

## SECTION 16620

### EMERGENCY POWER GENERATOR

#### PART 1 – GENERAL

##### 1.1 Description

- A.** This Section includes the requirements for a diesel fuel driven standby generator complete with weatherproof sound attenuating enclosure. Provide engine/generator set (genset) as indicated on the design documents including but not limited to the following:

Diesel fuelled engine

Electric starting system with batteries, charger

Electric generator

Sound attenuating enclosure

Fuel system, tank, pumps, filters

Muffler

Control panel

Accessories

Emission control for State of Arizona

- B.** Contractor shall be responsible for the modifications to the equipment location, conduit and cable/wiring layout, concrete pad dimensions, pad penetrations and other changes which will be required to meet the actual equipment supplied. All modifications shall be approved by the Engineer prior to installation.
- C.** Contractor shall provide standby equipment that is in compliance with the Federal and State of Arizona clean air and emissions requirements.
- D.** One acceptable manufacturer shall accept prime responsibility through Contractor for complete power unit.

- E. Provide the size of the unit as indicated for soft start loads. If a unit of greater kW capacity than the unit specified is supplied, Contractor shall be responsible for any changes in size of conduit, wire, circuit breakers, transfer switch, fuel system, building, or related equipment which will be required to meet the applicable codes and standards.

## 1.2 References

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

ANSI C37 Series - Power Switchgear.

ANSI C50.10 - General Requirements for Synchronous Machines.

ANSI C50.13 - Cylindrical Rotor Synchronous Generators.

ANSI C50.14 - Combustion Gas Turbine Driven Cylindrical Rotor Synchronous Generators.

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

43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.

115 - Test Procedures for Synchronous Machines.

### 3. National Electrical Code (NEC)

### 4. National Electrical Manufacturing Association (NEMA)

### 5. National Electrical Safety Code (NESC)

### 6. Society of Automotive Engineers (SAE)

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

UL50 - Electrical Cabinets and Boxes.

UL508 - Electric Industrial Control Equipment.

UL1008 - Automatic Transfer Switches.

## **8. International Electrical Testing Associations**

### 7.22 Emergency System

9. Standard for Electrical Safety in the Workplace, NFPA 70E
10. Occupational Safety and Health Administration, OSHA.
11. All electrical and control equipment and material shall bear the recognized Underwriters Laboratories, Inc. (UL) seal of approval. It is Vendor's responsibility to obtain local inspection approval for all non-UL labeled equipment and pay all fees in connection with the same.

## **1.3 Factory Tests**

1. Conform to Standard Engine Field Test Codes to determine the following
  - a. Engine-generator set net power output.
  - b. Fuel consumption.
  - c. Overall engine-generator set efficiency.
  - d. Certification that engine-generator meets Federal and State emissions limits.
2. Correct test results for estimated field operating conditions of 500 ft. elevation MSL and 122 degrees F ambient air temperature.
3. Submit actual and corrected test results as specified in Section 1330.

## **1.4 Submittals**

- A. Submit as specified in Section 1330.
- B. Complete drawing and wiring diagrams including, but not limited to showing coordination and connections between the following:
  1. Engine generator.
  2. Generator control panel.

3. Automatic starting controls.
4. All auxiliaries.
5. Engine Emissions Data for use with commercially available No. 2 diesel fuel.
6. Complete genset dimensions, weights, foundation requirements and connection locations for all piping, cabling
7. Weatherproof enclosure dimensions and weights
8. Exhaust System
9. Sound attenuation guarantees
10. Complete O & M Manuals

## **PART 2 – MATERIALS**

### **2.1 Acceptable Manufacturers**

#### **A. Engine**

1. Caterpillar Inc.
2. Cummins Inc, Onan Division
3. Kohler Company.
4. Generac Power Systems

#### **B. Generator**

1. Caterpillar, Inc.
2. General Electric Company.
3. Onan Division of Cummins Inc.
4. United States Motor Corporation.
5. Generac Power Systems

