SECTION 16620

permanent standby engine-generators

# GENERAL

## DESCRIPTION

### Furnish one standby power generator set complete with all appurtenances as indicated, specified, or required for a complete package. Engine generator set shall be EPA certified. The unit shall have a double walled fuel tank meeting the requirements of UL 142.

### Furnish standby power generator set complete with Level 2 sound attenuating, weatherproof rodent proof enclosure, and all appurtenances as indicated, specified, or required for a complete package. Engine generator set shall be EPA Tier 4 certified. The unit shall have a double walled fuel tank meeting the requirements of UL 142.

## RELATED WORK SPECIFIED ELSEWHERE

### Section 16010: General Electrical Requirements.

### Section 16250: Automatic Transfer Switch.

### Section 16938: Power System Study.

## STANDARDS

### Construct equipment in accordance with the applicable requirements of the following standards:

#### National Electrical Code (NEC).

#### American National Standards Institute (ANSI).

#### National Electrical Manufacturers Association (NEMA).

#### Institute of Electrical and Electronic Engineers (IEEE).

#### Insulated Cable Engineers Association (ICEA).

#### American Society for Testing and Materials (ASTM).

#### Underwriters’ Laboratories, Inc. (UL).

## SUBMITTALS

### Submit shop drawings in accordance with the General Conditions.

### Submit shop and installation drawings and catalog data for the following equipment. Show applicable ratings, sizes, materials, manufacturers and part numbers, and overall dimensions and weights.

#### Itemized bill of material.

#### Engine.

#### Seismic Anchorage.

#### Generator.

#### Silencer.

#### Control panel.

#### Battery charger.

#### Batteries.

#### Jacket water heater.

*Include load bank only for sewage lift stations.*

#### Sound attenuation enclosure.

#### Base fuel tank

#### Particulate Filter

### Submit system schematic diagram showing all piping and wiring interconnections with sizes and quantities. Submit ladder-type schematic electrical diagrams with legend identifying all devices on diagrams.

### Submit installation fact sheet giving fuel, coolant, lubricating oil, and exhaust and ventilation requirements.

### Submit torsional vibration analysis.

### Submit factory test report including sound levels and exhaust emissions.

### Submit a start-up inspection report signed by the engine manufacturer’s authorized field service representative.

### Obtain construction and operating permits from the South Coast Air Quality Management DISTRICT on behalf of the DISTRICT. Submit copy of complete application prepared by the Contractor and original of permits to DISTRICT. All costs associated with permit application including fee shall be paid for by the Contractor.

### Provide an information copy of the standard engine inspection and maintenance service contract. The contract shall be for the complete system including all auxiliary support systems.

### Submit two hard copies of operation and maintenance manuals and one soft copy on CD.

### Submit structural calculations to certify anchoring requirements for the genset. Calculations shall be done by a California registered engineer.

### All functions and features identified in this specification are to be provided regardless of if they are a standard of the manufacturer. Acceptance of any submittal where required items were not included does not alleviate the Contractor from the need to provide the items per plans and specifications.

## O&M MANUAL

* 1. Upon engine-generator delivery, submit operation and maintenance manuals describing the equipment including the following:

#### Project-specific layout drawings of components specified.

#### Project-specific narrative and tables for the following:

##### Replacement parts list.

##### Lubrication (each type, location, and frequency).

##### Common problems and troubleshooting.

##### Personnel safety/issues.

##### Listing of low-normal-high levels for all fluids, pressures, and temperatures.

##### Control panel and instruments.

#### Control schematics, ladder diagrams, and interconnection drawings.

#### Catalog cuts and technical manuals for system components.

#### Copy of guarantees and warranties issued for the various items of equipment, showing dates of expiration.

#### Copies of test results.

#### Information copy of the standard engine inspection and maintenance service contract as described above. Service contract shall cover the complete system, including all auxiliary support systems.

