

**SPECIFICATIONS - DETAILED PROVISIONS**  
**Section 11250 – Outdoor Standby Power Diesel Engine Generator Set**  
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**SECTION 11250**  
**OUTDOOR STANDBY POWER DIESEL ENGINE GENERATOR SET**

**PART 1 - GENERAL**

**1.01 GENERAL**

- A. The Contractor shall fabricate, install, test, and leave ready for operation one (1) stationary standby power diesel engine generator set complete with sound attenuated weatherproof enclosure, sub-base fuel storage tank, and all appurtenances, as specified herein and shown on the Drawings. Where specific project requirements stipulate, generator set shall be provided with a load bank, if required, a diesel particulate filter (DPF) system. Load bank and DPF systems shall be in accordance with the requirements specified herein and shown on the Drawings.
- B. The generator set shall be a complete and operable emergency standby power system capable of providing electrical power during periods of failure of the normal utility power supply. The generator set shall be rated 277/480 volt (reconnectable), 3-phase, 4 wire, 60 Hz.
- C. The generator set shall be minimum capacity shown on the Drawings and be suitably sized to provide electric power necessary to start and operate all motor loads and low voltage transformer loads as specified herein. A unit larger than shown on the Drawings shall be furnished, if necessary, to operate specified loads.
- D. Generator set shall automatically start via signal from automatic transfer switch at the facility.

**1.02 RELATED SECTIONS**

- A. The Contract Documents are a single integrated document, and as such all Specification Sections apply. It is the responsibility of the Contractor and its subcontractors to review all Sections and ensure a complete and coordinated project.
- B. Related Specification Sections include, but are not limited to, the following:
  - 1. Division 1 – General Requirements
  - 2. Division 11 – Equipment
  - 3. Division 15 – Mechanical

4. Division 16 – Electrical
5. Division 17 – Instrumentation and Controls

### 1.03 STANDARDS AND CODES

A. Equipment and materials, including installation of same, shall meet or exceed the applicable requirements of the following standards and codes (latest edition):

1. California Building Standards Commission, California Code of Regulations  
Title 24, Part 9 California Fire Code
2. International Electrotechnical Commission (IEC)  
IEC 60034-1 Rotating Electrical Machines - Part 1: Rating and Performance
3. International Standardization Organization (ISO)  
ISO 3046 Reciprocating Internal Combustion Engines  
ISO 8528 Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets
4. National Electrical Manufacturers Association (NEMA)  
NEMA MG1 Motors and Generators  
NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches  
NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
5. National Fire Protection Association (NFPA)  
NFPA 30 Flammable and Combustible Liquids Code  
NFPA 37 Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines  
NFPA 70 National Electrical Code

NFPA 110 Standard for Emergency and Standby Power Systems

6. Underwriters Laboratories (UL)

UL 142 Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids

UL 489 Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

UL 508A Standard for Industrial Control Equipment

UL 2200 Standard for Stationary Engine Generator Assemblies

- B. All materials and equipment, and the design, construction, and installation thereof, shall comply with all applicable provisions of the Federal Occupational Safety and Health Administration (OSHA), and California Occupational Safety and Health Administration (Cal OSHA).
- C. Where the Drawings or these Specifications call for material, equipment and workmanship to be of better quality or higher standard than required by the above standards and codes, and applicable rules and regulations, then said Drawings and Specifications shall prevail. Nothing on the Drawings or in these Specifications shall be construed to permit work in violation of the above standards and codes.
- D. In the event of a conflict or disagreement between the Drawings and Specifications; and standards; codes; federal, state, and local laws and ordinances; or industry standards; the most stringent requirements shall govern. The Contractor shall promptly notify the District in writing of such differences.

**1.04 CONTRACTOR SUBMITTALS**

A. Shop Drawings/Submittals

Contractor shall prepare and submit shop drawings/submittals for all generator set equipment and materials to be furnished by the supplier for review and acceptance by District prior to fabrication and delivery. Shop drawings/submittals shall be provided in accordance with the District's General Conditions, Section F – Labor and Construction.

Shop drawings/submittals shall show the ratings, performance data, dimensions, weights, materials of construction and other relevant details of the generator set equipment and material to be furnished. Manufacturer product literature and specifications shall be marked to clearly identify all applicable information and crossing out inapplicable information. Applicable sizes, model numbers, and options shall be clearly marked. Sufficient data and details shall be provided to demonstrate compliance with these Specifications and the Construction Drawings.

As a minimum, shop drawings/submittals shall include the following information:

1. Detailed Bill of Materials for all generator set equipment, materials, and components, listing: quantity, manufacturer's name, description, and catalog/part number.
2. Manufacturer catalog cut sheets, specification sheets, technical data, illustrations, diagrams, etc. for all generator set equipment and components indicating sizes, ratings, performance capabilities, operating parameters and recommended ranges, materials of construction, standard features, options, accessories, etc.
3. Manufacturer's statement of exhaust emissions and emission performance data for the proposed generator set. Exhaust emission test parameters and measurements shall be in accordance with EPA protocol.
4. Detailed shop drawings of generator set and enclosure layout (plan and elevation views), including alternator, engine, exhaust silencer and outlet, diesel particulate filter system (where specified), load bank system, fuel tank, fuel and air filters, generator set engine control panel (ECP), battery charger, batteries, electrical connections, piping connections, access openings, air louvers, and associated equipment.
5. Design calculations and recommendations, including, but not limited to: generator set size selection, sub-base fuel storage tank sizing, sub-base fuel storage tank normal and emergency vent sizing, normal vent piping back pressure, emergency vent piping back pressure (where specified), exhaust system sizing, and exhaust system back pressure. The unit shall be capable of operating the loads shown on the Drawings and in the sequence specified in Part 1.05 herein, with a maximum allowable instantaneous voltage dip of 20 percent.
6. Dimensional drawings for generator set, including sound attenuated enclosure and sub-base fuel tank showing locations and requirements for all external connections and mountings/supports. Dimensional drawings

for sub-base fuel tank showing locations and sizes of all tank fittings, lift eyes, and mounting holes.

7. Weights and center of gravity of all equipment (dry and operating).
8. Complete information and data for vibration isolators provided between alternator/engine base frame and sub-base fuel tank.
9. Equipment seismic restraint and anchorage calculations prepared by a registered professional civil or structural engineer in the State of California. Calculations shall be prepared in accordance with the California Building Code (latest edition) for Occupancy/Risk Category IV Facilities with Seismic Importance Factor = 1.5. Safety factor for overturning shall be 1.5:1. Calculations shall be based on project specific seismic design parameters, which are provided in the Specification Special Conditions or Special Requirements.
10. Complete information, drawings, schematics, diagrams, and technical data for the generator set ECP, including all instrumentation and components. ECP schematic diagram (block diagram) shall show all panel components and interconnections. ECP wiring diagram shall show wiring for internal components and terminal strip(s) for landing all external connections (power, instrument cables, signals, control, etc.).
11. Certification of two-year free subscription for computer software to interface with the ECP and engine electronic control module, including software updates.
12. Complete information, drawings, schematics, diagrams, and technical data for DPF emissions monitoring controller (where specified), including all instrumentation and components. Controller schematic diagram (block diagram) shall show all DPF system components and interconnections. Controller wiring diagram shall show wiring for internal components and terminal strip(s) for landing all external connections (power, instrument cables, signals, control, etc.).
13. Complete information, drawings, schematics, diagrams, and technical data for load bank system, including all instrumentation and components. Load bank control panel schematic diagram (block diagram) shall show all load bank system operation, safety circuits, associated components and interconnections. Load bank control panel wiring diagram shall show wiring for internal components and terminal strip(s) for landing all external connections (power, instrument cables, signals, control, etc.). Overcurrent protection and control devices shall be identified and their ratings marked.

Load bus configuration and load connection termination area shall be clearly identified. In addition, an interconnection drawing shall be provided for all instrumentation and control wiring related to the load bank.

14. Detailed instructions for unloading, handling, storage, and installation, including mounting and connection procedures for all mechanical and electrical equipment.

