

**SECTION 11562  
ENGINE GENERATOR: DIESEL**

**PART 1--GENERAL**

**1.01 DESCRIPTION**

**A. SCOPE:**

This Section specifies the requirements for the provision and acceptance testing for a complete and operable diesel engine driven generating system, including all devices and equipment specified herein, shown on the drawings, or required for the service. The generation system shall include the following:

1. Diesel Engine-driven generator set
2. Low exhaust emissions
3. Control system
4. Cooling system
5. Fuel supply tank
6. Generator set accessories
7. Mounting system
8. System control and testing
9. Field Testing
10. Diesel particulate filter
10. Permanently installed load bank
11. Testing with load bank

**B. OPERATING REQUIREMENTS:**

The electric power generating system shall have a site capability of what is shown on the contract drawings, unless specified otherwise by the manufacturer. This power will be applied for Standby operation.

**1.02 QUALITY ASSURANCE**

**A. REFERENCES:**

This paragraph references the following documents: ISO 8528 and those listed below. They are part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

References	Title
API Standard 670-76	Noncontacting Vibration and Axial Position Monitoring System with Addenda through January 1984
ASME PTC 17-1973	American Society of Mechanical Engineers, Reciprocating Internal Combustion Engines Performance Test Codes, 1973
NEMA MG-1-89	National Electrical Manufacturers Association Standards Publication Motors and Generators
NFPA 37-1984	National Fire Protection Association Standard 37-1984; Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 110-93 level 1	National Fire Protection Association Standard 110-93; Standard for Emergency and Standby Power Systems
SAE J431-79	Society of Automotive Engineers; Automotive Gray Iron Casting, 1979
SAE J435C-74	Society of Automotive Engineers; Automotive Steel
SAE J438B-70	Society of Automotive Engineers; Tool and Die Steels, 1970
UBC	Uniform Building Code

**B. UNIT RESPONSIBILITY:**

The Contractor shall assign unit responsibility for all the diesel engine driven generating system components to the engine generator manufacturer. Engine - Generator set mounted subassemblies such as cooling system, base, air intake system, fuel system and tank, exhaust outlet fittings and equipment, and generator remote mounted controls shall also be designed, built, and assembled as a complete unit by the engine - generator manufacturer.

**C. DESIGN REQUIREMENTS:**

**1. ENGINE:**

- a. Rating - Engine brake horsepower shall be sufficient to deliver full rated generator set kW/kVA when operated at rated rpm and equipped with all engine-mounted parasitic and external loads such as radiator fans and power generators
- b. Fuel - Diesel engines shall be able to deliver rated power when operating on No. 2 diesel fuel having 35 degree API (60°F) specific gravity.
- c. Fuel consumption - Diesel fuel rates shall be based on fuel having a low heating value (LHV) of 18,390 Btu/lb when used at 85°F and weighing 7.001 lb. /U.S. gal.
- d. Low exhaust emissions – The engine shall be certified to U.S. EPA Nonroad Source Emission Standards, 40 CFR 89, Standby Generators and comply with local Air Quality Management District (AQMD) rules and regulations.

2. GENERATOR:

- a. Voltage dip for motor starting shall not exceed 20% for any individual load step.
- b. Verify the size of the specified generator based on the following parameters and the requirements above:

<u>STEP 1</u>	<u>HP/KVA</u>
Pump 1 (RVSS)	75
Evap. Cooler	7.5
Gen Rm Fan	2
LTG panel	25
<u>STEP 2</u>	
Pump 2 (RVSS)	75
<u>STEP 3</u>	
Pump 3 (VFD-standby)	0
Pump 4 ((RVSS-Future)	75
<u>20% Contingency</u>	<u>52</u>
Total	312

3. ENGINE-GENERATOR:

- a. Start time and load acceptance - Engines shall start, achieve rated voltage and frequency, and be capable of accepting load within 10 seconds when properly equipped and maintained, including block heater.

D. NOISE REQUIREMENTS AND CONTROL:

Mechanical sound level when the generator set is fully loaded shall not exceed 110 dBA when measured at a distance of 5 feet from the generator. The sound level shall not exceed 67 dBA when measured at the site property line adjacent to the residential homes.

E. MANUFACTURER'S QUALIFICATIONS

The complete power generation system, including engine, generator, exhaust system, dual wall fuel tank with leak detection, and electronic control panel, shall be the product of one manufacturer who has been regularly engaged in the production of complete generating systems for at least ten (10) years.

All components shall have been designed to achieve optimum physical and performance compatibility and prototype tested to prove integrated design capability. The complete system shall have been factory fabricated, assembled, and production tested as performed by Caterpillar or approved equal. The naming of a specific manufacturer does not waive any requirements of this specification.

The supplier shall be the engine-generating system manufacturer's authorized local representative, who shall provide initial start-up services. The supplier shall have 24 hour service availability. The supplier shall provide factory-trained technicians who are qualified to perform trouble-shooting and repairs on the system.

F. FACTORY TESTING:

1. Functional tests. Functional testing of the complete power generation system final assembly shall be performed at the generator set manufacturer's factory to assure proper system operation. The engine generator set shall be load tested after the assembly is installed into the enclosure. Engine generator unit shall operate continuously without stoppage for a period of 8 hours. Engine generator shall operate not less than 1/2 hour at each load point at  $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ , and full load, and two hours at 0.8 power factor or greater. If stoppage becomes necessary during this period, the test shall be restarted from the beginning.

