engine shall be electronically-controlled, fuel injected, and shall be provided with all necessary fuel system equipment including piping, fittings, valves, pump, filters, strainer, and appurtenances.

G. A fuel oil filter shall be installed in the piping ahead of the injection pumps on each unit. Pressure transducers shall be provided on both sides of the filter to indicate condition of the filter.

H. Install a fuel oil solenoid valve in the piping ahead of the fuel filters on the unit, if required to prevent flooding of the engine's fuel system.

I. Acceptable manufacturers for diesel engine:

1. Cummins,

2. Caterpillar,

3. Or equal.

2.3 SUB-BASE FUEL TANK

A. Fuel tank shall meet requirements of NFPA 30, and UL 142 listed as secondary containment generator base tank.

B. Fuel tank shall be double-walled, sub-base fuel tank constructed of heavy-gauge steel, designed for supporting the generator set.

C. Tank shall be painted with a UV and chemical resistant epoxy coating system. The interior of the tank shall be treated with a rust preventative for extended corrosion protection.

D. Tank shall be sized for a minimum of 24-hour generator run time with full load at standby rating.

E. Secondary containment for engine fluids shall be sized for 110%.

F. Tank shall include openings for fuel fill, normal and emergency vent pipes (primary and secondary), fuel level gauge, low level switch, secondary containment basin switch, and four (4) spare 2-inch opening with male plug.

G. Fuel fill shall be equipped with a 5-gallon spill box

H. Fuel tank shall be equipped with an overfill prevention valve.

2.4 GOVERNOR, ELECTRONIC SPEED CONTROL

A. The engine governor shall control engine speed while optimizing both steady state and transient engine performance. The governor shall monitor all significant engine parameters, and adjust engine performance according to speed, altitude, temperature, after cooler or combustion air temperature, jacket water temperature, and filtered fuel pressures.

B. The governor shall incorporate programmable control software capable of adjusting engine operation to desired performance levels. The governor shall be configured to avoid interruption of power; it shall be programmed such that in the event of system faults which do not require shutdowns, the engine shall continue operation at power levels sufficient to remain within performance limits.

C. The governor shall display real time and historical data to allow the user to optimize operation and provide accurate service information in the event of a malfunction. The service information shall be accessible through a data link for remote monitoring, or through an RS-232 or RS-485 serial communication port. A data link failure shall not cause an interruption of engine operation.

D. The engine governor shall maintain +/-0.5 percent steady state speed regulation and be adjustable from a remote location. Speed drop shall be adjustable from 0 (isochronous) to 10 percent from no load to full rated load. Ramping up to rated speed during startup shall be delayed with a controlled rate of acceleration until engine oil pressure is assured. In the event of a DC power loss, the fuel system shall remain closed.

E. Acceptable manufacturers for governor:

1. Cummins,

2. Caterpillar,

3. Or equal.

2.5 RADIATOR, ENGINE MOUNTED

A. The radiator shall be sized to cool the engine continuously while operating at full rated load and at site conditions.

B. A thermostatic valve shall be installed to maintain a constant temperature of the water leaving the engine.

C. The fan, fan drive, and fan belts shall be covered by a strong grille for personnel protection.

D. The cooling system shall be filled with a permanent anti-freeze solution capable of protecting the engine at a temperature of +15 degrees F.

2.6 INLET AIR SYSTEM

A. The air cleaner shall be engine mounted with dry element requiring replacement no more frequently than 250 operating hours or once each year. The air cleaner shall be designed to permit easy replacement of the element.

2.7 EXHAUST SYSTEM

A. The exhaust silencer shall effectively reduce exhaust noise and arrest spark propagation. Exhaust silencer shall be sized as recommended by engine manufacturer. Exhaust piping system shall not exceed engine manufacturer’s engine backpressure requirements. Exhaust silencer shall be housed inside enclosure.

B. If exhaust direction is upward, provide a stub stack and suitable rain cap. If exhaust direction is horizontal, miter the pipe end to prevent intrusion of rainwater, and direct the exhaust into the upward discharge of the radiator fan.