B. Operation and Maintenance Manual

Contractor shall prepare and submit a complete and organized operation and maintenance (O&M) manual in accordance with the General Conditions, Section F - Labor and Construction, and Detailed Provisions, Specification Section 01430.1. As a minimum, the O&M manual shall include the following information:

1. Equipment Information, Performance Data, and Drawings
  - a. Detailed Bill of Materials for all generator set equipment, materials, and components, listing: quantity, manufacturer's name, description, and catalog/part number.
  - b. Manufacturer catalog cut sheets, specification sheets, technical data, illustrations, diagrams, etc. for all generator set equipment and components indicating sizes, ratings, performance capabilities, operating parameters and recommended ranges, materials of construction, standard features, options, accessories, etc.
  - c. As-built shop drawings for all equipment and components, including fabrication and assembly drawings, panel drawings, wiring diagrams, and schematics. Electrical wiring diagrams and schematics shall also be provided for all interconnecting power and signal wiring between equipment, instrumentation, and control devices.
2. Equipment Unloading, Storage, and Installation Requirements
  - a. Unloading, handling, and long-term storage requirements.
  - b. Complete, detailed installation instructions for each equipment and component item.



3. Equipment System Operation
  - a. Complete, detailed equipment pre-startup and pre-energization instructions and checklists.
  - b. Complete, detailed operating instructions for each equipment and component item, including system startup and shutdown procedures and sequence.
  - c. Safety provisions and precautions, including explanations for all safety considerations relating to operations and maintenance, and protective equipment and clothing requirements for same.
4. Equipment Service and Maintenance Data
  - a. Maintenance data shall include all information and instructions required by District's personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions properly throughout its full design life.
  - b. Recommended schedule of maintenance tasks.
  - c. Lubrication charts and tables of alternate lubricants.
  - d. Details of calibration and adjustment.
  - e. Alarms and troubleshooting instructions.
  - f. Name, address and phone number of manufacturer and manufacturer's local service representative.
5. User Manuals
  - a. User manuals and application guides for all microprocessor based equipment and accessories, including but not limited to: genset ECP and operator interface, load bank control panel controller, and DPF system control panel controller (if applicable).
6. Equipment Warranties

C. Shop Service and Parts Manuals

Contractor shall provide complete and organized shop service and parts manuals for the standby generator set. Contractor shall submit one (1) electronic (searchable PDF format) copy of the shop service and parts manuals. The shop service manuals shall address testing, adjusting, troubleshooting, disassembling and assembling of all engine components. System schematics and detailed technical descriptions of systems theory shall also be included in the service manuals. In addition, complete parts manuals shall be provided, including drawings (blowup drawings preferred) with lists of part numbers (serial numbers), descriptions, quantities, and ratings/sizes.

**1.05 CONDITIONS OF SERVICE**

- A. The generator set shall be capable of operation under any combination of the following conditions without mechanical or electric damage.

|                      |   |
|----------------------|---|
| Ambient Temperature: | 0°F to 120°F  |
| Relative Humidity:   | 10% to 90%  |
| Altitude:            | 1,500 ft (minimum - Contractor shall confirm for actual project site) |
| Air Supply:          | From Outside  |

- B. The generator set shall be capable of starting and operating each of the loads shown on the Drawings and in the following sequence. Generator set manufacturer shall submit generator sizing calculations and confirm generator size based on equipment furnished and existing equipment (if applicable). Generator set manufacturer shall use actual equipment motor performance for generator sizing (SKVA and FLA). The generator set shall be designed to start each of the connected loads in separate steps.

Unless specified otherwise on the drawings, all equipment is 460 volt, 3 phase, 60 Hz with across the line full voltage start.

- C. Step 1 shall consist of starting the first connected load, which is the low-voltage transformer and lighting panel. When the first connected load has started and is running, Step 2 shall commence. Step 2 shall consist of starting the second connected load. When the second connected load has started and the first and second connected loads are running, Step 3 shall commence, and so on until all connected loads are running.

**1.06 QUALITY ASSURANCE**

- A. All materials, equipment, and parts of the standby generator shall be new and unused, of current manufacture, of highest grade, and assembled in a workmanlike manner. The generator set shall be factory assembled, tested by the engine manufacturer, and shipped to the job site by his authorized distributor having a parts and service facility in the local area. The generator set shall be as manufactured by Olympian (supported by Caterpillar), Caterpillar, Cummins, or Generac (no substitutes).
- B. Standby generator set shall be provided with an extended warrantee against defective parts or workmanship under the terms of the manufacturer's/supplier's standard warranty for a total of two (2) years from date of project acceptance, and shall cover full parts and labor.

**1.07 PERMITS AND REQUIREMENTS FOR SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)**

- A. Permits to construct and to operate are required from the SCAQMD for the emergency standby generator set. The emergency standby power system shall conform to all requirements of SCAQMD for standby generators. Manufacturer shall equip the generator set with the necessary devices to meet the current SCAQMD regulations for the operation of a diesel emergency standby generator. Generator set shall be "pre-certified"/"pre-approved" by SCAQMD for emergency standby power service. Generator set shall meet the applicable tier standards required by SCAQMD Best Available Control Technology (BACT) requirements and SCAQMD Rule 1470.
- B. Contractor shall coordinate with the manufacturer to obtain engine data for the proposed generator set, and shall be responsible for providing all engine data required as part of the SCAQMD permit process. Contractor shall provide District with application form for SCAQMD Permit to Construct and Operate, including provision for a minimum of 12 hours per month of maintenance operation. Application form shall be complete except for District information and signature. District shall execute application and submit same to SCAQMD for approval, along with all required permit fees.

**1.08 SAFETY**

- A. All equipment furnished under these Specifications shall comply with the safety orders of local, state, and federal governing bodies. All rotating components such as drive shafts, couplings, flywheel, and vee-belts that will be exposed to District's

Operations personnel shall be enclosed in solid, sheet metal safety enclosures in compliance with said safety orders.

- B. Heat protective devices shall be installed where necessary to protect personnel from accidental contact with any parts of the engine exhaust system during the performance of normal generator set operation or maintenance functions. Heat protective devices shall comply with OSHA standards, and may include metal screen protectors or insulation. Insulation shall be designed and fabricated for easy removal and provided with environmental coverings suitable for the location and exposure.

## **PART 2 - PRODUCTS**

### **2.01 ENGINE**

- A. Engine shall be diesel, four-cycle, 1,800 rpm (maximum), liquid-cooled, and turbocharged and after-cooled (air-to-air). The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the generator and all connected accessories when operating on No. 2 domestic burner oil. Diesel engines requiring premium fuels will not be considered. Two-cycle engines are not acceptable. The engine shall be manufactured by Caterpillar, Cummins, John Deere, Mitsubishi, Perkins, Fiat Power Technologies (FPT), or Generac; no substitutes.
- B. The engine-generator set shall be mounted on a heavy duty torsionally stiff structural steel frame (skid) to maintain proper alignment between components. Frame shall be fabricated from channel or I-beam to ensure adequate mounting surface contact and minimal deflection.
- C. The generator set shall be equipped with a skid-mounted, engine-driven radiator with blower fan, coolant pump, and all accessories. The cooling system shall be sized to operate at full rated load and 120°F ambient air entering the generator unit enclosure. The cooling system shall be filled with ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact per Cal/OSHA requirements. The generator set supplier shall be responsible for providing a properly sized cooling system based on the generator unit enclosure static pressure restriction.
- D. A DC electric starting system with positive engagement shall be furnished. The starting motor voltage shall be as recommended by the engine manufacturer. The electric starter shall be capable of a minimum of three complete cranking cycles without overheating.

- E. As a minimum, the engine shall be provided with the following components and features:
1. Positive displacement, mechanical, full pressure, lubrication oil pump.
  2. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
  3. An engine driven, mechanical, positive displacement fuel pump.
  4. Replaceable dry element air cleaner with restriction indicator.
  5. Engine mounted battery charging alternator and solid-state voltage and current regulator.
- F. Provide electronic governor consisting of a magnetic pickup speed sensor, adjustable electronic control, and an actuator mounted with the fuel pump. Governor shall provide automatic isochronous generator set frequency control. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25 percent.
- G. Performance, materials, and workmanship shall be in accordance with Diesel Engineer Manufacturer's Association standard practices.

## **2.02 ENGINE FUEL SYSTEM**

- A. The sub-base fuel storage tank shall have sufficient capacity to allow continuous operation of the generator set for a minimum of 24 hours at 100% of full-rated load.
- B. The diesel fuel system shall consist of an engine-driven fuel supply pump, fuel line check valve, fuel filters, and secondary containment (double walled) sub-base fuel storage tank. The main fuel pump on the engine shall be capable of supplying fuel directly from the sub-base storage tank without the need for an intermediate pump.
- C. The fuel filters shall be skid mounted and shall be the combination fuel filter/water separator type. Elements shall be easily replaced without breaking any fuel line connections, disturbing the fuel pumps or any other part of the engine. All fuel filters shall be conveniently located ahead of the injection or circulating pump so that the fuel shall be thoroughly filtered before it reaches the injectors. No screens or filters requiring cleaning or replacement shall be used in the injection or circulating pump, or in the injection valve assemblies.