2. Prototype test. The system manufacturer must be able to certify that engine, generator and controls have been tested as complete systems in accordance with NFPA 110 of representative engineering models (not on equipment sold).

G. SHIPMENT, HANDLING, AND STORAGE:

The equipment shall be protected during shipment, handling, and storage as specified in the Contract Documents.

1.03 ENVIRONMENTAL CONDITIONS

The engine-generator set manufacturer shall verify that the diesel engine is correctly sized and is capable of driving the generator with all accessories in place and operating, at the generator set kW rating after derating for the range of temperatures expected in service and the altitude of the installation.

1.04 SUBMITTALS

The following submittals shall be made in accordance with the Contract Documents.

1. Manufacturer and manufacturer's type designation.
2. Manufacturer's catalog and/or other data confirming conformance to specific design, material and equipment requirements including:

Engine:

- Type, aspiration, compression ratio, and combustion cycle
- Bore, stroke, displacement, and number of cylinders
- Engine lubricating oil capacity
- Engine coolant capacity without radiator
- Engine coolant capacity with radiator
- Coolant pump external resistance (maximum)
- Coolant pump flow at maximum resistance
- EPA low exhaust emissions compliance certificate
- Exhaust Silencer
- Diesel particulate filter

Generator: Model

Frame  
Insulation class  
Number of leads  
Weight, total  
Weight, rotor  
Air flow

At rated voltage:

Efficiency at 0.8 power factor for:

50% load
75% load
100% load

Time constants, short circuit transient (T'D)  
Time constants, armature short circuit (TA)  
Reactance, sub-transient - direct axis (X''D),  
Reactance, transient- saturated (X'D)  
Reactance, synchronous - direct axis (XD)  
Reactance, negative sequence (X2)  
Reactance, zero sequence (X0)  
Fault current, 3 phase symmetrical  
Decrement curve

Radiator: Model

Type  
Fan drive ratio  
Coolant capacity, radiator  
Coolant capacity, radiator and engine  
Weight, dry  
wet

System: Dimensions:

Length  
Width  
Height  
Weight, dry  
wet

Power rating at 0.8 power factor

kVA rating  
Fuel consumption at standard conditions for:

50 % load
75 % load
100% load

Combustion air inlet flow rate

Exhaust gas, flow rate  
stack temperature  
Exhaust system back pressure (maximum)  
Heat rejection to: coolant  
after cooler  
exhaust  
atmosphere from engine  
atmosphere from generator

Load Bank KW and size

Auxiliary equipment - Specification or data sheets, including electrical equipment and controls, vibration isolators, Diesel particulate filter, and silencer.

3. Drawings - General dimensions drawings showing overall generator set measurements, mounting location, and interconnect points for load leads, fuel, exhaust, cooling and drain lines.
4. Wiring diagrams - Wiring diagrams, schematics and control panel outline drawings published by the manufacturer in Joint Industrial Council (JIC) format for controls and switchgear showing interconnected points and logic diagrams for use by contractor and owner.
5. Warranty - Written warranty from the manufacturer.
6. Service - Location and description of supplier's parts and service facility including parts inventory and number of qualified generator set service personnel.
7. Certified copies of factory test
8. Installation requirements, showing clearances required for maintenance purposes.
9. Thermal wrap. Two copies of factory documentation on the material being used shall be submitted for verify compliance with this specification.
10. Submit the generator sizing calculation per paragraph 1.02C (2)(b).
11. Operations and maintenance information in accordance with paragraph 2.14.

12. Earthquake Design Data. Submit with the shop drawings complete seismic calculations, details of construction, and method of attachment for generator set mounting to base and for anchor bolts for anchoring base to concrete slab. The calculations and details shall be signed by a Professional Engineer who has demonstrated proficiency in Structural Engineering or Civil Engineering and is registered in the State of California. Mounting system shall be capable of withstanding earthquake forces of seismic zone 4 in accordance with the Uniform Building Code, latest edition.

#### 1.05 SERVICE AND WARRANTY

The manufacturer shall have a local authorized dealer who can provide factory trained servicemen, the required stock of replacement parts, technical assistance, and warranty administration.

##### A. PROXIMITY TO JOB SITE

The manufacturer's authorized dealer shall have a parts and service facility within 75 miles of the job site.

##### B. WARRANTY ADMINISTRATION

The manufacturer's authorized dealer shall be capable of administering the manufacturer's and dealer's warranty for all components supplied by the selling dealer, including but not limited to the genset system, Diesel particulate Filter, and resistive load bank (who may or may not be the same as the servicing dealer).

##### C. WARRANTY TERMS

The manufacturer's and dealer's extended comprehensive warranty shall in no event be for a period of less than five years from date of initial start-up of the system or 1,500 operating hours, whichever comes first. It shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Applicable deductible costs shall be specified in the manufacturer's warranty. Submittals received without written warranties as specified will be rejected in their entirety.



D. WARRANTY NAMEPLATE

A warranty nameplate of not less than 6 inch by 8 inch must be affixed to the generator set with the following data:

Warranty Period:

Start-up Date:

Termination Date:

Supplier Name:

Supplier Address:

24-Hour Emergency Number:

Preventive maintenance to be performed by:

E. PARTS AVAILABILITY

The generator set supplier shall guarantee 100 percent parts availability within 48 hours from the time an order is entered with the dealer.