## 2.2 Design Criteria

- A. Preassembled power module.
- B. Conform to NEC, NESC, NEMA. and IEEE C62.1.
- C. Completely self-contained and integrally assembled, with the engine, generator, exciter, starter, batteries, charger, intake air cleaner, radiator and fan, fuel system, fuel tank, muffler, air handling system, weatherproof sound attenuated enclosure, base and all necessary parts to make a complete installation.
- D. Complete with all auxiliaries, interconnecting piping, instruments, wiring, rigid steel base, tools, and spare parts.
- E. Compactly assembled and rigidly mounted on a steel skid ready for installation and external connections.
- F. All engine and generator controls required for proper operation, including generator output breaker.
- G. Outside power connection cabinet, inside light, duplex convenience receptacle, (and a screened, baffled, and louvered air intake and hot air discharge).
- H. Power for battery charger and water jacket heater from an outside source.
- I. Designed for maximum reliability and dependability of operation.
- J. Capable of being brought up to full speed, placed on the line, and brought up to full load in 10 seconds or less at full power.
- K. Size guaranteed to start the motor load as specified with a maximum voltage drop of 10%.
- L. Arranged to provide control as follows:
  - 1. Micro-processor based control panel for monitoring and control genset operation.
  - 2. Local start-stop engine test switch to allow testing system without operating transfer switch.

3. When unit is up to speed and voltage required, transfer switch shall close automatically and unit shall pick up load, provided the engine has not been started by the engine test switch.

## 2.3 Engine

### A. General

1. Conform to SAE Internal Combustion Engine Standards.
2. Operate on No. 2 Diesel fuel.
3. Designed for emergency power service.
4. Starts from batteries, either automatically or manually.
5. Suitable for continuous operation at nameplate rating.
6. Operate in efficient manner free from all roughness and vibrations.
7. Basic 4 cycle engine with governor for speed regulation within 5%.
8. Maximum operating speed of 1,800 rpm.
9. Safety devices to shut down engine in case of low oil pressure, overcranking, high-water temperature, and overspeed protection independent of governor.
10. Lubricating oil pumps.
11. Integral cooling water radiator sized for 122 degrees F ambient, fan, temperature control hardware, water pump, and closed water cooling system.
12. Electric starting motor: 24Vdc.
13. Air filters: Dry type.
14. Cranking contactor with overcranking alarm and cranking limiter. Limit to 4 cranking cycles of 15 seconds each.

15. Lube oil filter: Cartridge type.
16. Water jacket heater for 120VAC operation, to maintain 140 degrees F minimum jacket water temperature during idle periods, thermostatically controlled.
17. Automatically regulated, battery charging alternator.

**B. Fuel System**

1. No. 2 Diesel fuel.
2. Double wall UL listed diesel fuel tank integral to genset skid base.
3. Provide leak detection.
4. Size tank for a minimum of 24 hours supply of fuel.
5. Normal and emergency venting.
6. Provide all tank nozzles and openings.
7. Provide spill containment at tank fill location.
8. Provide all necessary pumps, filters, piping, valves.
9. Fuel train components shall be engine mounted.
10. Provide access for all electrical cabling to engine controls, generator without compromising tank and containment.
11. Tanks shall be equipped with a level transmitter which shall generate a 4-20 mA signal to indicate fuel level. Provide terminal blocks in the generator control panel for connection to Owner's control system.
12. Provide a backup low fuel level switch for Owner's alarm.
13. Coordinate fuel fill with site requirements.
14. Provide paint specification data.

**C. Muffler**

1. Provide critical grade type exhaust silencer for use in residential area to be mounted inside the genset enclosure.
2. Provide all mounting accessories including mounting brackets, flexible fittings, elbows, piping, rain cap and rain skirt with all hardware.
3. Provide exhaust outlet at an elevation of 14 feet above finished grade level. Provide flexible section to connect to muffler.

**D. Batteries**

1. 2-12V lead-acid type storage battery, minimum ampere-hour rating as specified by manufacture or capacity described in item #2 below, or 90 A.H. whichever is greater.
2. Size for full cranking speed for 10 cycles of 15-second cranking with engine at 0°F ambient temperature.
3. Filled with proper quantity of electrolyte and fully charged at time of installation.
4. Suitable hydrometer mounted on a support adjacent to batteries.
5. Suitable racks for mounting batteries.