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- D. The secondary containment fuel storage tank shall be constructed of 12 gauge (minimum) carbon steel, have inner and outer walls with an interstitial space (annulus) between the walls, and be provided with a means for monitoring the interstitial space for a leak. The fuel storage tank shall be an atmospheric tank, designed and constructed in accordance with NFPA 30 and UL 142. The fuel storage tank shall be suitable to operate at pressures from atmospheric to 0.5 psi (minimum) gauge pressure, 2.5 psi gauge pressure under emergency venting conditions, and 3 psi to 5 psi gauge pressure under test conditions. The fuel storage tank shall be UL listed, and shall meet all state and federal requirements for aboveground diesel fuel storage tanks, including design, fabrication, and installation. The fabricated fuel storage tank shall be factory tested to between 3 psi and 5 psi in accordance with UL testing requirements.
- E. The fuel storage tank shall be furnished as a complete, factory fabricated, assembled, and tested assembly and listed as an assembly by UL under UL 142. The primary and secondary containment tanks shall be of rectangular configuration. The secondary containment tank volume shall be 110% of the primary tank. The interior of the primary tank shall be cleaned and free of any mill scale, loose material, or debris. The fuel storage tank assembly shall be suitable for mounting to a concrete foundation over a non-shrink grout pad (1/2" +/- thick) and continuous beneath storage tank bearing surfaces.
- F. The primary and secondary portions of the fuel storage tank shall not encroach upon the electrical stub-up area for conduit, including conduit for all power, control, and signal conductors and cables. As a minimum, the sub-base fuel storage tank shall be provided with the following connections, components, and options:
1. One (1) top mounted FNPT fuel supply connection in primary space (size per generator set manufacturer).
  2. One (1) top mounted FNPT fuel return connection in primary space (size per generator set manufacturer).
  3. One (1) top mounted 2" FNPT fuel fill connection in primary space.
  4. One (1) top mounted 2" FNPT normal vent connection in primary space.
  5. One (1) top mounted 2" FNPT mechanical fuel level gauge connection in primary space.
  6. One (1) top mounted 2" FNPT analog fuel level monitoring connection in primary space.

7. One (1) top mounted 2" FNPT low fuel level warning connection in primary space.
8. One (1) top mounted 2" FNPT spare connection in primary space.
9. One (1) top mounted FNPT emergency vent connection in primary space (size per generator set manufacturer).
10. One (1) top mounted FNPT emergency vent connection in secondary space (size per generator set manufacturer).
11. One (1) bottom mounted FNPT leak detection connection in secondary space (size per generator set manufacturer).
12. Internal baffles and outside wall stiffeners.
13. Four (4) side mounted lift eyes with sufficient capacity to lift complete generator set.
14. Top mounting holes for generator side base frame and vibration isolators, if applicable.
15. Bottom mounting holes for anchorage to concrete foundation.
16. Identification signage and labels in accordance with NFPA 704.
17. Identification nameplates for each tank connection.

The tank fill connection and normal vent connection shall be located outside the generator set enclosure to facilitate tank filling and vent pipe routing. All other connections shall be accessible from inside the generator set enclosure and positioned to permit easy access to the appurtenances mounted to the various tank connections.

- G. As a minimum, the sub-base fuel storage tank shall be provided with the following appurtenances:
1. Fill connection drop tube terminating within 6" of bottom of tank.
  2. Threaded fill cap, powder coated cast iron, vapor tight, padlockable, Model 178 as manufactured by Morrison Bros. Co., or equal.
  3. Mechanical fuel gauge with graduated increments, visible from top of tank.

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4. Low fuel level warning sensor and controller, fuel compatible wetted parts, adjustable, NEC Class I, Division 1 rated. Low fuel level warning sensor/controller shall be wired to the generator set ECP for local and remote warning indication.
5. Leak detection sensor and controller, fuel compatible wetted parts, NEC Class I, Division 1 rated. Leak detection sensor/controller shall be wired to the generator set ECP for local and remote alarm indication.
6. Emergency vent for primary space, opening pressure = 0.5 psig, full open pressure = 2.5 psig, Model 244 as manufactured by Morrison Bros. Co., or equal.
7. Emergency vent for secondary space, opening pressure = 0.5 psig, full open pressure = 2.5 psig, Model 244 as manufactured by Morrison Bros. Co., or equal.
8. Normal vent cap, double outlet, aluminum body, 20 mesh stainless steel screens, and female NPT connection, Model 155 as manufactured by Morrison Bros. Co., or equal.
9. Five (5) gallon steel spill containment box with lockable hinger cover.

Threaded reducing bushings shall be provided as required to complete the connection of instruments to the tank openings. 2" Schedule 40 steel pipe and fittings shall be provided for the tank normal vent extension and vent cap. Vent cap shall be 12'-0" (minimum) above the bottom of the sub-base fuel tank. Vent extension shall be provided with a lateral pipe support connected to the top of the generator set enclosure. Schedule 40 steel pipe and fittings shall be provided for the primary and secondary emergency vents. All unused tank openings shall be provided with threaded plugs.

The fuel storage tank shall be provided with diesel fuel level monitoring system capable of continuously transmitting fuel level over a 2 wire system. The fuel level monitoring system shall be provided in accordance with Part 2.12 herein.

### **2.03 ENGINE COOLING SYSTEM**

- A. The cooling system shall consist of a unit-mounted radiator with blower type fan, integral jacket water circulating pump, and thermostatic control.
- B. An engine driven fan behind the radiator will draw outside air through the enclosure intake air louvers, then through the radiator, and subsequent discharge out of the enclosure. Intake air louvers shall be provided in the size and quantity



necessary to provide sufficient air flow for combustion and cooling of the engine and generator set.

- C. A barrier between radiator and enclosure walls/roof shall be installed to prevent radiator air recirculation. Barrier shall be constructed of 14 gauge (minimum) galvanized sheet metal.
- D. Engine radiator overflow tube and crank case fume disposal tube shall be vented to the exterior of the enclosure in front of the radiator.
- E. Radiator drain shall be valved and routed through a short piping extension to the outside of the enclosure to facilitate proper draining.
- F. The radiator shall be of sufficient capacity to operate the engine at full rated generator load at 120°F ambient temperature.
- G. The engine cooling system shall be charged with a 30%-50% ethylene-glycol based antifreeze to provide corrosion and antifreeze protection.
- H. Sensors shall be provided to detect low coolant level.

#### **2.04 ENGINE EXHAUST SILENCING SYSTEM**

- A. Engine shall be provided with a properly sized critical grade (or better) exhaust silencer. The exhaust silencer shall be selected to meet the sound levels specified for the entire generator set assembly, including outdoor sound attenuated enclosure. As a minimum, the exhaust silencer shall be capable of a dynamic insertion loss of at least 30 dBA. The exhaust silencer shall be a separate unit, except where a combination exhaust silencer and DPF is specified. In general, the exhaust silencer shall be located in the generator set enclosure. Where a combination exhaust silencer and DPF is specified, the unit may be located outside the generator set enclosure; however, additional sound attenuation shall be provided, if necessary to achieve the sound levels specified for the entire generator set assembly (reference Subsection 2.08 herein). Exhaust silencers shall be as manufactured by Donaldson, Maxim, or equal.
- B. Exhaust silencer shall be constructed of carbon steel and shall be equipped with flanged or plain end inlet and outlet, support brackets, and a drain plug to remove any condensation.
- C. Exhaust silencer shall be provided with a stainless steel bellow expansion joint (flexible connector) installed between the engine and silencer. The exhaust silencer location and orientation shall be as required to accommodate additional exhaust system components (such as a DPF, if applicable) and achieve the

specified generator set enclosure sound attenuation. The exhaust pipe outlet from the exhaust silencer shall be oriented vertically and shall be provided with a removable rain cap (sized the same diameter as the outlet).

- D. Exhaust silencer, exhaust piping, and DPF (where specified) shall be sized to ensure that the exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer.
- E. Exhaust silencer, exhaust piping, and DPF (where specified) shall be mounted so that their weight is not supported by the engine nor will exhaust system loads due to thermal expansion be imposed on the engine.
- F. Exhaust silencer and associated carbon steel piping/components shall be provided with a high temperature rated protective coating, suitable for continuous service at the maximum engine exhaust temperature.
- G. Exhaust silencer, exhaust piping, and DPF (where specified) shall be factory installed, including all supports and appurtenances.