1.05 PERMITS

Contractor shall obtain and pay for all permits, licenses, and inspections required for electrical construction work by public agencies, utility companies having jurisdiction, and the South Coast Air Quality Management District.

AIR QUALITY PERMIT ADVISORY. Contractor shall be advised of the following potential conditions relative to securing permits to construct from the South Coast Air Quality Management District (SCAQMD). Contractor shall be solely responsible for verifying the permitting process, obtaining all permits, required emissions controls, and all other permitting issues. The following information is presented only to inform the Contractor about the potential permitting procedure and potential requirements.

- Permit(s) to construct is required from the SCAQMD before construction of a new emitting device can commence.
- Contractor shall make timely application for such permit(s).
- Contractor is responsible for scheduling but shall be advised that the SCAQMD may require up to 180 calendar days (typically 90) to issue a permit to construct after an application is filed.
- SCAQMD may require emission controls that are equivalent to “Best Available Control Technology” (BACT) and Rule 1303 Requirements for any new equipment that is not already permitted.
- SCAQMD may require stringent emission controls for new emissions units. The Contractor is advised to diligently determine the emission controls required, and to

guarantee that the emission levels required by SCAQMD and the permit shall be met by the equipment provided by the Contractor.

- The Contractor is advised to consult with SCAQMD personnel to clarify all issues.
- The Contractor shall provide the permit application to EMWD for the records. EMWD shall be listed as the owner/operator on the permits associated with permitting.

## PART 2--PRODUCTS

### 2.01 ACCEPTABLE PRODUCTS

The following equipment shall be manufacturer's standard production model. The engine generator shall be "pre-certified/pre-approved" by AQMD for emergency power service and modified as necessary to provide the specified features and to meet specified operating conditions. The Tier rating shall be in accordance with EPA Tier Certification Requirements. There are no equals.

Equipment	Manufacturer
Engine-generator	Caterpillar, Generac, Cummins, (no equal)
Thermal Wrap	Advanced Thermal Products, Inc.

### 2.02 ENGINE

The engine shall be a stationary, liquid cooled, 1800 rpm, four cycle design, direct injection engine with forged steel crankshaft and connecting rods. The cylinder block shall be cast iron with replaceable wet liners and have four valves per cylinder. Design shall be not less than 6 cylinders, turbocharged and after-cooled. Engine shall not be manufactured with any Class I ozone depleting substances (ODS) as defined by Federal Register Vol. 57 No. 86.

### 2.03 ENGINE EQUIPMENT

The engine shall be equipped with manufacturers standard air filters, fuel filters, pressure gauges, lubricating oil cooler, filters, and pressure gauge, water pump and temperature gauge, service hour meter, flywheel, and flywheel housing when applicable.

The engine must be a certified CI engine that meets the following standards:

1. 0.15 g/bhp-hr or less PM emission standard.
2. Emission standards specified in AQMD Rule 1470 for other pollutants.

## 2.04 FUEL SYSTEM

### A. FUEL/WATER SEPARATOR

A Raycor fuel/water separator shall be provided to protect the fuel system from water damage.

### B. FUEL LINES

Flexible fuel lines between engine and fuel supply shall be provided to isolate vibration.

### C. FUEL SYSTEM MAINTENANCE

The fuel transfer pump, injection pumps, rack and pinion assembly, and timing mechanism shall be maintenance and adjustment free for the life of the equipment. The fuel filter shall not require changing more frequently than once per year or every 250 hours, whichever comes first. Fuel/water separators shall not require draining more frequently than once per week

### D. REMOTE FUEL FILL STATION

Fill station shall be Pryco Inc. remote fill station or equal. Station shall include NEMA 4X dual compartment enclosure with separate electrical compartment which shall accept 120 - 240 volt AC single phase input and separate fueling compartment. Electrical compartment shall include input contacts for visual and audible alarm for 90% and 95% diesel tank fill levels. Fill system shall include 2" cam-and-groove connector, check valve and manual isolation valve. Fill compartment shall act as containment are for spills while filling and will include a lockable drain valve.

## 2.05 GOVERNOR

### A. GENERAL

The engine governor shall control engine speed and transient load response within commercial and ISO 8528 tolerances. It shall be selected, installed, and tested by the generator set manufacturer. The Engine shall have pre-lubed pump that runs in all test and exercise modes prior to startup of motor.

### B. SPEED CONTROL

The engine governor shall be an electronic speed control with 24 volt DC Electric Actuator. Speed droop shall be 0 (isochronous) from no load to full rated load. Steady

state frequency regulation shall be +/-0.25%. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

## 2.06 COOLING SYSTEM

### A. GENERAL

The engine jacket water cooling system shall be a closed circuit design with provision for filling, expansion, and deaeration.

The cooling pump shall be driven by the engine. Auxiliary coolant pumps required for heat exchangers or separate circuit aftercooling shall also be engine driven. The cooling system shall tolerate at least 172 kPa (25 PSI) static head. Coolant temperature shall be internally regulated to disconnect external cooling systems until operating temperature is achieved.

### B. RADIATOR, ENGINE MOUNTED

Heat rejected to the engine jacket water shall be discharged to the atmosphere through a close coupled radiator. The generator set shall be installed in a noise suppressed enclosure and have a 30% antifreeze/coolant mixture. The radiator shall cool the jacket water while the engine is operating at full site capability and 0.25 H<sub>2</sub>O external air restrictions.