#### Marked tab dividers for each of the following sections:

##### List of equipment furnished for project with name, address, and telephone number of vendor.

##### List of serial numbers of equipment furnished.

##### A copy of shop drawings for mechanical, electrical, and instrument equipment in final form.

##### Manufacturer's operation and maintenance instructions and parts lists.

#### Documentation of permit to operate for the air quality management DISTRICT.

#### Line out nonapplicable text and illustrations. The section of the manual on operation shall describe the functions and limitations of each component and its relationship to the system of which it is a part. Where several models, options, or styles are described, the manual shall identify the items actually provided.

#### Provide complete operating and maintenance instructions for each item of equipment, setting forth a detailed, step-by-step procedure for starting, stopping, operating, and maintaining the entire system as installed. Include a schedule of recommended maintenance intervals.

## MANUFACTURER’S SERVICES

### Provide equipment manufacturer’s services at the jobsite for the minimum man-days listed below, travel time excluded:

### Two man-days to check the installation and advise during start-up, testing, and adjustment of the equipment and to instruct the DISTRICT’s personnel in the operation and maintenance of the equipment. Submit operation and maintenance manuals prior to this instruction.

### Written certification, in a form approved by the DISTRICT, shall be provided by the equipment manufacturer or his authorized representative. This certification shall verify:

#### That the equipment and its installation has been inspected on the job by the manufacturer and that the equipment is in first-class condition throughout, has been installed in accordance with manufacturer’s requirements and recommendations, and that the installation is approved by the manufacturer.

#### That the equipment is operating in a safe and satisfactory manner and is delivering capacities and performance not less than the capacities and performance specified and/or indicated on the drawings.

## TOOLS AND ACCESSORIES

### Furnish and deliver all special tools, instruments, accessories, and special lifting and handling devices shown in the approved instruction manuals. Unless otherwise specified or directed by the DISTRICT, the items shall be delivered to the DISTRICT, with the Contractor’s written transmittal accompanying each shipment, in the manufacturers’ original containers labeled to describe the contents and the equipment for which it is furnished. The Contractor shall deliver a copy of each transmittal to the DISTRICT for record purposes.

## WARRANTY

### Equipment furnished under this section shall be guaranteed against defective parts or workmanship for a period of 24 months from date of field testing and acceptance by the DISTRICT.

## MEASUREMENT AND PAYMENT

### Payment for the work in this section shall be included as part of the lump-sum bid amount stated in the Proposal.

# MATERIALS

## MANUFACTURERS

### The engine, generator, generator control panel, and fuel tank unit shall be manufactured in the U.S. by manufacturers currently engaged in the production of such equipment. An authorized distributor maintaining a parts depot and service facility shall be located within a 75-mile radius of the jobsite.

### The engine-generator shall be manufactured by Caterpillar Inc. Engine Division or approved equal.

## RATING

### The rating of the standby engine-generator shall be as listed below and based on operation of the set when equipped with all operating accessories, such as air cleaners, lubricating oil pump, fuel injection pump, radiator fan, and jacket water pump. The specified standby kw shall be for continuous electrical service during interruption of the normal utility source.

*Insert or select kw rating and voltage below.*

### Standby kw: 125 kw (minimum) unless otherwise shown on the drawings.

### Engine Speed: 1,800 rpm (maximum).

### Voltage: 480/277 volts, 3 phase, 4 wire.

### Frequency: 60 hertz.

### Power Factor: 0.8.

### Altitude: 1,300 feet above sea level.

### Outside Temperature: 120°F maximum, 30°F minimum.

### Humidity at Maximum Temperature: 95%.

### The momentary rms voltage dip shall not be greater than 35% of rated voltage when full load at rated power factor is applied to the generator.

### Insert load data below. For sewage lift stations, insert “full voltage” under starting method and delete sentence below regarding solid-state starters. This requirement will enable the generator to start the pumps with the bypass starters.