## **2.05 ALTERNATOR**

- A. The alternator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling. Alternator shall be 3-phase, synchronous-type with a power factor of 0.8, frequency of 60 hertz, and voltage of 277/480. Alternator shall be 12 lead, extended range, readily able to be reconnected, and initially configured for 277/480 (unless noted otherwise). The insulation material shall meet NEMA standards for Class H insulation and be impregnated in a polyester varnish or vacuum impregnated with epoxy varnish to be fungus resistant. Temperature rise of the rotor and stator shall not exceed NEMA Class F (130°C rise by resistance over 40°C ambient at unit full load rating). The excitation system shall be of brushless construction.
- B. The alternator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300 percent of rated current for 10 seconds during a fault condition.

- D. The instantaneous voltage dip shall be within acceptable limits for each load step specified in Part 1.05, herein, and in no case shall the maximum instantaneous voltage dip exceed 20%.

## **2.06 VOLTAGE REGULATOR**

An automatic voltage regulator (AVR) shall be provided to maintain alternator output voltage within +/- 1.0 percent for any constant load between no load and full load. The regulator shall be completely solid state design, and shall include electronic voltage buildup protection, volts per hertz regulation, over-excitation protection, loss of sensing protection, temperature compensation, limit voltage overshoot on startup, and be environmentally sealed for protection against vibration and atmospheric deterioration.

## **2.07 ENGINE-GENERATOR SET CONTROLS**

- A. Generator set shall be equipped with an ECP that provides complete control and monitoring of the engine and alternator functions and performance. The ECP shall incorporate a microprocessor based controller with operator interface that provides local and remote system control, monitoring and protection. The ECP shall be capable of PC based updating of all necessary parameters, firmware, and software. Manufacturer shall provide minimum two-year free subscription for computer software to interface with the ECP and engine electronic control module, including all software updates.
- B. Critical control components shall be environmentally sealed to protect against failure from moisture and dirt. The ECP shall be mounted on a separate support stand isolated from engine/alternator vibration. ECP/circuit breaker arrangements mounted on the generator set in such a way that restricts access to the AC generator terminal box are not acceptable.
- C. The ECP shall provide full local annunciation of NFPA 110, Level 2 safety indications and shutdowns. The generator set and ECP shall be provided with all instrumentation and components necessary to control, monitor display, and transmit the engine and alternator functions and allow adjustments of listed adjustable parameters as specified herein. ECP shall be provided with illuminating lights and backlight digital displays. Where specified, the ECP shall provide remote annunciation of safety indications and shutdowns in accordance with NFPA 110, Level 1.
- D. As a minimum, the ECP shall monitor and display (digitally) the following:
  - 1. Engine oil pressure
  - 2. Coolant temperature
  - 3. Engine rpm

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4. Fuel level
  5. System DC volts
  6. Engine operating hours (non-resettable)
  7. Generator AC volts (L-L and L-N)
  8. Generator AC amps (per phase)
  9. Generator frequency
  10. Power factor
  11. kW, kVA, kVAR, kW-hr
- E. As a minimum, the ECP shall be provided with visual indication for the following alarm and status conditions:
1. Low oil pressure alarm
  2. High coolant temperature alarm
  3. Low coolant temperature alarm
  4. Low coolant level alarm
  5. Overspeed alarm
  6. Failure to start (overcrank) alarm
  7. Low battery voltage alarm
  8. High battery voltage alarm
  9. Low fuel level alarm
  10. Fuel tank rupture alarm (fuel in tank annulus, interstitial space)
  11. Battery charger fault
  12. High coolant temperature warning
  13. Low oil pressure warning
  14. "Emergency Stop" pushbutton depressed
  15. Control switch not in "Auto" position
  16. Four (4) spare alarm/warning conditions, District assignable

Alarm conditions shall cause the generator set to shutdown.

- F. Control Features and Interfaces. As a minimum, provide the following control features and interfaces:
1. Remote start/stop contacts
  2. Programmable auto cycle crank
  3. Programmable cool-down timer
  4. Remote fuel level transmission
  5. Audible alarm horn and silence pushbutton

6. Alarm reset pushbutton
  7. Emergency Stop pushbutton (red mushroom-type) with auxiliary terminals for remote "Emergency Stop" indication.
  8. Manual / Off / Auto (M-O-A) control switch with auxiliary terminals for remote "Auto" indication.
  9. "Generator Run" form "C" dry contact set rated 2A @ 30VDC (one N.O., one N.C.).
  10. "Common Alarm" form "C" dry contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set (one N.O., one N.C.).
  11. Dry contacts for remote start/stop, emergency stop, and M-O-A in auto position signals shall be 120VAC/30VDC rated and shall be wired to a terminal strip.
  12. The ECP shall be equipped with a communication module capable of Modbus/RTU RS-485 serial communication.
  13. A fused 20 amp 12VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
- G. All generator set wiring and terminations shall be properly identified by numbering or unique color coding. Such numbering and color coding shall correspond with identification on the wiring diagrams. Wiring shall land on terminal strips for connection, unless wiring is contained in a cable or harness with keyed plugs or connectors.
- H. If DPF system is required, the ECP shall be equipped with a time delay relay (TDR) to provide the functions described in Section 2.15, Generator System Control Description.

## **2.08 GENERATOR SET ENCLOSURE**

### **A. General**

Generator set, including: engine, cooling system, fuel system (except fuel tank), alternator, load bank, generator ECP, batteries, battery charger, and other auxiliary equipment required for a self-contained power generating system, shall

be housed in a sound attenuated enclosure suitable for mounting on an outdoor concrete pad.

B. Outdoor Sound Attenuated Enclosure

1. Generator set outdoor sound attenuated enclosure shall be weatherproof and shall be constructed of panels fabricated from minimum 14 gauge steel. Dense, closed-cell foam acoustic insulation shall be provided on enclosure inner surfaces. Roof panels shall be provided with mechanical retention pins for retaining the acoustic foam insulation. The combined generator set assembly, including engine, radiator fan, alternator, engine exhaust silencer (separate or combination silencer/DPF) and enclosure, shall attenuate sound levels to 75 dBA, or less, at a horizontal distance of 23 feet with the generator set running at full load.
2. Number of doors on enclosure shall be as required so that all normal maintenance operations, such as lube oil change, filter change, belt adjustment and replacement, hose replacements, ECP access, etc., may be accomplished without disassembly of any enclosure components. Access doors shall be fabricated of the same material as the enclosure walls and shall be reinforced for rigidity. Doors shall be equipped with rubber seals, stainless steel hinges, and flush fitting latches constructed of stainless steel or other corrosion resistant material. Door latches shall be key lockable, all doors shall be keyed alike. Door latch strike plates shall be stainless steel. All fasteners shall be stainless steel.
3. Enclosure air handling shall be designed and sized by the manufacturer to minimize static pressure drop through the enclosure and sound levels outside the enclosure.
4. Enclosure design shall be rodent-proof and tamper-proof, including conduit the stub-up area beneath the generator set unit.
5. Enclosure air intake and exhaust louvers and openings shall be equipped with bird screens.
6. Radiator access shall be through a hinged, lockable cover on the enclosure. Engine cooling fan and charging alternator shall be fully guarded to prevent injury.
7. Engine exhaust silencer shall be mounted inside the enclosure wherever feasible.

8. Where a DPF is specified, the unit shall be mounted on top of the enclosure, including units that combine the DPF and exhaust silencer.
9. Load bank shall be mounted inside the enclosure directly on the engine radiator core wherever feasible. Units installed outside the enclosure shall be installed horizontally over the enclosure upward discharging radiator air hood.
10. Enclosure shall be provided with integral stiffeners or interior secondary support members as necessary to support generator set components, including, but not limited to: exhaust silencer, load bank, and DPF (where specified).
11. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color utilizing electrostatically applied powder polyester paint.
12. Lube oil and radiator drains shall be equipped with Type 316 stainless steel threaded ball valves, extension piping (to outside of enclosure) and threaded end caps.
13. Battery charger shall be mounted inside the enclosure.
14. One (1) interior LED light fixture with ON/OFF switch to illuminate the generator set ECP. Lighting system shall obtain power via generator starting/battery system.
15. Corrosion resistant battery tray and hold-down clamps.
16. NEMA 1 circuit breaker box with main line circuit breaker(s) per Part 2.09 herein mounted inside the enclosure and readily accessible via enclosure door.
17. The generator set wiring shall be securely attached to substantial supports along its entire route. The use of adhesive backed wire anchors is not acceptable. At no time shall the route come near or be a part of any heat source, exhaust system, or exhaust support. Where installed wiring is required to pass through any enclosure panel or partition, the wiring shall be protected with an insulating grommet at the point of passage. All electrical facilities and equipment shall be pre-wired inside the enclosure with connections for external wiring terminating in junction boxes located at the electrical conduit and conductor stub-up area.