2.8 WIRING AND CONDUIT

A. Engine and generator control wiring shall be multi-strand, minimum 14 gauge, insulated copper wire rated at 600 volts AC, 90 degrees C dry or wet, resistant to heat, abrasion, oil, water, antifreeze, and diesel fuel. Each cable will be heat stamped throughout the entire length to identify the cable's origin and termination. Cables shall be enclosed in nylon flexible conduit which is slotted to allow easy access and moisture to escape. Reusable bulkhead fittings will attach the conduit to generator set mounted junction boxes.

2.9 COOLANT OR BLOCK HEATER

A. The engine shall be provided with a general purpose coolant or block heater with thermostats. All heaters shall be automatically deactivated while the engine is running.

2.10 STARTING SYSTEM

A. The engine starting system shall include 12 or 24 volt DC batteries, starting motor, starting relay, and automatic reset circuit breaker to protect against butt engagement. Starting system equipment shall meet the requirements of NFPA 110, Paragraph 5.6.4 – Prime Mover Starting Equipment for Level 1 installations.

B. The storage batteries for each unit shall be low maintenance, high output, lead-acid type, 12 or 24 volt system. Batteries shall be mounted in a leak-proof rubber or plastic lined caustic resistant frame and enclosure. Battery shall be provided with intercell connectors, bolts, racks, etc., as required for a complete system. The batteries shall have full warranty for two (2) years and shall have a minimum one-minute rating of 850 amperes for 12 volt system or 1400 amperes for 24 volt system to a voltage of 1.0 volts per cell.

2.11 BATTERY CHARGER

A. Provide a 12 or 24 volt automatic float battery charger with constant voltage regulation, suitable for maintaining the diesel engine generator set starting batteries. The rated output shall be such that this rating is not exceeded when charging the batteries from a totally discharged condition back up to equalizing voltage. Chargers shall operate at 120 volts AC, single phase 60 Hz, with shore power connection.

B. Provide battery chargers that meet the requirements of NFPA 110, Paragraph 5.6.4 – Prime Mover Starting Equipment for Level 1 systems.

2.12 WEATHER/SOUND ENCLOSURE

A. General:

1. Enclosure shall be designed and constructed for use with UL 2200 listed generator set package. Enclosure shall be factory installed as part of the package generator assembly.

2. Material: Constructed of minimum 0.125-inch thick aluminum formed panels.

3. Coating: Heavy duty, corrosion- and abrasion-resistant powder coating suitable for continuous exposure to marine environment.

4. Louver screens for all louvers to permit air circulation when engine is not running while excluding birds and rodents.

5. Provide lockable, hinged doors with hold back hardware to keep door fully open during maintenance. Doors shall fully open (180 degrees).

6. Lockable access for oil fill, coolant fill, distribution circuit breakers, and control panel.

7. Externally mounted emergency stop pushbutton, appropriately identified for the purpose.

8. Acoustic insulation - Reduce the sound level of the engine generator while operating at full rated load to a maximum of 78 dBA measured at any location 23 feet from the engine generator in a free field environment.

9. No wood or other combustible or flammable materials shall be incorporated as part of the enclosure.

10. Door hinges and latches shall be Type 316 stainless steel.

2.13 GENERATOR

A. General:

1. The generator set shall provide a rated standby power of a minimum of 275kW (344kVA) when operating at 277/480 volts connected, three-phase, 60 Hz, 0.80 power factor, at 1800 rpm alternator speed.

2. The generator shall be capable of starting loads with a transient voltage dip on application of each step not exceeding 15 percent of rated voltage.

3. The generator shall be close-coupled, open drip-proof, single bearing construction, brushless revolving field, synchronous alternating current type with windings in the pole faces of the rotating field.

4. The generator shall be supplied with a side mounted terminal box which is designed to accommodate the connections to the load. The terminal box shall be equipped with hardware for padlock.

5. The rotor assembly shall demonstrate 125 percent over speed capability at 170 degrees C for 2 hours. Rotor dynamic, two-plane balance shall not exceed 0.002 inch peak to peak amplitude at operating speed.

6. All winding insulation materials shall be at least Class H temperature rise in accordance with NEMA standards. No materials shall be used which support fungus growth. Materials shall be impervious to oil, dirt, and fumes encountered in diesel engine operating environments.