Additional restriction affecting air flow shall not limit the radiator's capability to adequately cool at maximum site temperature.

Air Flow Minimum Rated: Per manufacturer and adequate for Amb Cap of 125°F at connected load.

### C. FAN AND BELT GUARDING

The fan, fan drive, and fan belts shall be covered with 14 gauge punched steel mesh guarding for personnel protection. The guarding shall conform to IEC 34-5, ISO and OSHA standards.

### D. BLOWER FAN

The radiator cooling fan shall be a blower type driven from the engine. Air shall be drawn from the engine side and exhausted through the radiator core.

E. INLET AIR SYSTEM

The engine air cleaner shall be engine mounted with dry element requiring replacement no more frequently than 250 operating hours or once each year. If external ducting is required, maximum restriction to the combustion air inlet shall not exceed manufacturer's requirements.

2.07 LUBRICATION SYSTEM

A. GENERAL

The engine shall be of the wet sump type, provided with a full pressure lubricating oil system arranged to distribute oil to all moving parts of the engine. The lubricating oil pump shall be of the positive displacement type and shall be gear-driven from the engine crankshaft or camshaft. The pump shall have ample capacity to circulate the amount of lubricating and cooling oil required by the engine at all operating speeds.

B. OIL FILTER

A full flow filter shall be provided. A built-in pressure relief bypass complete with pressure actuated valve and capable of conveying the maximum rate of oil flow shall be provided around each oil filter.

C. OIL COOLER

The engine shall be equipped with a lubricating oil cooler, sized to cool the oil as recommended by the manufacturer. Aftercooler water shall be circulated through the water side of the oil cooler.

2.08 EXHAUST SYSTEM

A. GENERAL

The engine exhaust system shall be installed to discharge combustion gases quickly and silently with minimum restriction. System including particulate filter and silencer shall be designed for minimum restriction, without excessive back pressure.

Stainless steel piping shall be used, with radii of 90° bends at least 1 1/2 times the pipe diameter. Piping shall be installed with 9 in minimum clearance from combustible material or incorporate appropriate insulation and shielding. Provide a stainless steel flexible connection between the engine, exhaust piping, and wall thimble. Provide isolation of dissimilar metals if/where required.

Piping shall be supported and braced to prevent weight or thermal growth being transferred to the engine and flexible expansion fittings provided to accommodate thermal growth. Support dampers and springs shall be included where necessary to isolate vibration.

Long runs of pipe shall be pitched away from the engine and water traps installed at the lowest point. Exhaust stacks shall be extended to avoid nuisance fumes and odors, and outlets to a chimney with a vent cap.

**B. DIESEL PARTICULATE FILTER/SILENCER- SUPER CRITICAL(HOSPITAL)**

The silencer shall provide extreme noise attenuation for environments with low background noise and slight noise emissions would be objectionable.

Standby diesel generator shall be furnished with a passive type diesel particulate filter (DPF) which shall meet the following:

1. Shall be manufactured by Johnson Matthey, Miratech, or equal.
2. Should be at least a California Air Resources Board (CARB) Level 3 Verified with a particulate matter (PM) reduction greater than 85%
3. The CARB Executive order for the DFP should either list compatibility to the generator engine family name or approval shall be granted by the AQMD.
4. Suitable for horizontal mounting with flanged inlets and outlets.
5. Filter access hatch shall be located on the side of the DPF facing towards the front or side of generator to allow accessibility and maintenance of the filters in reference to contract drawings.
6. Housing shall be stainless steel.
7. CARB verified Diagnostic Module to continuously monitor temperature and backpressure. Diagnostic Module shall have LED visual indication and dry contact customer alarms for when backpressure or Temperature exceeds normal operating conditions.
8. DPF alarm system that will work in conjunction with the Diagnostic Module to remotely alarm when cleaning of the DPF is required.
9. Diagnostic module and DPF Alarm system shall be mounted with the generator control panel. power supply and associated control and monitoring signals shall be wired to the generator control panel.

10. At a minimum the following normally open contacts shall be provided for monitoring the particulate filter:
  - a. Cleaning is required
  - b. High Pressure alarm
  - c. High Temperature alarm
11. DPF monitors shall be provided with an Ethernet port connection to support alarm programming, trouble shooting, and downloading data.

Back pressure must not exceed 90% of engine manufacturer's specification and shall be coordinated with other exhaust system components (e.g. DPF, silencers, piping, etc.)

#### C. WALL THIMBLE

A NFPA 37 and 110 compliant factory-built ventilated wall thimble rated for 1250 °F shall be provided. The wall thimble shall include rainguard and a clamp. The thimble shall be GT Exhaust System Inc., Model 20-1-1600, or equal.

#### D. NOISE LEVEL

Mechanical sound level when the generator set is fully loaded shall not exceed 110 dBA when measured at a distance of 5 feet from the generator. The sound level shall not exceed 67 dBA when measured at the site property line adjacent to the residential homes.

#### E. EMISSIONS

Generator set shall be pre-certified by the local AQMD and meet the requirements outlined in SCAQMD Rule 1470.

### 2.09 THERMAL WRAP

#### A. GENERAL

Specified thermal wrap is for the purpose of insulating the hot surfaces on generator engines for personnel and structure safety. These surfaces are: turbocharger; exhaust manifold; exhaust pipe and pipe flanges from the generator to silencer. This shall protect personnel and structure.