## 2.09 GENERATOR SET AUXILIARY EQUIPMENT AND ACCESSORIES

### A. Jacket Water Heater

Engine mounted, thermostatically controlled, UL listed, circulation type jacket water heater(s) shall be provided for each engine. Jacket water heater(s) shall be sized by the generator set manufacturer to maintain jacket water temperature at 90°F in an ambient temperature of 30°F. Jacket water heater(s) shall be provided with power cut-off relay(s). Jacket water heater(s) shall operate on 120 or 240 volt, single phase, 60 hertz power, as indicated on the Drawings. Provide a separate receptacle for connection of the jacket water heater to the power supply circuit. Provide proper power supply circuits for the heater(s) as required for the voltage and load of the heater(s), connected to a lighting panel circuit as shown on the Drawings. Generator set supplier shall coordinate lighting panel circuit breaker voltage and amperage rating with Contractor to ensure that the proper circuit breaker is provided for the jacket water heater(s).

### B. Space Heater

Alternator shall be provided with a space heater. Space heater shall operate on 120 VAC, single phase electrical power.

### C. Starting and Control Batteries

1. A lead-acid battery set of the heavy-duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system. The battery set shall be capable of delivering the manufacturer's recommended minimum cold-cranking amps required at 0°F (per SAE Standard J-537). All necessary battery cables and clamps shall be provided.
2. Battery system shall be equipped with a lockout/blockout disconnect switch. Disconnect switch shall be rated for a minimum of 250 A continuous current and 1,250 A peak current, and shall be capable of padlocking in the "OFF" position. Disconnect switch shall be as manufactured by Littelfuse, or equal.
3. Battery tray(s) shall be provided for the batteries and shall conform to NEC 480-8. Battery tray(s) shall be constructed of non-metallic material. Construction shall be such that any battery spillage shall be contained within the tray to prevent a direct path to ground.



D. Battery Charger

Provide a 120 VAC, enclosed, automatic equalizing, dual-rate, selectable for lead-acid or activated glass mat (AGM) batteries, solid-state, constant voltage type battery charger with automatic AC line compensation. Battery charger shall be provided with a NEMA 1 enclosure with vibration isolators. DC output shall be voltage regulated and current limited. Charger shall have two ranges, float and equalize, and shall provide continuous taper charging. The charger shall have a continuous output rating of not less than 10A, and shall be sized to recharge the engine batteries in a minimum of 4 hours while providing the control power needs of the engine. The battery charger shall comply with UL 1564, and shall be provided with the following features and capabilities:

1. DC rated output matching batteries
2. DC ammeter
3. DC voltmeter
4. Equalize light
5. AC power on light
6. Low voltage light
7. High voltage light
8. Equalize test button/switch
9. AC circuit breaker
10. Low DC voltage alarm relay
11. High DC voltage alarm relay
12. Current failure relay
13. AC power failure relay
14. Fused DC output

Charger shall be Samlex Model SEC, 3 stage, fully automatic battery charger, or equal.

E. Electrical Connection Box

Generator set electrical components shall be factory installed, including wiring. All electrical components requiring connection to District's remote wiring, such as power for jacket water heater, alternator space heater and battery charger, and signals to/from the generator set ECP, load bank control panel, and DPF control panel (if applicable) shall be pre-wired to an electrical connection box(es). The electrical connection box(es) shall be located inside the generator set enclosure near the conduit stub-up area.

F. Generator Set Circuit Breakers

1. Provide a generator set mounted main circuit breaker equipped with a DC shunt trip. The circuit breaker shunt trip device shall be connected to engine/generator safety shutdowns and shall open the circuit breaker on a shutdown condition.
2. Provide a generator set mounted load bank circuit breaker.
3. Unless indicated otherwise on the Drawings, circuit breakers shall be molded-case thermal-magnetic type or electronic trip type, 480 volt, 3 pole, 60 hz, UL listed, and conforming to NEMA AB1 and UL489. Circuit breakers shall be mounted and wired in separate NEMA 1 steel enclosures with dead front panels. Circuit breakers shall be lockable in the "OFF" position. Circuit breaker enclosures shall be arranged to accept conduit connections stubbed-up through the concrete foundation and sub-base fuel storage tank. Provide sufficient wire bending space and terminals for connection of conductor compression type connectors. The main circuit breaker enclosure shall be equipped with one ground bus bar and one isolated neutral bus bar. Bus bars shall be tin-plated copper, rigidly mounted, and provided with terminals suitable for termination of manufacturer ground and neutral conductors, and generator output feed conductors (size and quantity as indicated on the Drawings).
4. Unless indicated otherwise on the Drawings, circuit breakers shall utilize an 80% rated thermal-magnetic trip units. Manufacturer's selection of the circuit breaker type and associated trip curve shall be coordinated with the alternator thermal damage curve to ensure that the circuit breakers protect the alternator from damage due to a line-to-line short, or line-to-ground short. Circuit breaker current continuous current ratings shall be selected for the maximum full load capabilities of the generator set and load bank. Circuit breaker short-circuit current rating shall be as determined by the Contractor's short-circuit and protective device evaluation and coordination studies performed in accordance with Specification Section 16040. As a minimum, circuit breakers rated 250 A and less shall have a short-circuit current rating of at least 18,000 A at 480 VAC, and circuit breakers rated over 250 A shall have a short-circuit current rating of at least 35,000 A at 480 VAC.
5. Generator/exciter field circuit breakers will not be acceptable for overcurrent protection.

G. Grounding and Bonding

1. Provide a factory installed, code sized grounding conductor from the alternator ground pads to the engine generator frame and to a grounding lug in the generator set main circuit breaker enclosure. Grounding lug shall be sized to accept the grounding electrode conductor(s) and grounding conductor(s) in the generator feed conduit(s), as indicated on the Drawings.
2. Provide a factory installed, code sized neutral conductor from the alternator neutral to a neutral block in the generator set main circuit breaker enclosure. Provide a neutral block capable of connecting a minimum of two customer neutral conductors of the same size as the generator set neutral conductor.
3. Provide factory installed bonding and grounding conductors from all electrical equipment, components, devices, instruments, panels, and boxes to engine generator frame ground.
4. Provide factory installed bonding and grounding conductors for any electrically isolated section of metallic piping or equipment.

H. Vibration Isolation and Anchorage

1. Provide vibration isolators with type, location, and quantity as determined by the generator set manufacturer. Vibration isolators shall be provided between the alternator/engine and base frame, or between the base frame and sub-base fuel tank. Vibration isolators shall be elastomeric pad type or spring type.
2. Elastomeric isolator pads shall be oil and water resistant elastomer or rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over the pad area, and factory cut to sizes that match the requirements of the supported equipment.
3. Spring isolators shall be freestanding, steel, open-spring isolators with seismic restraint.
  - a. Housing: steel with resilient vertical limit stops to prevent spring extension due to seismic loads or if weight is removed; factory drilled baseplate bonded to elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt.

- b. Outside Spring Diameter: not less than 80% of compressed spring height at rated load.
  - c. Minimum Additional Travel: 50% of required deflection at rated load.
  - d. Lateral Stiffness: more than 80% of rated vertical stiffness.
  - e. Lateral Restraint Rating: more than 110% of calculated maximum seismic force per isolator.
  - f. Overload Capacity: support 200% of rated load, fully compressed, without permanent deformation or failure.
  - g. Minimum Deflection: 1 inch.
4. Vibration isolators shall be as manufactured by Cal Dyn, or equal.
5. Generator set sub-base fuel tank shall be rigidly anchored to a reinforced concrete foundation. Anchor bolts shall be Type 316 stainless steel and shall be drilled and epoxied (wedge anchors are not acceptable). Generator set manufacturer shall determine the required size, location, and embedment depth of anchor bolts. Anchor bolt embedment depth shall be limited to the overall thickness of the reinforced concrete foundation minus 3 inches.
- I. Engine Exhaust System Piping, Components, and Insulation
- 1. Engine exhaust piping shall be constructed of carbon steel or stainless steel pipe. Piping thickness and connection type shall be per manufacturer's recommendations.
  - 2. A bellows expansion joint shall be provided at the engine exhaust connection. Bellows expansion joint shall be constructed of Type 321 stainless steel.
- J. Engine Fuel System Piping and Components
- 1. Unless indicated otherwise on the Drawings, engine fuel system piping shall be carbon steel ASTM A53 or A106, Grade B, Schedule 40, seamless pipe. Connections shall be threaded, welded, or flanged. Threaded fittings shall be ASTM A197, ANSI B16.3, Class 150 minimum. Welded or flanged

fittings shall be ASTM A234, ANSI B16.9, Standard Weight, smooth-flow (mitered fittings are not acceptable).