**E. Battery Charger**

1. Conform to UL50 and UL508.
2. Automatic, self-regulating, constant voltage type with silicon diode rectifiers and regulating system.
3. Designed for floating charge and equalizing, charge.
4. Operate from 120-V, single-phase, 60-Hz ac supply.
5. Capable of fully charging batteries within 24 hours.



6. Transformer, silicon diode stacks, ammeter, voltmeter, switches, and other components as required to accomplish trickle charging of batteries.
7. Enclosed in all steel cabinet for wall mounting, and conduit connection.
8. Screens on top and bottom of steel cabinet to cover ample size opening for ventilation.
9. Alarm contracts available for Owner's use:
  - a. Battery charger off
  - b. Battery charger malfunction and/or battery low voltage

**F. Instrumentation**

1. Totally enclosed gauge panel to be located approximately 5'-0" above the ground in the final installation with following instrumentation installed:
  - a. Lubricating oil pressure gauge.
  - b. Water temperature gauge.
  - c. Engine battery charging amperage.
2. Isolated (no voltage) alarm contacts suitable for operation on 120 VAC for each of the following alarm points (contacts close on alarm for remote alarm):
  - a. High engine lube oil temperature.
  - b. Low engine lube oil pressure.
  - c. High jacket water temperature.
  - d. Engine Overcranking.
  - e. Engine Overspeed.
  - f. Engine failure to start.

3. Local indicating lights for each alarm point specified.
4. Completely shop-wired and tagged with terminations properly identified and located to provide entrance for external piping and wiring connections at top of panel.
5. Low lube oil pressure, high jacket water temperature overspeed, and overcranking shall shut engine down only when these values reach dangerous limits.

## **2.4 Generator**

### **A. Alternator**

1. Conform to IEEE 43, 56, and 115, ANSI C37 Series, and C50.10, C50.13, and C50.14.
2. Full load rating as indicated at 0.8 power factor prime/continuous duty.
3. Suitable for solid grounding of generator neutral.
4. Voltage: 480/277VAC, Dual wiring configuration (Delta or Wye), 3-phase, 3-wire, or 3-phase, 4-wire, 60-Hz. Alternator to be delivered in the Wye Configuration.
5. Maximum speed: 1,800 rpm.
6. Temperature rise of 80°C above 40°C ambient.
7. Air cooled, self-ventilated.
8. Open type enclosure.
9. Excitation by brushless permanent magnet.
10. Stator and rotor insulation, Class F or H limited to a Class B rise.
11. Overload rating: 110% rated load for 2 hours.
12. Maximum balanced telephone influence factor (TIF): 300.
13. Short circuit ratio: 1.0.

14. Generator field discharge resistor mounted and connected in control panel.

**B. DC Exciter**

1. Conform to IEEE 43, 56, and 115, ANSI C37 Series and C50.10, C50.13, and C50.14.
2. Rating as required.
3. Silicon controlled rectifier type or engine-driven type.
4. Air cooled, self-ventilated.
5. Designed to permit voltage build-up from residual magnetism. Field flashing from separate source is not acceptable.
6. **Excitation controls including, but not limited to, the following**
  - a. Voltage level and field limiting device.
  - b. Voltage drop.
  - c. Voltage gain.

**C. Voltage Regulator**

1. Conform to IEEE 43, 56, and 115, ANSI C37 Series and C50.10, C50.13, and C50.14.
2. Rating as required.
3. Modular construction, solid state design.
4. Voltage regulation from no load to rated load within a band of  $\pm 2\%$  of rated voltage.
5. Steady state voltage within  $\pm 1/2\%$  of rated voltage.