7. The alternator shall be brushless, 4-pole, has a minimum of winding insulation Class H and 150 degree C rating.

8. The generator shall be supplied with permanent magnet generators (PMG) to provide power to the voltage regulator.

B. Frame: The generator frame shall be fabricated from heavy steel members welded to the end bell or bearing bracket pilot rings. The generator feet shall be welded to the frame. Eye bolts shall be fastened to the generator frame to facilitate lifting of the generator with an overhead hoist. Steel wrapper cover shall enclose the frame assembly.

C. Stator: The generator stator core shall be constructed of laminated electrical grade steel. The laminations shall be secured under pressure and clamped to steel end rings. Windings shall be inserted into the stator slots and the entire assembly shall be vacuum pressure impregnated with 100 percent epoxy resin. The stator leads shall terminate in standard connection lugs for connection to bus bar terminal assemblies.

D. Rotor:

1. The shaft shall be machined from high strength steel stock or forging. The mechanical centerline shall be scribed on the drive end for proper alignment.

2. The spider shall be laminated and be an integral part of the rotor pole.

3. The poles shall be individually punched of high strength laminations which are held together with rivets or bolts. The field windings shall use insulated copper wires which are wet layer wound on the laminated poles. The wound poles shall be anchored to the spider with specially made tapered keys. Damper bars shall be inserted below the surface of the pole face and shall be welded/brazed to a continuous shorting ring or plate. The rotor assembly shall be shrunk and keyed on the shaft. The rotor shall be dynamically balanced to assure compliance with NEMA vibration limits and long bearing life. A dynamically balanced blower shall be mounted on the shaft at the drive end.

E. Exciter:

1. The generator exciter shall be brushless with the circuit consisting of an inverted synchronous AC generator with the field winding stationary and three-phase armature windings rotating with the generator rotor. The AC output shall be rectified through a three-phase full wave semiconductor bridge rectifier mounted on the rotor shaft.

2. The exciter armature shall be constructed from laminations and riveted under pressure. The three-phase windings shall be inserted in the slots and the entire assembly shall be vacuum pressure impregnated with 100 percent epoxy resin. The exciter armature shall be pressed on a tubing and keyed into position.

3. The three-phase full wave rectifier shall be constructed of three forward and three reverse diodes. Diodes shall be mounted on two separate rings acting as negative and positive polarity heat sinks. The rectifier assembly shall be keyed on the same tubing as the exciter armature. Both the exciter armature and the rectifier assembly shall be dynamically balanced. The sleeve tubing shall be pressed and keyed on the main rotor shaft.

4. The exciter stator shall be constructed of laminations stacked under pressure and welded. Field windings shall be inserted and the entire assembly vacuum pressure impregnated with 100 percent epoxy resin. The stator shall be mounted on the bearing bracket.

F. Permanent Magnet Generator: The permanent magnet generator (PMG) shall provide power to the voltage regulator under all operating conditions regardless of the main generator output. The PMG shall be a single-phase AC generator with rotating permanent magnets providing excitation.

G. Bearings: Provide regreasable type bearings with grease fill and drain ports.

H. Acceptable manufacturers for generator:

1. Cummins,

2. Caterpillar,

3. Or equal.

2.14 VOLTAGE REGULATOR

A. The voltage regulator shall be digital, microprocessor based, with fully programmable operating and protection characteristics. The regulator shall be capable of sensing true RMS voltage in all three phases of the generator output or operating in single phase sensing mode. The regulator shall exhibit the following operational characteristics:

1. Generator output voltage maintained within +/- 1 percent at steady state conditions.

2. Generator output voltage maintained within +/- 1 percent of rated value for any load variation between no load and full load.

3. Generator output voltage drift less than +/- 1 percent of rated value at constant temperature.

4. Generator output voltage drift less than +/- 0.5 percent of rated value within a 40 degree change in temperature over an ambient temperature range of -40 degrees C to 70 degrees C.

5. Response time of less than 20 milliseconds.

6. Voltage buildup with generator output as low as 6 volts.

7. At full throttle engine starting, the regulator output voltage overshoot shall be less than 5 percent of its rated value with respect to the volts per hertz curve (meets ISO 8325-3 Class G2 Specifications).

8. Power dissipation of 55 watts at 15 amperes under normal operating conditions; less than 55 mA while at rest.

9. Telephone Influence Factor (TIF) of less than 50.

10. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) suppressed to MIL Standard 461C, Part 9, and VDE 875, level N.