2. Engine supply and return fuel line connections to the engine shall be made with flexible fuel hose to facilitate component movement during operation. Flexible hose shall be factory installed, rated for diesel service, and provided with braided stainless steel wrapping. Flexible fuel hose shall be rated for a minimum of 100 psi and 300°F.
3. Vent piping shall be provided for the sub-base fuel storage tank normal vent. Vent piping shall be factory installed and shall extend a minimum of 12' above the bottom of the fuel tank. Where feasible, vent piping shall be routed outside the generator set enclosure, adjacent to the enclosure end, and shall be provided with lateral support near the top of the enclosure. Where vent piping is routed inside the generator set enclosure, watertight flashing shall be provided around the roof penetration. Vent piping routing shall not interfere with access to any generator set equipment or components.
4. The top of the vent piping shall be equipped with an updraft vent cover designed to direct fuel vapors outward and upward in accordance with NFPA 30 requirements. Vent cover body and cap shall be die cast aluminum, and provided with a 40 mesh stainless steel debris and insect screen. Vent cover shall be Model 354T, as manufactured by Morrison Bros. Co., or equal.

## **2.10 DIESEL PARTICULATE FILTER (DPF) SYSTEM**

Where shown on the Drawings, the generator set shall be furnished with a DPF system to reduce the diesel particulate matter (PM) in accordance with SCAQMD Rule 1470. The DPF system shall meet the following requirements:

- A. The DPF system shall utilize a low temperature passive DPF.
- B. The DPF shall be as manufactured by Johnson Matthey or Miratech, no equal.
- C. The DPF shall meet California Air Resources Board (CARB) Level 3 requirements at a minimum, and shall be verified for the specific engine make/model that it will be installed on and with a PM reduction greater than 85%.
- D. The CARB Executive Order for the DPF shall either list compatibility to the generator engine family name or approval shall be granted by SCAQMD.

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- E. The proposed engine shall be a certified CI engine that meets the following standards:
  - 1. PM emission standards specified in SCAQMD Rule 1470 Part (c)(2)(C)(iv).
  - 2. Emission standards specified in SCAQMD Rule 1470 Part (c)(2)(C)(vii) for other pollutants.
- F. Total exhaust system backpressure shall not exceed 90% of engine manufacturer's maximum allowable backpressure and shall be coordinated with other exhaust system components (e.g. piping, fittings, rain cap, etc.). Generator set supplier shall confirm exhaust size shown on the Drawings is sufficient to ensure the total exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer.
- G. The DPF system shall be equipped with continuous exhaust backpressure monitoring and shall provide notification when high backpressure limit is reached. A normally open dry contact that closes if the backpressure limit is reached shall be provided for District's use.
- H. The DPF unit shall be provided with an integral exhaust silencer. As a minimum, the combination DPF/silencer unit shall be capable of a dynamic insertion loss of at least 30 dBA.
- I. The DPF unit housing shall be suitable for horizontal installation and shall be provided with flanged inlet and outlet nozzles at each end of the housing. The DPF housing and flanges shall be constructed of Type 304 stainless steel. The DPF housing shall be provided with Type 304 stainless steel support brackets.
- J. The DPF system shall be provided with a DPF monitoring controller. The monitoring controller shall be factory mounted on the generator set. The monitoring controller shall be suitable for operating on generator set battery power and shall accept instrumentation wiring from inlet and outlet thermocouples, inlet exhaust pressure sensing line, and engine run status signal from the generator set ECP. The monitoring controller shall be provided with LED visual indicating lights and customer dry contact alarm/warning output signals for high exhaust backpressure alarm, high exhaust backpressure warning, and two analog outputs (temperature and pressure). All exhaust pressure sensing lines shall be constructed of Type 304 stainless steel tubing and fittings.

- K. The DPF system shall be provided with thermocouples for monitoring exhaust inlet and outlet temperatures. Thermocouples shall meet the following requirements:
1. Each thermocouple probe shall be Type K, with a 1/4" diameter sheath constructed of Inconel. Probe mounting threads shall be 1/2" diameter NPT. Probe length shall be as determined by the generator set supplier for the exhaust piping size and threaded outlet for thermocouple. Contractor shall coordinate size and location of exhaust piping threaded outlets for thermocouples with generator set supplier.
  2. Thermocouple probes shall be provided with industrial protection heads suitable for outdoor installation. Protection head shall be constructed of cast iron, hot dipped galvanized. Protection head shall be provided with 1/2" FNPT openings for probe connection tube entry and extension cable entry. An internal terminal block shall be provided for termination of cable wiring.
  3. Thermocouple probes and protection heads shall be Model NB1-CAIN-14, as manufactured by Omega, or approved equal.
- L. The DPF manufacturer shall provide all necessary equipment and appurtenances required for a complete and operable system, including, but not limited to: DPF/silencer, monitoring controller, inlet/outlet thermocouples, backpressure piping and tubing, backpressure transducer, pressure gauge, and moisture separator.
- M. The DPF monitoring controller shall be equipped with an HMI screen for visual display of temperature, DPF back pressure, and other DPF monitoring parameters.
- N. The DPF monitoring controller shall have Modbus Ethernet communication (TCP/IP communication protocol) capable of remote transmission of DPF system data, status, and alarms.
- O. The DPF monitoring controller shall have two digital outputs: High-Pressure Warning (HPW) and High-Pressure Alarm (HPA).
- P. The DPF monitoring controller shall be capable of storing approximately five (5) years of data at 1-minute datalogging intervals. The DPF emissions monitoring controller shall be Johnson Matthey's Soot Alert, or equal.

## 2.11 LOAD BANK SYSTEM

- A. All generator sets shall be furnished with a load bank system. The load bank system shall operate with the generator set to maintain sufficient load on the generator and create adequate engine exhaust temperature for proper operation of the DPF and compliance with SCAQMD emissions requirements.
- B. The load bank system shall consist of a resistive load bank, load bank control panel, and appurtenances. The load bank system manufacturer shall coordinate with the generator set manufacturer to ensure that all necessary equipment and components are provided, and that said equipment and components comply with these Specifications.
- C. The load bank and associated control panel shall be designed in accordance with the latest applicable NEMA, NEC, and ANSI standards. The load bank and control panel shall be UL 508A listed and labeled. The load bank and control panel shall be as manufactured by ASCO (Avtron Loadbank), Simplex Inc., or equal.
- D. The load bank shall be designed as a supplemental load to the generator set, and shall be sized at 50-60% of generator nameplate kW rating (not 100%). The load step resolution provided by the load bank system shall be a nominal 20% to 25% of the load bank rating. The load bank shall be designed and fabricated for continuous duty cycle operation, with no limitations.
- E. The load bank shall be air cooled via air from the engine radiator fan. Load bank sizing shall be coordinated with available air flow engine radiator fan and associated heat rejection when operating under maximum ambient temperature conditions. The load bank shall be radiator-mounted wherever feasible, and suitable for installation directly on the engine radiator core. Where generator set enclosure constraints do not allow for the load bank to be radiator-mounted, the load bank shall be installed horizontally over the enclosure upward discharging radiator air hood.
- F. The static pressure drop across the load bank shall not exceed 0.10" of water column with generator set operating at full rated load. The main input load bus, load step relays, fuses, and control relays shall be located within the load bank enclosure. The load bank shall be designed for installation and operation outdoors. The load bank enclosure shall be rated NEMA 3R, or better. All exterior fasteners shall be stainless steel.
- G. Load elements shall be helically or spirally wound chromium alloy rated to operate at approximately 1/2 of maximum continuous wire rating. Elements shall be fully supported across their entire length within the air stream using segmented ceramic



insulators on stainless steel rods. Element supports shall be designed to prevent a short-circuit to adjacent elements or to ground.