The thermal wrap shall consist of, but not limited to, the following materials in layers:

1. Outer fiberglass cloth.
2. One (1) inch fiberglass mat.
3. Stainless steel mesh liner on interior surface.
4. Lashing hooks.
5. Stainless steel mechanical wire for lashing.
6. Velcro strips sewn on for fastening open seam.

#### B. MATERIAL

Outer fiberglass cloth - The cloth shall be silicone impregnated with a specially formulated silicone rubber designed to meet rigid requirements of the Military Specification, MIL-Y-1140C. This special high temperature, flame retardant silicone rubber provides greater life and improved resistance to abrasion, flexing, tear and puncture. Silicone coated cloth is unacceptable.

1.	Weight	34 oz/sq yd, ( $\pm 10\%$ )
2.	Thickness	.037 inches
3.	Tensile strength Method Warp Fill	FED STD 191/5102 225 lbs/inch avg 200 lbs/inch avg
4.	Tear strength Method Warp Fill	FED STD 191/5136 35# minimum average 35# minimum average
5.	Burst strength Method Result	ASTM-D-774 450 PSI minimum
6.	Base fabric and weave	Fiberglass, satin weave
7.	Color and coating	Silver aluminum
8.	Temperature resistance	-67 to 500°F
9.	Flame resistance Method	FED STD 191-5903.2



Flame out	5 seconds
Afterglow	10 seconds
Char length	1-inch

### C. FIBERGLASS INSULATION

Fiberglass mat shall be noncombustible, nonalkaline, chemically stable, and resist corrosion. Fiberglass mat shall meet Military Specification MIL-1-16411-E and Navy certifiable MIL-1-24244. The mat blanket shall be made of long textile chopped fibers, no binders, high density and strong physical properties in applications up to 1,200°F.

#### 1. Thermal conductivity

300°F at 0.27 BTU/in/hr/ft sq/degree F  
 500°F at 0.41 BTU/in/hr/ft sq/degree F  
 700°F at 0.52 BTU/in/hr/ft sq/degree F

#### 2. Tensile strength (avg.)

Parallel to roll	14.7 psi
Across roll	15.3 psi

#### 3. Weight

Half (1/2) inch 6 ozs. (±10%) per sq. ft. nominal  
 One (1) inch 12 ozs. (±10%) per sq. ft. nominal

#### 4. Size of fiber

Average fiber diameter  
 0.00035 inches

#### 5. Fusion temperature

No fusion or melting at  
 1,300°F

#### 6. Alkalinity

Less than 0.20%

#### 7. Stability

No physical change after being subjected to saturated steam at 225 lbs. for 16 hours.

#### 8. Resistance to vibration

Excellent

Stainless steel mesh liner on interior surface - A woven stainless steel mesh liner shall be sewn in as an integral interior part of the flexible and removable thermal blanket. The mesh liner is the part of the blanket which comes in contact with the superheated exhaust piping and manifold.

#### D. EXECUTION

Exhaust piping and manifold - All edges of the thermal blanket are to be machine stitched. Permanently mounted stainless steel hooks (binding hooks) as fasteners shall also be fixed to edges for binding blanket edges together. This is to allow for easy removal and replacement of the thermal blanket without destroying the blanket during maintenance and/or repair of the engine. Stainless steel mechanical wire shall be provided as a part of the package. Use of "hot rings" is unacceptable for binding edges or securing blankets.

### 2.10 GENERATOR SYSTEM

#### A. GENERATOR

The AC generator shall be synchronous, four pole, revolving field, single pre-lubricated bearing, air cooled by a direct drive centrifugal blower fan, and directly coupled to the engine with flexible drive discs. The armature shall have skewed laminations of insulated electrical grade steel, two-thirds pitch windings. The rotor shall have amortisseur (damper) windings of layer-wound, mechanically-wedged winding construction. The rotor shall be dynamically balanced. The exciter shall be brushless, three phase, with full wave silicon diodes mounted on the rotating shaft and a surge suppressor connected in parallel with the field winding. Field discharge resistors shall not be acceptable. The regulator shall be digital. Generator shall have permanent magnet excitation power.

AC output leads shall be brought out to field connection bus bars accessible through removable plates on either side of the sheet metal output box.

Insulation system components shall meet NEMA MG1 temperature limits for a Class H insulation system. Actual temperature rise measured by resistance method shall not exceed 125 degrees Centigrade to provide additional allowance for internal hot spots. The generator and exciter insulation systems shall be suitably impregnated for operation in severe environments for resistance to sand and other air-borne contaminants.

## B. EXCITER

A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear loads on the generator. The PMG shall sustain field excitation power for optimum motor starting and shall sustain short circuit current for selective operation and coordination of system overcurrent devices.

## C. VOLTAGE REGULATOR

The automatic voltage regulator shall be temperature compensated, digitally controlled pulse width modulated solid -state design, and include overvoltage and overcurrent protection functions. The automatic voltage regulator shall be equipped with three phase rms sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and to limit overshoot. Overvoltage protection shall sense AC generator output voltage, In the event of regulator failure or loss of reference, the regulator shall shut down its output on a sustained overvoltage of one second duration. Over excitation protection shall sense regulator output and shut down its output if overload exceeds ten seconds duration. Both overvoltage and over excitation protection shall be latched, requiring the AC generator to be stopped for reset.