11. Maintain stable voltage control with less than 5 percent total harmonic distortion.

B. The regulator shall include the following features:

1. A voltage level rheostat to provide generator output voltage adjustment from -10 percent to +10 percent of nominal voltage, in addition to a programmable output voltage level from -25 percent to +25 percent.

2. Automatic gain adjustment to provide output voltage compensation for changes in load or frequency.

3. Manual gain adjustment from 0 to 10 percent to provide compensation for line losses between generator output terminals and the load.

C. The regulator shall allow system parameter setup and monitoring and provide fault alarm and shutdown information through a diagnostic interface allowing connection to an external personal computer (not provided). The regulator shall be factory set and field programmable for the following:

1. Voltage output.

2. Minimum voltage.

3. Voltage droop/crosscurrent adjustment.

4. Voltage gain (IR compensation).

5. Internal voltage gain.

6. Current output.

7. Field current variation.

8. Single or three phase sensing.

9. Dual voltage/frequency slopes.

10. Slope intersect (knee) frequency.

11. Under frequency set point.

12. Overvoltage trip.

13. Overvoltage trip time.

D. The regulator shall include the following alarm and shutdown features:

1. Overvoltage/undervoltage.

2. Overfrequency/underfrequency.

3. Overcurrent.

4. Over Speed.

5. Over Temperature.

6. Overexcitation.

7. Loss of excitation.

8. Rotating diode failure.

9. Instantaneous overcurrent trip.

10. Loss of sensing.

11. Loss of frequency.

12. EEPROM failure.

E. The regulator shall be protected against long term overcurrent conditions. Generator output shall shut off when shorted, or when the excitation current exceeds normal values for more than 15 seconds. The regulator shall not be damaged or operate improperly when subjected to an open or shorted input due to sensing loss, or when the sensing source has shorted to ground or an adjacent conductor.

F. The regulator shall be suitable for operation in a temperature range from -40 degrees C to 70 degrees C.

G. The regulator shall be salt spray resistant as described by MIL Standard 810-C, Method 509.1 and ASTM B117.

H. The regulator shall be manufactured by the manufacturer of the engine-generator set.

2.15 HIGH TEMPERATURE INSULATION BLANKETS

A. General: Exhaust silencer and exhaust piping shall be insulated with high temperature insulation blankets, as required by the manufacturer.

2.16 ENGINE MOUNTED CONTROL PANEL

A. General: Provide an engine mounted UL 508 listed control panel for local monitoring, control, and indication of engine parameters. Control panels shall be a NEMA Type 3R enclosure or weatherproof, vibration isolated, and approved for NFPA 110 Level 1 system installations.

B. Panels shall include an LCD display to monitor the following parameters:

1. Speed.
2. Engine Intake Manifold Temperature.
3. Exhaust Temperature.
4. Engine Oil Pressure.
5. Fuel Pressure.
6. Coolant Temperature.
7. DC battery voltage.
8. Fuel consumption rate.
9. Total fuel consumption.
10. Operating hours.
11. Generator AC Voltage, each phase, line to line, 1 percent accuracy.
12. Generator AC current, each phase, 1 percent accuracy.
13. Generator power, kW total and per phase.
14. Generator power, kVA total and per phase.
15. Generator power, kVAR, total and per phase.
16. Generator power, kWh total.
17. Generator power, kVARh total.
18. Generator power factor, average and per phase.
19. Generator percent of rated power, total.

20. Generator frequency.

21. Real time clock.

22. Stamps event code, hour of first and last, total occurrences.

23. Sensor diagnostics, open, shorted.

24. Fault History.

C. Provide panels with a local annunciator that includes all the safety indicator functions that meets the requirements of NFPA 110, Table 5.6.5.2 – Safety Indications and Shutdowns for Level 1 systems, and include the following additional status/fault indicators and optional shutdowns:

1. Diagnostic LED status indicators, one red, one amber.

2. Engine status indicators, run, auto, stop.

3. Engine protection alarms with configurable High/Low limits.

4. High coolant temperature alarm indication.

5. Any distribution circuit breaker (serving loads within the packaged engine-generator assembly) trip alarm indication.

6. Low coolant level shutdown.

7. The battery charger AC failure alarm shall be provided with an adjustable time delay (on delay) with a range of 1 to 999 seconds.