The change in resistance due to temperature shall be minimized by maintaining conservative watt densities.

The overall tolerance of the load bank shall be +5% to 0% kW at rated voltage. A +5% to -5% rating that allows the load bank to deliver less than rated kW will not be acceptable. The load bank shall deliver full rated kW at rated voltage.

- H. Protective devices shall include an over-temperature switch to sense the load bank exhaust air. The switch shall be electrically interlocked with the load application controls to prevent load from being applied in the event of an over-temperature condition. In addition, the over-temperature condition shall initiate a "Load Bank Fail" output signal (dry contact). The load bank shall be provided with a separate main circuit breaker. In addition, branch fuses shall be provided on all three phases of switched load steps above 50 kW. Branch fuses shall be current limiting type with an interrupting rating of 200 KAIC at 480V.

The exterior of the load bank shall be provided with the appropriate warning/caution labels on all access panels.

I. Load Bank Control Panel

The load bank system shall be provided with a local control panel. As a minimum, the control panel shall be provided with the following features, functions, and capabilities:

1. Control features:
  - a. Power ON/OFF switch
  - b. Master load ON/OFF switch
  - c. Load step switches for ON/OFF application of individual load steps
  - d. Automatic/Manual selector switch
2. Visual indicators:
  - a. Power ON indication light
  - b. OVER-TEMPERATURE light
3. A remote activated "load dump" circuit shall be provided as part of the load bank control circuitry. Provisions shall be provided to remove the load bank offline from the operation of a remote normally closed set of auxiliary

contacts from an automatic transfer switch or other device. In the event of the remote contact opening, all load shall be removed.

4. The control panel enclosure shall be rated NEMA 1 where mounted inside the generator set enclosure, and rated NEMA 4 where mounted to the outside of the generator set enclosure. Panel enclosures mounted outside the generator set enclosure shall be provided with hinged doors and padlockable door hasps.
5. An automatic load step controller shall be provided for maintaining a minimum load on the generator set. The controller shall monitor the connected downstream loads and shall automatically add or subtract load steps in response to facility load changes as to maintain a minimum load level on the generator set. The controller shall include an initial time-delay circuit, and automatic time delayed load step application circuit. A remote contact closure shall be provided for activation and transfer of control. A separate current transformer shall be provided for sensing of downstream loads.
6. An integral control power transformer shall be provided to supply 120 volt, 1 phase, 60 hertz to the load bank's control and safety circuitry. Transformer primary and secondary control circuits shall be fuse protected.

## **2.12 DIESEL FUEL LEVEL MONITORING SYSTEM**

The generator set shall be provided with a continuous diesel fuel level monitoring system. The continuous diesel fuel level monitoring system shall meet the following requirements:

- A. Ultrasonic liquid level measurement system shall consist of an electronic transducer device to provide continuous diesel fuel level monitoring within the sub-base fuel storage tank.
- B. The device shall be capable of continuously transmitting liquid level data over a two wire (4-20 mA isolated output signal) system. The device shall be capable of being calibrated without removing the transducer. The transmitter housing shall be constructed of fire resistant ABS plastic and shall be rated NEMA 6P. Ultrasonic liquid level measurement system shall be suitable for installation with low sulfur diesel fuel.
- C. The device shall be capable of accurately measuring the level of clean or dirty liquids (0.2% of measuring range). The device beam width shall be 2" in diameter. The transducer material shall be constructed of PVDF and shall be provided with

FKM gasket. Level transducer shall be capable of measuring the entire level range in the storage tank.

- D. The transducer assembly shall be provided with a minimum 1" NPT connection suitable for installation in a female threaded coupling, and rated for a working pressure of 30 psi (minimum) at a temperature of 140 degrees F.
- E. Manufacturer shall provide written confirmation that the material selection for all transducer wetted components and electrical control system is suitable for use with low sulfur diesel fuel.
- F. Ultrasonic liquid level measurement system shall be Omega, or equal.
- G. Level monitoring device shall be factory installed in the sub-base fuel tank and tested prior to shipment. Level monitoring device signal cables shall be connected to the generator set ECP. The generator set ECP shall be configured to provide the continuous level measurement via Modbus/RTU RS-485 serial communication protocol for District use.

### **2.13 PAINTING AND PROTECTIVE COATINGS**

- A. Generator set enclosure, engine, alternator, ECP, and components shall be coated using the standard surface preparation and paint normally supplied by the manufacturer for this application.
- B. Carbon steel fuel piping, including vent piping, shall receive two coats of epoxy (primer plus finish coat), or manufacturer's equivalent.

### **2.14 SPARE PARTS**

- A. For each generator set, Contractor shall furnish the spare parts normally provided with said equipment plus the following:
  - 1. Two (2) complete sets of filters for fuel, oil, and air systems.
  - 2. Two fuses of each rating.
  - 3. Supply of lubricants for first lubricant change.
  - 4. All additional lubricants and fuel required while generator is in operation during factory testing, and field startup, testing and initial operation.
- B. Spare parts shall be packed in suitable containers or boxes bearing labels clearly designating the contents and the piece of equipment for which they are intended.

Spare parts shall be delivered to the District at the same time of equipment field startup and testing.

## 2.15 GENERATOR SYSTEM CONTROL DESCRIPTION

If a DPF system is specified, the generator system shall operate in automatic or exercise mode. Each mode is described further in the section below.

### A. Automatic Mode

1. The load bank control panel shall be set to automatic mode.
2. Upon loss of utility power, the ATS shall signal the generator to start.
3. The load bank shall be de-energized at all times until the DPF needs to be cleaned.
4. When the DPF needs to be cleaned, the pressure will rise to a pre-set level and the DPF emissions monitoring controller shall generate a DPF "High Pressure Warning" (HPW) signal. The HPW signal shall energize the load bank.
5. When the load bank is energized, it shall automatically adjust to maintain a minimum load on the generator set.
6. Once the DPF pressure drops below its pre-set level, the DPF HPW signal shall drop out and the load bank shall de-energize.
7. The ECP time delay relay (TDR) shall override the DPF HPW signal and shall de-energize the load bank on either of the following conditions:
  - Condition 1: Generator set cooldown (ECP "Engine Cool Down" contact shall energize the TDR).
  - Condition 2: Pump start (remote MCP contact shall energize the TDR).
8. Upon restoration of utility power, the ATS start generator signal shall de-energize and the generator set shall go into "Engine Cool Down" mode.
9. After "Engine Cool Down" mode is completed, the generator set shall shut off.

- B. Exercise Mode
  - 1. Prior to exercising the generator, the load bank control panel shall be set to manual mode. The load bank control panel has load step selector switches for 25%, 50%, 75%, and 100% of the total load bank rating. The operators shall select the load step.
  - 2. During generator exercising, the load bank shall remain energized at the selected load step, except during Conditions 1 and 2 (generator set cooldown, or pump start) described in Part 2.15A.7 above.

### **PART 3 - EXECUTION**

#### **3.01 GENERAL**

- A. Generator set shall be fully assembled, pre-wired, and ready for delivery, prior to commencing factory performance testing as specified herein.
- B. The Contractor shall arrange to have the manufacturer or supplier of the equipment furnished under this Section provide the services of competent factory-trained personnel to supervise generator set installation and startup and field testing activities.

#### **3.02 DELIVERY AND HANDLING**

- A. Deliver equipment properly packaged and mounted to facilitate handling.
- B. Deliver equipment with recommended lube oil and coolant installed.
- C. Handle equipment carefully to prevent physical damage. Lift equipment using manufacturer supplied attached points and in accordance with manufacturer's printed instructions.
- D. Do not install damaged equipment; remove any damaged equipment from the site and replace with new equipment.

#### **3.03 INSTALLATION**

- A. Coordinate routing of all facility conduit related to generator set with manufacturer and ensure all conduit stub-ups are located properly for bottom entry into generator set conduit stub-up area and aligned with associated terminal connections per manufacturer's equipment shop drawings.

- B. Install equipment in strict accordance with manufacturer's written installation, application, and alignment instructions.
- C. Install equipment and material in accordance with the applicable portions of NFPA 30 and 110.
- D. Anchor generator set to concrete foundation with Type 316 stainless steel anchor bolts (cast-in-place or drilled and epoxied). Anchor bolt type, number, diameter and embedment shall be per the manufacturer's anchorage calculations. Unless specified otherwise, install a continuous and level layer of 1/2" +/- thick high strength non-shrink grout beneath all sub-base fuel storage tank bearing surfaces.
- E. Furnish and install all interconnecting conductors and cables between generator set and facility electrical equipment.
- F. Furnish and install equipment grounding connections and materials for the generator set in accordance with NFPA 70 for a separately derived system.
- G. Adjust short circuit protective devices in accordance with the manufacturer's recommendations and Contractor's short circuit and protective device coordination studies.

