

## SECTION 16600: ALTERNATE POWER SYSTEMS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION:

- A. This section of the specifications includes the furnishing, installation, connection, and testing of the engine generator system consisting of the generator, transfer switches and auxiliary equipment.
- B. The engine generator system shall be fully automatic and shall constitute a unified and coordinated system ready for operation.
- C. The engine generator system shall include, but not be limited to, diesel engine, lube oil system, fuel oil system, cooling system, intake and exhaust system, starting system, generator, battery system, load transfer system, control system and supervisory system.

#### 1.2 RELATED WORK:

- A. Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).

#### 1.3 QUALITY ASSURANCE:

- A. The supplier of the diesel-engine generator set shall be responsible for satisfactory total operation of the system and its certification. This supplier shall have had experience with three or more installations of systems of comparable size and complexity as regards to coordinating, engineering, testing and supervising. Each of these installations shall have been in successful operation for three or more years.

#### 1.4 SUBMITTALS:

In accordance with section 01340, SAMPLES AND SHOP DRAWINGS, furnish the following:

- A. Shop Drawings and Product Data:
  - 1. Data shall be submitted in the following form:
    - a. Technical data sheets (TDS): These include published performance, rating and derating curves, published ratings, catalog cuts, pictures, manufacturer's specifications, material composition, and gauge thickness.
    - b. Description of operation (DO): Manufacturer's literatures and, if suitable, diagrams.
    - c. Shop Drawings (SD): Scaled drawings showing dimensions, plan views, side views, elevations and cross sections.

- d. Diagrams (DGM): These include control system diagrams, elementary diagrams, control sequence diagram or table, wiring diagrams, interconnections diagrams, wireless connection diagrams, illustrative diagrams, and flow diagrams, and other like items.
- B. Prior to the final inspection deliver four copies, to the Architect of the following:
- 1. A certificate by the manufacturer of the engine-generator set that the auxiliary electrical power system has been properly installed, adjusted and tested.
  - 2. Operation and Maintenance Manuals:
    - a. Submit complete operating and maintenance manuals for the engine-generator set and auxiliaries including wiring diagrams, technical data sheets and information for ordering replaceable parts.
    - b. Include complete interconnection diagrams which indicate all components of the system.
    - c. Include complete diagrams of the internal wiring for each of the items of equipment.
    - d. The diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
    - e. Furnish copies of complete lists of the spare parts and special tools recommended for two years of normal operation of the complete system including the manufacturer's names, addresses, catalog numbers and prices.
    - f. Labeled terminal blocks with wire numbers.

#### 1.5 JOB CONDITIONS:

- A. Unless specified otherwise, each component of the engine-generator system shall be capable of operating as specified herein at 1000 feet above sea level which with average ambient air temperatures ranging from a minimum of 5 degree F in winter to maximum of 105 degrees F in summer.

#### PART 2 - PRODUCTS

##### 2.1 DIESEL ENGINE-GENERATOR SET - GENERAL:

- A. The engine generator system shall be in accordance with NFPA, UL, NEMA and ANSI, as specified and as shown on the drawings.
- B. Provide a complete fully automatic, diesel engine-generator system. **Generator set and all components shall be provided with a 5 year factory warranty on all components. [Add6-15.a]**
- C. Published Rating:

1. Shall be not less than 300 KW/Standby at 480Y/277 volts 3-phase, 4-wire, 60 Hz, 0.80 power factor.
- D. Assemble, connect and wire the equipment at the factory so that only the external connections need to be made at the construction site.
  - E. Thoroughly clean and paint the metal surfaces at the factory with manufacturer's primer and standard finishes.
  - F. Coordinate the components of the system and their arrangements, electrically and mechanically.
  - G. Connections between components of the system shall conform to the recommendations of the manufacturer of the diesel engine-generator set.
  - H. Couplings, shafts, and other moving parts shall be enclosed and guarded. Guards shall be metal, ruggedly constructed, rigidly fastened and readily removable for convenient servicing of the equipment without disassembling any pipes and fittings.
  - I. Protect the diesel engine and its water cooling system at all times against freezing weather conditions.
  - J. Shall have the following features:
    1. Mounted on a common, rigid, welded, structural steel base at the factory.
    2. Shall automatically start, accelerate to the specified RPM and deliver the specified KW/KVA output at 60 Hz within 10 seconds after a single pole contact closes in a remote device.
    3. Shall recover rapidly from instantaneous changes between no load and the specified KW/KVA rating, and the reverse changes of load, without damage.