D. Panels shall accept an external dry contact closure for low fuel main tank safety indication from the aboveground diesel fuel storage tank level monitoring panel. This circuit shall be powered from the generator control system 24VDC batteries and shall be provided with an adjustable time delay (on delay) with a range of 1 to 999 seconds.

E. The panel shall include the following controls:

1. Emergency stop pushbutton .

2. Three position control switch: Run, Auto, Off.

3. Lamp test pushbutton.

4. Alarm acknowledge pushbutton.

5. Keypad for access to LCD display values.

F. The panel shall be provided with an optional programmable relay output module with relay outputs for customer external alarm and status signal interconnections. Relay outputs shall be programmed to provide the following:

1. Generator in auto.

2. Generator running.

3. Battery system common alarm.

4. Generator common alarm.

5. Fuel Tank Level Low.

6. Fuel Tank Leak.

7. Two spare output contacts minimum.

8. One output powered from the generator control system 24 VDC batteries to energize the fuel oil solenoid open when the generator is running.

9. Two outputs powered from the generator control system 24 VDC batteries to energize fuel system anti-siphon solenoid valves to open when the generator is not running.

10. Two outputs powered from the generator control system 24 VDC batteries to shunt trip the low voltage distribution circuit breakers.

G. The control panel shall be provided with a Modbus RS-232 or RS-485 serial communication interface port available for customer connection for remote monitor, upload/download historical fault info, and service/maintenance activities.

H. The panel shall be manufactured by the diesel engine generator set manufacturer.

2.17 LOW VOLTAGE DISTRIBUTION CIRCUIT BREAKERS

A. Provide generator mounted with low voltage distribution circuit breakers. Circuit breakers shall be UL listed, three pole, 600V rated with shunt trip and auxiliary contacts, and shall be capable of being padlocked in the OPEN position, or shall be in a pad-lockable enclosure.

B. The distribution circuit breakers shall be accessible through pad-lockable sound enclosure doors.

2.18 INSTRUCTION AND NAMEPLATES

A. The engine and generator shall have corrosion resistant nameplates at a visible location on the generator.

B. The system shall have affixed a permanent engraved nameplate stating that the equipment is suitable for use as Level 1, Class 24, Type 10 life safety emergency power in accordance with NFPA 110 requirements.

C. Placards shall be a summary of start-up, running, and shutdown operations for the engine and generator. Each operational step shall be covered by direct or succinct statements.

2.19 DESCRIPTION OF OPERATION

A. Manual operation: The diesel engine electrical generator shall manually start and stop in response to controls located at the local control panel. Manual operation shall occur in the following steps:

1. To start the engine generator set:

a. Place the Engine Control Switch in the "RUN" position.

2. To stop the engine generator set:

a. Place the Engine Control Switch in the "STOP" position.

B. Automatic operation: Generator shall start upon loss of primary power detected by automatic transfer switch.

C. Provide an adjustable time delay from 0 to 30 minutes which shall delay the "STOP" signal to the engine generator set so that it may run unloaded after a "STOP" signal is received. The timer circuits shall be active during both manual and automatic operations.

D. Shutdowns: The diesel engine electrical generator set shall stop immediately, and shall be prevented from starting, after one or more of the shutdown alarms listed in NFPA 110, Table 5.6.5.2 – Safety Indications and Shutdowns for Level 1 systems or any the following alarms have occurred, regardless of the mode of operation (MANUAL or AUTO):

1. High coolant temperature.

2. Low coolant level.

3. Overcurrent.

4. Any distribution circuit breaker trip.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide field services including startup, commissioning, testing support, and user training of the diesel engine generator set equipment shall be by a qualified factory-trained manufacturer's employees.

3.2 UNWITNESS FACTORY TESTING

A. Tests are to determine proper operation and capacity of the equipment and to demonstrate compliance with the specifications. All equipment that fails any test will be rejected, and complete retesting will be required after the manufacturer corrections or modifications to equipment which has previously failed any test.

B. The equipment shall be tested to assure compliance with the specifications, NEMA MG 1, and the manufacturer's quality control provisions. Provide copies of all factory test reports.