### **3.04 PERFORMANCE TESTS**

#### **A. Manufacturer/Supplier Testing**

Each completed generator set shall be factory tested. Testing shall be performed at the manufacturer's or supplier's regular place of business and shall be conducted on a "resistive load bank". Testing may be witnessed by the District's representative. Manufacturer/supplier shall provide written notice to the District a minimum of two (2) weeks prior to testing. Three (3) certified copies of the test results shall be forwarded to the District within five (5) days following the testing. Test results shall be reviewed and approved by the District prior to shipping the generator set to the project site. As a minimum, manufacturer/supplier testing shall consist of the following:

1. Perform engine manufacturer's recommended pre-starting checks.
2. Start engine and make engine manufacturer's after-starting checks during a reasonable run-in or warm-up period.
3. Run generator set continuously as follows:
  - a. Operate the generator set for one (1) hour at 1/2 full rated load.

- b. Follow above run immediately with one (1) hour at 3/4 full rated load.
  - c. Follow above run immediately with two (2) hours at full rated-load.
  - d. If safe operating limits as specified hereunder and recommended by the generator set manufacturer are exceeded during the preceding test, the necessary changes and adjustments shall be made and the complete test shall be repeated.
4. Instrumentation: The following generator set parameters shall be read and recorded at 15-minute intervals throughout the test:
- a. Engine Oil Pressure
  - b. Jacket Water Temperature
  - c. Engine RPM
  - d. Ambient Air Temperature
  - e. Generator Voltage
  - f. Generator Amperage
  - g. Generator Frequency
  - h. Power Factor
  - i. Kilowatts (kW)

Note: All engine instrumentation readings must remain static one (1) hour prior to end of test period.

5. Control Test:

Demonstrate operation of all local alarms and status indicators as specified in Part 2.07.E.

**B. Pre-Startup, Startup, and Field Testing**

Prior to final acceptance, Contractor shall perform pre-startup, startup, and field test each generator set. Contractor, a representative of the generator set supplier, and the District will be present. Contractor shall be responsible for the proper conduct of the tests and to furnish equipment and labor required to make the tests. Contractor shall provide all materials, supplies, and instruments required for the tests, including, but not limited to, fuel and all metering equipment. Contractor shall leave the fuel tank full at the conclusion of all field testing.

1. Pre-Startup

As a minimum, pre-startup shall include the following:

- a. Perform engine manufacturer's recommended pre-starting checks.
- b. Verify that all equipment, components, and auxiliary devices are properly installed, lubricated, adjusted, and ready for operation.
- c. Check and record all fluid levels.
- d. Test and record insulation resistance of all power buses, components, feeders, and branch circuit conductors.
- e. Verify that all equipment and material is properly bonded and grounded. Verify tightness of all power and control conductor terminations.
- f. Check all auxiliary devices for proper operation, including battery charger, jacket water heater(s), alternator space heater, fuel storage tank level and leak detection sensors and controllers, and generator set ECP (including local and remote annunciation), and load bank instrumentation and control panel (where specified).
- g. Test and record all alarms and safety shutdown devices for proper operation and annunciation. Test alarms and safety shutdowns to the fullest extent possible. Simulate alarm conditions where necessary to avoid equipment damage.
- h. Start engine and check for exhaust leaks, fuel leaks, oil leaks, excessive vibration, etc.
- i. Verify and record voltage output and phase rotation at the transfer switch, prior to connecting the transfer switch to the load.
- j. Interrupt normal electrical service from power utility and verify automatic starting of generator set and transfer switch operation from "Normal" to "Emergency". Adjust ATS time delays for generator set starting and transfer per manufacturer's recommendations and District preferences.
- k. If the site is located 500 feet or less from a school, Contractor shall comply with the following applicable limits or in accordance with



the latest revision of SCAQMD Rule 1470, whichever is more stringent:

- i. If the generator set is on school grounds, it shall not be operated whenever there is a school sponsored activity.
  - ii. If the generator set is located 328 feet or less from a school, it shall not be operated between the hours of 7:30 a.m. and 4:30 p.m. on days when school is in session. If a DPF is installed, the generator set shall not be operated between the hours of 7:30 a.m. and 3:30 p.m.
  - iii. If the generator set is located more than 328 feet and less than or equal to 500 feet from a school, the generator set shall not be operated between the hours of 7:30 a.m. and 3:30 p.m. on days when school is in session. A generator set that emits particulate matter (PM) at a rate of 0.01 g/bhp-hr or less is not subject to this restriction.
- l. Equipment operating hours shall be recorded on a daily basis during all testing.
  - m. Generator set shall be tested by actual starting of the facility equipment specified herein, and their continuous operation for a one (1) hour period. During that period, Contractor shall observe and record the following data at 15-minute intervals: engine oil pressure, engine jacket water temperature, engine RPM, generator voltage per phase, amperage per phase, frequency, power factor, and kW.
  - n. Where a DPF system is specified, proper system operation shall be verified, including associated instrumentation, controller, and local/remote annunciation of all alarm and status signals. DPF operating parameters shall be monitored and recorded for a one (1) hour period (total period). During the first 30-minutes of that period, the DPF system shall be tested by operation with the load bank system only, followed by simulating the de-energizing load bank conditions and the DPF HPW condition as described in Part 2.15. During the field testing period, Contractor shall measure and record the following data at 15-minute intervals: engine exhaust backpressure, engine exhaust temperature at DPF.

- o. Load bank system operation shall be verified, including associated instrumentation, control panel and local/remote annunciation of all alarm and status signals. Load bank system operating parameters shall be monitored and recorded for a one (1) hour period (total time). During the first 30-minutes of that period, the generator set shall be operated with the load bank system only with a minimum of 10-minutes at each load bank step, followed by 30-minutes of operation with the actual facility equipment and load bank system. Load bank system shall be automatically operated with actual facility loads and load bank steps shall be added or subtracted to maintain a minimum load level on the generator set. During the field testing period, Contactor shall measure and record the following data at 15-minute intervals: load bank temperature, generator voltage per phase, amperage per phase, frequency, power factor, and kW.
- p. If the equipment or generator set and accessories do not operate in a satisfactory manner, the trouble shall be located and promptly repaired by the Contractor.
- q. Contractor shall assemble all recorded field data and submit same to District for review and approval. An analysis of the actual field test will determine the acceptability of the unit. If the unit does not perform in conformity with these Specifications and/or the certified test data, the Contractor will be required to remove, replace, and restore the equipment to full compliance with these Specifications at his expense.

2. Startup

All testing described above for pre-startup shall be repeated during startup.

**3.05 MANUFACTURER'S CERTIFICATION**

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the generator set has been installed, adjusted, and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the performance of field testing and the preparation of any reports.
- B. Manufacturer's written certification shall be provided in accordance with Sections 01810 and 11005.

### **3.06 CLEANUP**

- A. All parts of the equipment and materials shall be left in a clean condition. Exposed parts shall be clean of dust, dirt, diesel, oil, grease, and other materials and debris. All, fuel, oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and cleaned.
- B. Paint touch-up matching factory color and finish shall be applied to all scratches on equipment, components, panels and enclosures.

### **3.07 INSTRUCTION**

- A. After the generator set has been installed, tested, and adjusted, and placed in satisfactory operating condition, the equipment manufacturer shall provide classroom instruction to District's personnel in the use and maintenance of the equipment. Manuals and handouts shall be provided to each participant. Instruction shall address function and operation of engine-alternator, major sub-systems, and components. Instruction shall be provided on the generator set ECP, load bank control panel, and DPF control panel (where specified). Instructions shall include the following: operator interfaces, menu navigation, changing control parameters, modifying setpoints, routine maintenance, troubleshooting, adjustments, and repairs.
- B. Four (4) hours of instruction shall be provided unless otherwise specified. Contractor shall give the District formal written notice of the proposed instruction period at least two (2) weeks prior to commencement of the instruction period. Scheduled training shall be at a time acceptable to the District and the manufacturer. During this instruction period, the manufacturer shall answer any questions from District personnel. The manufacturer's obligation shall be considered ended when he and the District agree that no further instruction is needed. Cost for this instruction shall be included in the price bid.

**END OF SECTION**

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