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

Generator output voltage drift no more than +/-0.5% of rated value at constant temperature.

Generator output voltage drift no more than +/-2% of rated value over ambient operating temperature range of 0°C to 50°C.

Telephone Influence Factor (TIF) of less than 50.

Electric Interference/Radio Frequency Interference (EMI/RFI) suppressed to commercial standards.

## D. CIRCUIT BREAKER

The circuit breaker shall be mounted and connected in a guarded drip proof freestanding enclosure meeting NEMA 1, IP 22 and IEC 144 requirements. Cable lugs shall be provided for customer connections. Provide the following:

1 - Molded case circuit breaker 600 Amp frame, 3-pole, single-throw, 100% rated, stationary-mounted with manual operating handle, ground fault circuit interruption overload and short circuit trips, complete with cable lugs. Breaker shall be equipped with a 3-phase, solid state, selective trip device with adjustable long-time pickup and delay, adjustable short-time pickup and delay, and adjustable ground fault pickup and delay trip features. The breaker shall be qualified for 600 volt operation and tested in accordance with UL Standard 489.

1 - Shunt trip, 24 volt DC, on circuit breaker wired to terminal board.

3 - Current transformers, 5 ampere secondary.

1 - Ground connection point.

## 2.11 STARTING SYSTEM

### A. GENERAL

The engine starting system shall include 24 volt DC starting motor(s), starter relay, and automatic reset circuit breaker to protect against butt engagement. Required cables will be furnished and sized to satisfy circuit requirements. The system shall be capable of starting a properly equipped engine within 10 seconds at ambient temperatures greater than 70°F with jacket water heater.

### B. WATER JACKET HEATER

Jacket water heater(s) shall be provided to maintain coolant temperature of 90°F while the engine is idle. Heaters shall be rated 1500 watts at 240 volt AC single phase power and include thermostatic controls.

### C. BATTERIES

Batteries for starting and control shall be selected and supplied by the generator set manufacturer. They shall be a heavy duty SLI lead acid type with thru-partition connectors, mounted near the starting motor. Batteries shall be housed in a hard rubber or polypropylene case with provision for venting, mounted on a corrosion resistant or coated steel battery rack.

Starting batteries shall be rated 24 volt DC with a minimum of 210 ampere-hour with 1,250 cranking amps. Sizing shall consider specific application requirements of engine oil viscosity, ambient starting temperature, control voltage, overcharging and vibration.

Batteries shall be located as close to the starting motor as practical, away from spark sources, and permit easy inspection and maintenance.

The battery shall be guaranteed by the manufacturer on a pro-rated basis for 20 years and shall deliver no less than 80 percent of its rated capacity for the full 20 year warranty period.

#### D. ALTERNATOR

An engine mounted belt driven battery charging alternator shall be installed with an automatic voltage regulator. It shall be suitable for heavy duty applications with a rating of 24 volts, 45 amperes minimum.

#### E. BATTERY CHARGER

A skid mounted dual rate 10 ampere battery charger shall be provided which shall accept 120 - 240 volt AC single phase input to provide 24 volt DC output. It shall be fused on the AC input and DC output and incorporate current limiting circuitry to avoid the need for a crank disconnect relay. An AC voltage power switch shall be mounted on the face of the charger and shielded from accidental switching. The charger shall include an AC ammeter and voltmeter, a failure malfunction alarm switch, a low battery alarm switch, and be housed in a NEMA 1 enclosure. The charger shall be rated for operation at plus 50°C ambient. Charger voltage regulator shall be temperature compensated.

### 2.12 FUEL STORAGE

Provide a dual wall 24-hour (full-load) sub-base fuel tank not exceeding 660 gallons capacity. It shall be equipped with the necessary openings including: fill, vent (extend vent to building exterior), gauges, fill and return openings. The tank shall be double wall design specifically for generator set mounting, 12 gauge steel bottom and baffles, 7 gauge top and side channel supports, and 1 inch vent fitting through the roof with flame arrestor; shall be UL listed double wall construction for secondary containment with generator base tank primed and finished in enamel. Provide a remote annunciation low level switch and double wall tank leak switch for a remote alarm to the SCADA system. Provide a 90% and 95% high level alarm switch to connect to the remote fill station. Provide a high level alarm switch when the fuel level is beyond a preset level (normally 102%). Provide a red alarm light on the control panel that activates when the switch is activated.

### 2.13 CONTROLS

#### A. CONTROLS-GENERATOR

The control panel shall be designed and built by the engine-generator manufacturer. It shall be mounted with the generator and incorporate 100% solid state microprocessor based control circuitry, sealed dust tight, watertight modular components with metal housings, and digital instrumentation. The panel shall be labeled with ISO symbols and comply with IEC 144, IP 22, and NEMA 12 for external environmental resistance, and IP 44 and NEMA 12 for resistance of the internal sealed modules.

The panel shall be labeled with ISO symbols and include the following equipment:  
Generator AC output metering devices: Displays for volts, hertz, and amps in a single environmentally sealed module. Numeral height shall be 0.5 in. with not less than 0.5% accuracy true RMS throughout a temperature range of -40° to +70°C. Distorted generator output voltage waveform of a crest factor less than 5 shall not affect metering accuracy. Panel shall be installed so that the top of the panel shall not exceed 72" from the bottom of the sub base fuel tank/floor.