## **D. Generator Control Panel**

- 1.** Control panel shall be genset mounted for complete control and monitoring of the engine, generator and accessories. Panel shall incorporate self-diagnostics and fault logging. Provide suitable enclosure to meet the environmental conditions. Enclosure shall include a hinged door with provision for padlocking.
- 2.** Control shall be micro-processor based.
- 3.** The control panel shall include the following as a minimum:
  - a.** Automatic start/stop operation
  - b.** Adjustable cycle cranking
  - c.** Digital AC metering unit with the following metering capabilities and features:
    - RMS line current (each phase)
    - RMS line-to-line voltage (all three)
    - RMS line-to-ground voltage (each phase)
    - Megawatts (instantaneous and peak block or rolling block demand)
    - Megawatt hours
    - Megavars (instantaneous and peak block or rolling block demand)
    - Megavar hours
    - Power Factor
    - Frequency
    - ANSI C12.20 0.2 accuracy compliant
    - Harmonics (individual, even, odd, total) to 50th harmonic
  - d.** Engine monitoring
  - e.** Shutdown sensors and alarms with horn and reset
  - f.** Adjustable cool-down timer
  - g.** Emergency stop push-button
  - h.** Lamp test
  - i.** Voltage control

- 4.** Control Panel displays:
  - a.** Engine oil pressure
  - b.** Coolant temperature
  - c.** Engine speed
  - d.** DC volts
  - e.** Engine running time
  - f.** Percentage of rated power
  - g.** Digital meter outputs listed above.
  
- 5.** Control panel indications for protection and diagnostics:
  - a.** Low oil pressure
  - b.** High coolant temperature
  - c.** Low coolant level
  - d.** Over-speed
  - e.** Over-crank
  - f.** Eng stop shutdown
  - g.** Approaching high coolant temperature
  - h.** Approaching low oil pressure
  - i.** Low coolant temperature
  - j.** Low dc voltage
  - k.** Control switch out of "Auto"
  - l.** Low fuel level
  - m.** Battery charger failure
  - n.** High battery voltage

6. Protective relay function including:
  - a. Under-voltage
  - b. Over-voltage
  - c. Over-frequency
  - d. Under-frequency
  - e. Reverse power
  - f. Over-current
  - g. Overload – kW level
7. Dry contacts for remote alarm annunciation. Provide connection as inputs to the control system PLC.
  - a. Generator run status
  - b. Generator failure
  - c. Low coolant alarm
  - d. Low fuel level
  - e. Battery status
8. Instrument transformers, terminal blocks, and wiring.

## 2.5 Enclosure

- A. Construction:
  1. Pre-fabricated weatherproof, sound attenuated metal enclosure with base mounted fuel tank.
  2. All bolted construction suitable for installation on a concrete slab.
  3. Seismic mounts, snubbers and vibration isolation.
  4. Enclosure rated to a wind load of 120 mph.
  5. Access doors with provision for locking in closed position.
  6. Corrosion resistant hardware.

7. All openings flashed and sealed for a weatherproof installation.
8. The enclosure shall attenuate the generator noise when running at full load not to exceed 72 dBA at 20 feet in any direction.
9. Provide supports, brackets, hardware to install all equipment.
10. The installation shall be complete with all equipment and accessories assembled, factory tested and ready for external piping and wiring connection.
11. Provide engineered lifting system with integral rings, spreader bars all labeled.

**B.** Ventilation:

1. Baffled ventilation system outside air intake louvers.
2. Insect screens.
3. Intake and discharge ducting.
4. Flexible connections on hot air discharge.
5. Fans and controls/interlocks.

**C.** Electrical Systems:

1. Install and pre-wire all electrical components and system in accordance with the References and Division 16.
2. Install a GFCI duplex receptacle strategically located to allow maintenance on the Genset.
3. Provide all necessary conduit, boxes and fittings for a complete installation.

## **2.6 Starting System and Equipment**

- A.** Complete electric starting system.
- B.** Interlock preventing automatic restart attempts if engine has been stopped by low lube oil pressure, high water temperature, or failure to start.

- C. All automatic equipment coordinated with the engine generator.
- D. Operate from 24 VDC.
- E. Necessary starting control equipment to perform required functions.