### The engine-generator shall be capable of starting and running the following loads in the sequence listed. Maximum voltage dip shall be 25%. Provide oversized generator and/or engine-generator unit to comply with this requirement. [Assume solid-state starters are set at 400% current limit and motor is fully loaded during starting.]

|  |  |  |  |
| --- | --- | --- | --- |
| Load | **hp or kw** | **Starting Method** | **Step** |
| Auxiliary loads | 10kw | NA | 1 |
| HVAC | 3 ton | FVNR | 1 |
| Pump 2 | 20 hp | FVNR | 2 |
| Pump 3 | 20 hp | FVNR | 3 |

[Note to the Engineer: Table to be adjusted for each project]

## ENGINE

### **General:** The engine shall be the standard low-emission version of the product of the manufacturer, a current production model, and have the following features:

#### Full compression ignition diesel.

#### Two- or four-stroke cycle.

#### Water cooled.

*Include following two paragraphs for units larger than 100 kw.*

#### Turbocharged, aftercooled, retarded four degrees.

#### With or without aftercooler.

#### Capable of the rated output when operating on a commercially available No. 1-D or 2-D diesel fuel (ASTM D 975).

#### The engine shall meet AQMD requirements of Tier 4 final.

### Provide the engine with the following accessories:

#### Fuel, lube oil, and intake air filters.

#### Intake air silencer, high frequency type or combination intake filter/silencer.

#### Lube oil cooler.

#### Fuel transfer pump with 12-foot suction lift.

#### Flexible fuel lines.

#### Engine-mounted water pump.

#### Coolant and oil drain valves.

#### Jacket water heater.

#### Coolant shut-off valves for jacket water heater.

#### Particulate Filter (when required)

### Starting System:

#### Provide a d-c electric starting system with positive engagement drive. Generators rated 200 kw and larger shall have a 24-volt starting system.

#### Provide lead-acid storage batteries of the heavy-duty diesel-starting type. The batteries shall have sufficient capacity to provide for one-and-one-half-minute total cranking time without recharging and shall be 20-hour rated no less than 200 amp-hours. Provide a free-standing corrosion-resistant fiberglass battery box. Provide battery cables and replaceable connectors.

*Select ampere rating of charger below. Use 10 amperes for 250-kw to 500-kw generators. Use 20 amperes for 600 kw and larger.*

#### Provide a UL-listed, two rate, current-limiting battery charger to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressors, d-c ammeter, and fused a-c input. A-C input voltage shall be 120 volts. Amperage output shall be no less than 10 amperes. Charger output shall be at least 25% greater than the auxiliary equipment power demand. Provide a dry contact for monitoring common fault and alarm. Charger shall be UL listed as manufactured by La March, Sens, or equal.

### Governing System:

#### Provide an adjustable isochronous governor of the electrical-hydraulic or all electric type with electrical speed sensing. Governor shall provide adjustable speed setting from 58- to 62-hertz adjustable speed regulation, adjustable load limit from 100% to 110% of unit rating, and shall also control the engine at recommended idle speed. The governor shall be capable of maintaining the frequency constant within ±0.25% for any constant load from no load to full generator rating. After a sudden load change of 25% of rated load, the governor shall reestablish stable operating conditions in not less than one and one-half seconds. Stable operation is defined as operation at a frequency that is constant within ±0.25% of rated frequency. The maximum change of frequency during the one and one-half second surging period shall not exceed 1.5 hertz.

#### Install the electronic control portion of the governor in the generator control panel. Governor shall be Woodward 2301A, JDEC, or equal.

### Lubrication System:

#### Fix a pressure-type lubricating system with gear-type oil pump and full flow oil filter to the engine. Filters shall be threaded spin-on type, conveniently located for servicing. Provide filters with a spring-loaded bypass valve to ensure oil circulation if filters are clogged.

#### Provide an oil drain with readily accessible manual valve with piping extended for easy access and proper capture of waste oil.

### Engine-Mounted Fuel System:

#### Provide an engine-mounted fuel filter with spin-on type replaceable elements, fuel pressure gauge, accessible manual shutoff valve, and engine-driven positive displacement fuel pump.

#### Provide a water separator on the engine just ahead of the fuel filters to prevent condensation, or other water, present in the fuel from reaching the engine filters, pumps, or injectors. Construct of heat-resistant Lexan, with an aluminum-perforated baffle, for easy viewing of the amount of water contained.