#### B. ENGINE MONITORING DEVICES

Display of operating hours, engine RPM, battery DC volts, oil pressure, and jacket water temperature. A momentary switch shall be provided to continuously display a selected operating parameter. The display shall annunciate fault shutdowns, cycle programming, and diagnostic codes for troubleshooting. Engine monitoring signals provided by engine mounted lubricating oil pressure and coolant temperature transducers shall be communicated over a serial data link through a Data Sending Unit (DSU) to the panel control module. The safety logic shall shut the engine down if the serial data link is lost.

Diagnostic Module and DPF alarm system shall be provided to monitor the exhaust temperature and back pressure of the diesel particulate filter (DPF). DPF monitors shall be installed on the of side of the generator control panel. Output signals from the DPF monitors shall be connected to the generator control panel for remote monitoring.

#### C. CONTROLS

Generator voltage level rheostat and ammeter/voltmeter phase selector switch shall be mounted on the panel door. The engine start-stop switch shall be door mounted and include positions for off/reset, run/start, stop, and automatic mode.

Start-stop logic shall have provisions for cycle cranking and cool down operation.

Shutdowns/annunciation: The generator set shall shut down and red flashing LEDs shall signal operational faults of high water temperature, low oil pressure,--over crank, and over speed.

Safety devices: ISO red emergency stop pushbutton shall be provided, and all controls, annunciation, and monitors labeled with ISO symbols.

#### D. CONTROL WIRING

Control wiring from the generator shall be No. 16 min AWG stranded wire, 90°C 600 VAC insulation, UL and CSA listed. Wire identification shall be located on the wire 6.35 in. from the terminal, while routing shall avoid sharp edges. Control panel ground wire shall be 12 AGW with green and yellow striped insulation rated 90°C 600 VAC UL and CSA listed. Wire shall be labeled "GND" and have a ring terminal sized for a 10-32 screw.

#### E. ALARM AND SHUTDOWN CONDITIONS

Indicate the following alarm and shutdown conditions; provide RESET switch to clear fault:

1.	Low oil pressure	pre-alarm
2.	High engine temperature	pre-alarm
3.	Low engine temperature	pre-alarm
4.	Low fuel	pre-alarm
5.	Battery charger fail	alarm
6.	Low DC voltage	alarm
7.	Circuit breaker (trip or off)	alarm
8.	Generator overload	alarm
9.	Low oil pressure	shutdown
10.	High engine temperature	shutdown
11.	Low coolant level	shutdown
12.	Overcrank	shutdown
13.	Overspeed	shutdown
14.	Overvoltage	shutdown
15.	Undervoltage	shutdown
16.	Underfrequency	shutdown
17.	Spare (1)	alarm or shutdown
18.	DPF high pressure	alarm
19.	DPF high temperature	alarm
20.	DPF cleaning Required	alarm

#### F. METERING

Metering shall be RMS indicating, 0.5% accuracy, digital.

1. Voltmeter
2. Ammeter
3. Frequency meter
4. Phase select switch
5. Running time

#### G. ALARM MODULE

A solid state microprocessor alarm module shall be included in the panel and include red and yellow flashing LEDs and silencable alarm horn to annunciate alarm conditions for low oil pressure, high water temperature, and low system DC voltage. The horn shall resound on subsequent alarms after silencing/acknowledgment, with the flashing LED displaying a solid light until the condition is corrected. It shall provide similar annunciation for remote contactors sensing low oil level, low coolant level, and one optional condition. A dry set of contacts rated at 2 amps shall be provided for remote customer monitoring of RUNNING status, TROUBLE alarm, HIGH EXHAUST BACKPRESSURE alarm, HIGH EXHAUST TEMP alarm, and CLEAN FILTER warning.

#### 2.14 LOAD BANK

Provide a radiator mounted resistive load bank.

1. Provide load bank per the requirements of the National Fire Protection Association (NFPA) for emergency stand-by power systems.
2. Local and remote controls
3. Indicating lights: Normal operation and cooling feature
4. Branch circuit contactors each step or each 50kw circuit max
5. Full rated copper bus bar with oversized terminal junction box
6. Radiator mounted – galvanized steel construction.
7. Coordinate size of load bank with generator and DPF manufacturers. Load bank minimum size of 150kw.
8. 480v, 3-phase, 60hz

#### 2.15 PRODUCT DATA

The following information shall be provided:

1. Certified factory test.



2. Operation and maintenance information as specified in 01430. In addition, the following:
  - a. Operating instructions - with description and illustration of all indicators and engine and generator controls.
  - b. Parts books - that illustrate and list all assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts, washers, etc.).
  - c. Preventative maintenance instructions - on the complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include a complete lubrication chart.
  - d. Routine test procedures - for all electronic and electrical circuits and for the main AC generator.
  - e. Troubleshooting chart - covering the complete generator set showing description of trouble, probable cause, and suggested remedy.
  - f. Recommended spare parts list - showing all consumables anticipated to be required during routine maintenance and test.
  - g. Wiring diagrams and schematics - showing function of all electrical components.

All manuals and books described above shall be contained in rigid plastic pouches.

3. Installation certification Form 11000-A specified in paragraph 11562-3.
4. Training certification Form 11000-B specified in paragraph 11562-3.02.

### PART 3--EXECUTION

The Generating System shall be installed and connected in accordance with manufacturer's recommendations. Installation shall be certified on Form 11000-A as specified in Section 01999.