## **2.7 Accessories:**

- A. All filters for 1 year operation.
- B. First fill of fuel, lubrication oils, coolant and water.
- C. Lube oil requirements for first year of operation.
- D. Special engine tools.
- E. Recommended spare parts.
- F. Touch-up paint for each color used.

## **2.8 Automatic Transfer Controls – See Also Section 16442-Switchboards**

- A. Conform to ANSI C37 Series, UL50, UL508, UL1008 and NEC Articles 517, 700, 701 and 702.
- B. Automatic transfer controls consisting of a two breaker source transfer system. Incorporate controls as described in this section to control the Main and Generator breakers in the switchgear as specified in Section 16442.
- C. Operates when any phase drops to 70% rated voltage and transfer back to normal when all phases are 90% or more of rated voltage.
- D. **Hand-Off-Test-Automatic Selector Switch**
  - 1. Hand position, manual starting with load transfer.
  - 2. OFF position, engine-generator cannot be started. no load transfer.
  - 3. Test position. manual starting, no load transfer.



- 4. Automatic position. automatic starting diesel engine and load transfer during power failure.
- E. Adjustable time delay 0-15 seconds on engine starting.
- F. Adjustable time delay 0-30 seconds on transfer to emergency.
- G. Adjustable time delay 0-2 minutes on transfer to normal.
- H. Adjustable time delay 0-10 minutes engine cool-down after transfer to normal.
- I. Engine starting contacts.
- J. Indicating lights to show switch position.
- K. Isolated output contact for remote alarm or indication of transfer. Provide connection as inputs to the control system PLC.
- L. Exerciser to automatically start the unit a minimum of 15 minutes once each week to any multiple of 15 minutes as often as needed.

## **2.9 Accessories**

- A. Two sets of special engine tools.
- B. Vibration isolators for base rail-equipment, pad mounted.
- C. Two spare lube oil filter cartridges.
- D. One spare air filter if dry type.
- E. Sufficient lube oil for start-up and one oil change for each engine/generator unit.
- F. 15 gallons of permanent type anti-freeze for cooling system for each engine/generator unit.
- G. Two spare fuses of each type provided.
- H. One quart of equipment touch-up paint.
- I. Weatherproof enclosure for the engine/generator set.

## **PART 3 – EXECUTION**

### **3.1 Installation**

- A.** Install as indicated on concrete slab. Installation shall meet the site seismic requirements.
- B.** Anchor skids as recommended by the engine-generator manufacturer.
- C.** Connect all electrical connections as required for satisfactory operation.
- D.** Ground genset and generator.

### **3.2 Field Quality Control**

- A.** Manufacturer's Field Services: Provide as specified in Section 1750.
- B.** Testing shall be in accordance with NETA standards.

#### **C Performance Tests**

- 1.** Provide as specified in DIVISION 1.
- 2.** Particular attention shall be given to the following:
  - a.** Automatic starting and reliability of operation.
  - b.** Ability to pick up full load in 10 seconds or less.
  - c.** Performance at 110% rated load.

### **3.2 Acceptance Testing**

- A.** Load Bank Test.
  - 1.** 25% Rated load 30 minutes.
  - 2.** 50% Rated load 30 minutes.
  - 3.** 75% Rated load 30 minutes.

4. 100% Rated load 3 hours.

Record voltages, frequency, load current, oil pressure, and coolant temperature at 10 minute intervals on each Load Bank Test.

- B. Perform vibration baseline testing plot amplitude versus frequency for each bearing cap.
- C. Automatic transfer testing. Record transfer time for each of the conditions
  - 1. Loss of normal power.
  - 2. Return to normal power.
  - 3. Loss of emergency power.
  - 4. All single phase conditions.
- D. Upon completion of tests, fill fuel tank.
- E. Upon completion of tests, verify all fluid levels. Top off any fluids as necessary.

#### **PART 4 MEASUREMENT AND PAYMENT**

##### **4.1 Measurement**

- A. No measurement will be made for this item.

##### **4.2 Payment**

- A. Payment will be made at the contract lump sum price bid and shall be considered full payment for providing labor and materials to perform this work.

**\*\* END OF SECTION 16620 \*\***