*Insert heater ratings below. Larger engines require two heaters. Check with manufacturer for quantity and size.*

### Jacket Water Heater: Provide a UL-listed, unit-mounted thermal circulation-type water heater incorporating a self-contained thermostatic switch, controlled by the exit coolant temperature from the heater to maintain engine jacket coolant to 90°F in an ambient temperature of 30°F. The heater shall be single phase, 60 hertz, 120 volts. Heater shall be Chromalox or equal. Provide hand valves in the heater hoses to facilitate changing heating elements without draining the entire cooling system.

### Safety Switches: Provide devices for indication and control of the following conditions at the generator control panel.

#### Low oil pressure (prealarm).

#### Low oil pressure with press-to-test feature (shutdown).

#### High water temperature (prealarm).

#### High water temperature (shutdown).

#### Overspeed (shutdown).

#### Overspeed trip and cranking termination shall be by a dual element electronic-type speed switch that operates on magnetic impulses from the flywheel ring gear or other engine-timed gear. Overspeed trip setting shall be 118% of synchronous speed. The low setting shall be used to automatically ensure continued engine cranking until the engine has reached 600 rpm, even if the oil pressure is up to an acceptable level at a lower speed.

#### Overcrank (shutdown).

### Emissions: Provide the engine with emission control equipment to ensure that gaseous exhaust emissions (for NOx, HC, and CO) do not exceed the maximum levels (Tier 4 final) established by the South Coast Air Quality Management DISTRICT. These maximum levels shall be at manufacturer’s rated speed and load as measured by SAE-J177 and SAE-J215 recommended practices. Verification of the ability to meet these emission specifications shall be submitted. Provide an active particulate filter. Filter shall be active type, Rypos or approved equal.

## GENERATOR

### General:

#### The generator shall be a 3-phase, 60-hertz, single-bearing, dripproof, rotating field, synchronous type, with 3-phase rotating armature brushless exciter. Provide Class F insulation on the stator and rotor. Further protect both with 100% epoxy varnish impregnation and an overcoat of resilient epoxy asphalt insulating material to increase resistance to abrasive dust or sand, high humidity, and light acidic, oil, or salt-laden atmospheres, as well as prevent fungus growth.

#### The wave form deviation factor of the line-to-line voltage at no load and balanced rated load at 0.80 power factor shall not exceed 5%. The rms of all harmonics shall be less than 3% and that of any one harmonic less than 2% at full rated load.

#### Conform to the applicable NEMA standards for motors and generators, MG-1. Base rating of generator on continuous operation at 0.80 power factor.

### Regulator: The voltage regulator shall be a solid-state, volts per hertz type with 3-phase sensing and shall maintain a constant and stable generator output voltage within ±1% of nominal for all steady-state loads from no load to full load with isochronous speed control and ±2% with speed droop operation. A 5% variation in frequency and the effects of field heating shall not affect the unit’s regulation performance. Provide stability and voltage range adjustments.

*Include paragraph below when generator is required to power variable frequency drives.*

## COOLING SYSTEM

### Provide an engine-mounted radiator with blower-type fan sized to maintain full load operation continuously at the specified maximum ambient temperature. Equip the radiator with a 1-inch-wide duct adapter flange and low coolant level switch gauge. Airflow restriction from the radiator shall not exceed 0.5 inch water. Provide ductwork with flexible connection section between radiator duct flange and exhaust louver. Provide fan guard for protection of maintenance personnel as required by CAL/OSHA.

### Ductwork shall be galvanized iron or steel sheets or aluminum sheets. Anchor ducts securely to the building and install so as to be completely free from vibration during engine operation. Brace and reinforce ducts with angles or other structural members. Internal ends of slip joints shall be installed in the direction of flow. Provide a flexible duct connection at the radiator flange.

### Flexible connection shall be wire-reinforced glass fabric. The connection shall be rendered practically airtight.

### Fill the engine-cooling system with distilled water and a solution of 30% by volume ethylene glycol for freeze protection and 5% by volume of a borate-nitrite solution (NALCO 2000 or equal) to prevent rust and corrosion.