#### 3.01 FIELD INSPECTION AND TESTING

A. PREDELIVERY INSPECTION

A predelivery inspection must be performed by the system manufacturers' local dealer at the dealer's facility to insure no damage occurred in transit and all genset components, controls, and switch gear are included as specified herein.

B. PREDELIVERY TESTING

Prior to delivery and acceptance, the generator set shall be tested to show it is free of any defects and will start automatically and carry full load. This testing shall be performed at the facility of the system manufacturer's authorized supplier.

The testing shall be done on dry type, resistive load banks capable of definite and precise incremental loading. Salt water brine tanks or load banks requiring water as a source of cooling will not be allowed.

The load banks shall not be dependent on the generator control instruments to read amperage and voltage on each phase. Rather, the test instrumentation will serve as a check of the generator set meters.

Load bank testing shall be done in the presence of the Owner's Construction Manager or his appointed representative. Testing shall be for a minimum of two (2) hours under full load.

All consumables necessary for testing shall be furnished by the bidder. Any defects which become evident during the test shall be corrected by the bidder at no additional cost to the District prior to shipment to the job site.

C. PREDELIVERY TESTING PROCEDURE

A "start and test" shall be performed by factory trained technicians. All test equipment, facilities and personnel shall be provided by the supplier. Owner representatives shall be invited to witness all tests. The test shall be performed on the complete fabricated generator set within sound attenuated enclosure.

1. Check all electrical exhaust, fuel and water connections for proper size, continuity and tightness of fittings. Check out all fluids for appropriate levels. Check jacket water heater if operational. Start-up engine and make an initial start-up check of all operational equipment. Upon completion of initial start-up and system checkout, the supplier of the generator set shall perform a field test, with the Construction Manager

notified in advance, to demonstrate load carrying capability, stability, voltage and frequency.

2. Connect a load bank equivalent to at least 100 percent of the nameplate rating at unity power factor.
3. The generator set shall be run for 1 1/2 hours during first initial run for proper engine break-in, (1/2-hour no-load, 1/2-hour at 50 percent rated load, 1/2-hour at 75 percent load) then 100 percent for 2 hours. The test period shall extend until oil and water temperatures have stabilized for a period not less than 30 minutes. Records shall be maintained throughout this period at fifteen minute intervals to record water temperature, fuel pressure, oil pressure, ambient air temperature, voltage, amperage, frequency, kilowatts and power factor.
4. Test all safety devices using methods recommended by the manufacturer.
5. Test results shall be documented and forwarded for approval.
6. There shall be a 10-minute unloaded run at the conclusion of the test to allow engine to cool before shutdown.

D. POST-INSTALLATION TESTING

Following installation, the following tests shall be performed by the system manufacturer's qualified representative(s) in the presence of the owner's representative.

Prestart Checks:

- Oil level
- Water level
- Day tank fuel level
- Battery connection and charge condition
- Engine to control interconnects
- Engine generator intake/exhaust obstructions
- Engine room ventilation obstructions
- Removal of all packing materials

E. FIELD TEST

The Contractor shall provide all fuel for the tests. After the tests are complete the Contractor shall fill the fuel storage tank to 100% full. A "start and test" shall be performed by factory trained technicians. All test equipment, facilities and personnel shall be provided by the supplier. Owner representatives shall be invited to witness the following tests(s). There is a high school about 0.5 miles away from the pump station. Field testing shall not take place when school is in session. All field start-up and operational testing shall take place on the weekend, or outside the school day hours of 7:30 am to 3:30 pm on week days that school is in session.

1. Check all electrical exhaust, fuel and water connections for proper size, continuity and tightness of fittings. Check out all fluids for appropriate levels. Check jacket water heater if operational. Start-up engine and make an initial start-up check of all operational equipment. Upon completion of initial start-up and system checkout, perform a field test, with the Owner notified in advance, to demonstrate load carrying capability, stability, voltage and frequency.
2. The generator set shall be run for 1~hour during first initial run for proper engine break-in. Records shall be maintained throughout this period at five minute intervals to record water temperature, fuel pressure, oil pressure, ambient air temperature, voltage, amperage, frequency, kilowatts, and power factor. Testing shall meet requirements
3. Return to normal power source.
4. With prime mover in "Remote Start" condition and utilizing the building load, simulate failure of the normal power source by opening all breakers and switches.
5. Run the generator for one (1) hour running the intended site load; the test period shall extend until oil and water temperatures have stabilized for a period not less than 30 minutes. Observe occurrences and record readings every fifteen (15) minutes as in 2 above.
6. Test all safety devices using methods recommended by the manufacturer.
7. Measure noise level at the middle and both ends of the two residential wall segments.

8. There shall be a 10-minute unloaded run at the conclusion of the test to allow engine to cool before shutdown.
9. Test results shall be documented and submitted for approval.
10. Non-emergency generator start-up or operation will NOT be allowed from 7:30 am to 3:30 pm on days school is in session.

### 3.02 TRAINING

The Contractor shall cause the generating system manufacturer, as part of the commissioning services, to provide not less than 16 hours of on-the-job training. Training shall include the requirements of Section 01664 and the following:

1. Diesel Engine theory
2. AC Generator theory
3. General operational information for the specific equipment provided under this section.
4. Troubleshooting.
5. Operation of the equipment in automatic and manual modes.
6. Routine maintenance.

Training shall be certified on Form 11000-B as specified in Section 01999.

**END OF SECTION 11562**