C. The following measurements and tests shall be made on the generator and the exciter. Submit results to District for approval.

1. Resistance of armature and field windings.

2. Exciter field current at no load with normal voltage and frequency on the generator.

3. High potential tests of the generator field windings, exciter armature windings, and exciter field windings.

D. Load Tests:

1. The engine-generator set shall be tested under load.

2. Demonstrate motor starting capability of the engine-generator. Voltage dips shall be measured and recorded to demonstrate conformity to the specifications. Stepped testing using the skid-mounted load bank is acceptable for purposes of this test.

3. The engine-generator shall be operated for 1/2 hour at one-half the kW rating at 0.8 power factor.

4. The engine-generator shall also operate for one hour continuously at 100 percent of its kW rating at 0.8 power factor. The engine water temperatures shall not exceed manufacturer’s recommended operating temperature during this test.

5. The temperature rise of the windings of the generators shall be measured using the embedded temperature detectors.

6. Submit test results to District for approval prior to shipment of equipment to job site.

7. During the load tests, the following parameters shall be recorded at 15 minutes intervals:

    a. Time.

    b. Water temperature.

    c. Oil pressure.

    d. Fuel pressure.

    e. Exhaust temperature.

    f. Speed.

    g. Voltage output (phase-to-phase).

    h. Amperage (each phase).

    i. Power factor.

    j. Kilowatts.

    k. Generator winding temperature.

    l. Frequency.

E. Distribution Circuit Breaker Tests:

1. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with drawings and specifications.

    b. Inspect physical and mechanical condition.

    c. Inspect anchorage and alignment.

    d. Verify the unit is clean.

    e. Operate the circuit breaker to insure smooth operation.

    f. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

    g. Inspect operating mechanism, and contacts.

h. Alarm, Control, and Monitoring Equipment Tests:

2. Each alarm and safety shutdown provision shall be demonstrated by being caused by the abnormal condition unless an alternative test condition has been approved by the District prior to the scheduling of the tests.

3. Each protective device, control circuit and monitoring device shall be operated to demonstrate its proper operation.

F. Batteries and Battery Charger:

1. Inspect and test the batteries and battery charger for conformance with these specifications prior to shipment.

2. Each protective device, control circuit and monitoring device shall be operated to demonstrate its proper operation.

3.3 STARTUP, COMMISSIONING, TESTING

A. General:

1. Factory-trained manufacturer's employees shall be present for field services at the job site for the full duration to supervise and assist for the diesel engine generator set electrical system startup, commissioning, and testing. Date shall be coordinated after approval of the submittal.

2. The test results shall demonstrate proper performance of all systems during the tests. Field testing shall not be considered complete until acceptable results have been approved by the Engineer.

3. Repairs and adjustments shall be made to achieve satisfactory performance of the diesel engine generator set system. If repairs or adjustments are made during the tests, additional testing shall be performed at no additional cost to the District.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER CONSTRUCTION

This is to certify that the equipment supplied by (MANUFACTURER'S NAME) and described as (NAME OF EQUIPMENT) has been constructed in accordance with manufacturer's recommendations. The equipment was inspected by an authorized manufacturer's representative on (DATE) and has been serviced with the proper initial lubricants and is free from any undue stress. Applicable safety equipment has been properly constructed and proper electrical and mechanical connections have been made. Proper adjustments have been made and the equipment is ready for operation. All reports have been submitted to the DISTRICT and the equipment and or system is certified for field testing and startup.

Authorized Manufacturer's Representative		SUPPLIER's Representative	
Title	Date	Title	Date

MANUFACTURER'S CERTIFICATE OF FUNCTIONAL TESTING ASSISTANCE

Functional testing, including checks for proper rotation, alignment, speed, excessive vibration, and noisy operation has been performed, and the equipment has been operated under full-load conditions and is ready for full-time operation. Controls, protective devices, instrumentation, and control panels are properly installed and calibrated. The control logic for startup, shutdown, sequencing, interlocks, etc. has been tested and is properly operating. This testing, including initial equipment and system adjustment and calibrations, was performed in the presence of the manufacturer's representative on (DATE).

Authorized Manufacturer's Representative		SUPPLIER's Representative	
Title	Date	Title	Date