### Provide a coolant drain with readily accessible manual valve with piping extended for easy access and proper capture of waste coolant.

## EXHAUST SYSTEM

### Exhaust system shall consist of a silencer, flexible exhaust fitting, exhaust piping, insulation, and mounting hardware.

### Provide a chamber-type supercritical grade silencer constructed of Type 304 stainless steel with a baked on silicon-based coating rated for 1100°F minimum. Silencer shall provide an average noise attenuation of 33 to 40 dBA. Provide brackets, companion flanges, gaskets, and fasteners for mounting silencer. Silencer shall be as manufactured by Universal, Nelson, Riley-Beaird, GT Exhaust Systems or equal.

### Silencer and exhaust pipe size shall be sufficient to ensure that measured exhaust back pressure does not exceed the maximum limitations specified by the generator set manufacturer.

### Provide a seamless Type 316 stainless-steel bellows-type flexible exhaust fitting at least 18 inches long.

### Exhaust piping shall be carbon steel pipe 15253conforming to ASTM A53, Type E or S, or ASTM A135. Provide standard weight per ASME B36.10, Type 316 stainless steel per ASTM A312. Provide standard weight per ASME B36.19. Provide flanged or welded type fittings. Provide sufficient flanged fittings to permit the system to be entirely dismantled in sections. Use sweep elbows with a radius at least three times the pipe diameter.

### Provide vertical discharge tailpipe. Cap with a counterbalanced raincap.

### Cover the exhaust manifolds with an expanded metal guard for personnel protection.

### Cover the silencer and interior exhaust piping with lagging to maintain a surface temperature not to exceed 150°F.

## ELECTRONIC GENERATOR CONTROL PANEL

### Provide NEMA 1/IP22 control panel, mounted and wired to the engine-generator set. The panel shall include the following:

#### Automatic/manual start-stop engine control with programmable safety shutdowns and associated flashing LED indicators for low oil pressure, high coolant temperature, overspeed, overcrank, and emergency stop.

#### Cycle cranking, adjustable 1- to 60-second crank/rest periods.

#### Cooldown timer, adjustable 0 to 30 minutes.

#### Energized to run or shutdown fuel control systems.

#### LCD digital readout for engine oil pressure, coolant temperature, engine rpm, system d-c volts, engine running hours, eight system diagnostic codes, generator a-c volts, generator a-c amperes, and generator frequency.

#### Engine control switch.

#### Ammeter-voltmeter phase selector switch.

#### Emergency stop push button.

#### Indicator/display test switch.

#### 1Voltage adjust potentiometer.

#### 1Two panel illumination lamps and on/off switch.

#### 1Electronic isochronous governor and door-mounted adjust potentiometer.

#### 1Alarm modules to meet NFPA 99 code.

#### 1SCADA outputs. The following signals shall be hard wired from the generator to the SCADA system. Modbus or other serial communications methods to provide this information will not be accepted.

##### 4 to 20-ma signal outputs for the following:

##### fuel tank level

##### oil pressure

##### coolant temperature

##### battery voltage.

#### Dry contacts for future remote alarms wired to terminal strips from the following status and alarms:

##### Low oil pressure.

##### High coolant temperature.

##### Low coolant level.

##### Breaker position.

##### In auto.

##### Low battery voltage.

##### Run.

##### Common fail.

##### Low Fuel

##### Power Available

### Provide environmentally sealed, solid-state, microprocessor-based modules for engine control and AC metering.

### Provide a protocol converter or communication port that provides an Ethernet output for connection to RTU system.

## MAIN LINE CIRCUIT BREAKER

### Provide a main line molded case circuit breaker sized in accordance with the NEC. Install on the generator in a NEMA 1 enclosure or in the generator control panel to function as a load circuit interrupting and protection device. It shall operate both manually for normal switching function and automatically during overload and short-circuit conditions. Circuit breaker shall trip free of the handle. The handle position, or a luminescent flag, shall indicate “off,” “on,” or “tripped” breaker positions. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short-circuit protection. Insulated neutral terminals and a ground terminal shall be provided and marked. The circuit breaker shall meet standards established by UL, NEMA, and NEC. Do not use generator exciter field circuit breakers in lieu of a main line circuit breaker. Provide auxiliary contact for breaker position to remote alarm.

## LOAD BANK

### When required by design documents provide a 480-volt, 3-phase resistive load bank mounted on the radiator exhaust duct flange. The enclosure shall match, dimensionally, the radiator duct flange height and width without adapting transitional ductwork. Prime the metal surfaces of the enclosure surfaces with a polyvinyl-butyral resin-based etching primer. Paint the enclosure surfaces with a catalyzed-type polyurethane enamel.

### Size the load bank for 60% to 100% of the generator rating. Wire load bank for a minimum of four equal incremental load steps.

### Load resistors shall have a three-year warranty against defects in materials and workmanship.

### The load resistors shall be forced air cooled by the engine’s cooling fan. The load resistors shall not require a cool-down period.

### Provide a NEMA 3R enclosure for controls and mount on the engine-generator frame.

### Factory wire load bank to controls and controls to generator terminals. Controls shall include the following:

#### Main circuit breaker.

#### Fuse protection for control circuits.

#### Control power transformer.

#### Full voltage, non-reversing, magnetically held contactor for each resistive load step.

#### Fuse protection for each resistive load step.

#### Interlock circuit to de-energize load bank when automatic transfer switch is in emergency position.

#### Load step switch to manually energize incremental load steps.

#### Auto-manual selector switch. In manual, the load bank shall be connected to the generator and controlled by the load step switch. In auto, upon receiving a contact closure from the automatic transfer switch exerciser timer, the load bank shall be connected to the generator with a time delay between load bank steps.

### The load and control wiring shall be 105°C rated wire. The wire shall be sized so the maximum rating at the ampacity applied is less than 80% of its maximum rating at its ambient rating. All control wiring shall have wire numbers that are indicated on the wiring diagrams.

### The load bank shall be manufactured by Load Technology, Inc. (La Mirada, California), Simplex (Chicago, Illinois), Asco or equal.

*Specify load bank only for sewage lift stations.*

## FUEL SYSTEM

### Provide a sub-base mounted fuel storage tank capable of supporting the generator set at rated load for 24 hours. Provide access for electrical conduit from below. Tank shall be built and labeled in accordance with UL-142. Mounting feet shall provide 1 inch clearance between bottom of tank and foundation.

### Tank features shall include:

#### 2-inch filler neck and locking cap

#### Engine supply and return openings and draw tubes

#### Emergency vents per UL for both primary and secondary containment with approved caps.

#### Tank leak port

#### Fuel level indicator gauge, direct reading type

#### Low fuel level alarm switch, set at 4 remaining hours capacity

#### Secondary containment totally closed design, by double wall construction. Provide alarm contact for “liquid in containment basin.” Wire contact to alarm light in the generator control panel.

#### Analog fuel level transmitter with a 4-20mADC signal

#### Tank leak alarm contact

## TORSIONAL VIBRATION ANALYSIS

### Submit a torsional vibration analysis of the engine-generator combination, showing it free of harmful torsional vibration stresses within ±10% of its normal operating speed range, the natural frequency, critical speeds, relative amplitudes of angular displacement, and approximate nodal locations of the complete elastic system of the engine and driven equipment.

## SPECIALIZED PROGRAMMING SOFTWARE

### If any software is required to either configure the generator or diagnose components of the generator, three licensed copies shall be provided to the DISTRICT. In addition, the Generator Vendor shall provide 1 day of training on the use of the software.

## GENERATOR’S AUXILIARY ENCLOSURE

### Enclosure shall be durable, weather proof, made with aluminum materials with safety glass control panel for viewing. Finish color shall be as selected by the DISTRICT. It shall have the following features:

#### Externally mounted emergency stop switch with ring guard.

#### Rust free stainless steel hinges and locks for all access doors.

#### Noise attenuation with critical grade silencer for 73 dBA @ 21 feet.

#### Steel or aluminum screens to prevent rodents’ entry.

#### Provide a portable aluminum ladder with handrail for use by DISTRICT staff.

### Provide an aluminum, weather-protective and Level 2 sound attenuated enclosure. Enclosure material shall be a minimum thickness of 14 gauge. Lockable latches shall be of stainless steel. Doors shall have a common keyed latch. Provide two (2) sets of keys. Enclosure and engine exhaust system shall be sound attenuated to limit noise level when operating at full load to a maximum of 70 dBA at 23 feet in any horizontal direction from the center of the unit. Attenuation shall include exhaust manifold and silencer blankets of the removable/reusable type. Intake and discharge of cooling air shall be through openings that are covered for weather protection. Provide acoustical material on internal walls and surfaces of the enclosure. External holes and openings in the enclosure shall be covered with galvanized or coated mesh to prevent entry of birds and rodents.

# EXECUTION

## FACTORY TESTING

### Perform factory tests in the presence of the DISTRICT’s Representative prior to shipment. Provide seven days’ advance notice of test date. Include the following tests.

### Demonstrate proper operation of all safety devices, shutdown features, and alarms. Conduct load tests utilizing resistive load banks as follows:

|  |  |
| --- | --- |
| **Load** | **Hours** |
| 1/2 | 1 |
| 3/4 | 1 |
| Full | 4 |

### Record current, voltage, frequency, water temperature, and lube oil pressure every 15 minutes. At the end of two hours at full load (specified standby kw), the engine-generator shall be block loaded from no load to full load a total of two times, and the voltage dip and frequency dip shall be recorded by a strip chart recorder.

### Verify fuel consumption rate at 1/2, 3/4, and full loads. Note fuel consumption rates on a label located at fueling point.

E. Fill up tank after all tests are done to the DISTRICT’s satisfaction.

## PAINTING AND COATING

### Coat noninsulated exhaust pipes and silencers with a baked silicon-based coating rated for 1100°F minimum.

## START-UP AND TRAINING

### On completion of the installation, the initial start-up shall be performed by a factory-trained service representative of the engine supplier, who shall thoroughly inspect, operate, test, and adjust the equipment. The inspection shall include the soundness of all parts, the completeness of all details, the proper operation of all components with special emphasis on safety devices, the correctness of settings, proper alignments, and correct phase rotation to match other sources. Energize the jacket water heater 24 hours prior to the initial start-up.

### Field tests shall include the following:

#### Simulate power failure by tripping the main breaker and demonstrate complete manual and automatic start, load, unload, and stop sequence of the engine-generator.

#### Conduct a two-hour run, utilizing maximum available load. If available load is less than 75% of the generators’ rating, then add loads to obtain 75% generator loading (minimum).

#### Retest all alarms and shutdown features.

#### A written operational report including start-up inspection and field tests, signed by the manufacturer's representative, shall be submitted to the Owner prior to acceptance.

### Perform training to DISTRICT’s maintenance staff with hands on demonstration. Two 4-hour class sessions with hands out and as-built manuals shall be provided for each attendee.

## SCHEDULED OIL SAMPLING

### In order to forecast and minimize engine failure, the supplier of the equipment shall provide a quarterly (every three months) oil sampling analysis for a period of two years from date of acceptance. This scheduled oil sampling shall be of the atomic absorption spectrophotometry method as opposed to the spectographic analysis method and shall be accurate to within ±1 ppm for the following elements: lead, iron, chromium, copper, aluminum, and silicon. In addition, test the sample for the presence of water, fuel, dilution, and antifreeze.

### Provide equipment needed to take oil samples in a kit at the time of acceptance. Include a sample gun kit, bottles, mailers, and written instructions.

### Provide immediate notification by telephone or fax to the DISTRICT when analysis results show any critical reading. If readings are normal, provide a report by mail showing that the oil quality is within established requirements.

### This scheduled oil sampling program shall be available to the DISTRICT at the supplier’s normal rate, after the mandatory two years, and shall be continued thereafter at the DISTRICT’s option.

**END OF SECTION**