## 2.2 DIESEL ENGINE:

- A. Shall have the following features:
  1. Full Diesel, coupled directly to a generator.
  2. Not less than 4-cycle.
  3. Operating speed shall be 1800 RPM.
  4. The engine shall start cold in a 5 degree F ambient temperature while using No. 2 diesel fuel oil without the use of starting aids such as glow plugs and ether injections. Provide heaters necessary to accomplish cold start.
  5. ~~Fuel oil consumption of the engine rate shall not exceed 0.40 pounds of fuel oil per BHP per hour while the set is delivering 100 percent of its specified KW/KVA rating.~~ **Delete this paragraph. [Add6-15.b]**

- B. Electrical heaters, for maintaining the engines coolant temperature at the temperature recommended by the manufacturer of the engine, shall be factory installed. The temperature should be in the 90 - 100 degrees F range.
  - 1. Install thermostatic controls, contactors, and circuit breaker protected circuits for the heaters.
  - 2. The heaters shall operate continuously except while the engine is operating or the water temperature is at the predetermined level.

2.3 GOVERNOR: Shall have the following features:

- A. Isochronous; electronic.
- B. Steady-state speed band at 60 Hz shall not exceed plus or minus 1/3 of one percent.
- C. Frequency change at 60 Hz, for load changes equal to 25 percent of the set's specified KW/KVA rating, shall not exceed two percent and shall recover to 60 Hz within three seconds.
- D. Frequency change at 60 Hz, for load changes equal to 100 percent of the set's specified KW/KVA rating, shall not exceed eight percent and shall recover to 60 Hz within five seconds.
- E. While the engine is running, manual speed adjustments may be made.

2.4 LUBRICATION OIL SYSTEM:

- A. Shall have the following features:
  - 1. Pressurized type.
  - 2. Pump shall be built-in gear-driven-by-engine, positive-displacement type.
  - 3. Full-flow strainer and full-flow or by-pass filters.
  - 4. Filters shall be cleanable or replaceable type and shall remove particles as small as 12 microns without removing the additives in the oil. **Replaceable filters are acceptable. [Add6-15.c]**
  - 5. Incorporate an extended lube oil sump drain line passing out through the skid base. Terminate this line with a drain valve and plug.

2.5 FUEL OIL SYSTEM:

- A. Shall have the following features:
  - 1. Injection pump(s) and nozzles.
  - 2. Plungers shall be carefully lapped for precision fit and shall not require any packing.
  - 3. Filters or screens which require cleaning or replacement will not be permitted in the injection system assemblies.

4. When recommended by the manufacturer, return surplus oil from the injectors to the main storage tank by gravity or a pump.
  5. Filter System:
    - a. Dual primary filters shall be located between the main fuel oil storage and day tank.
    - b. Secondary filters (engine mounted) shall be located so the oil will be thoroughly filtered before it reaches the injection system assemblies.
    - c. Filters shall be cleanable or replaceable type and shall entrap and remove water from oil as recommended by the engine manufacturer.
  6. Subbase mounted tank (main storage tank) double wall, with low fuel and internal tank rupture alarm wired to generator alarm panel. Tank shall be sized to allow for 48 hour full load run time.
- B. Pipe: Black steel, standard weight, Fed. Spec. WW-P-404. At connection points to the engine, install a section of flexible piping.

## 2.6 JACKET WATER COOLING SYSTEM, RADIATOR HEAT DISSIPATION:

- A. Shall have the following features:
1. Shall dissipate the heat through a radiator with a fan. The fan shall be engine driven unless indicated otherwise on the drawings.
  2. Cooling capacity shall be not less than the cooling requirements of the engine-generator set and its lubricating oil while operating continuously at 100 percent of its specified rating.
  3. Water circulating pumps shall be the centrifugal type driven by engine. Incorporate pressure relief devices where required to prevent excessive pressure increase after the engine stops.
  4. Radiator and cooling system rated for full load operation in 122EF (50EC) ambient as measured at the generator air inlet.
- B. In accordance with the recommendations of the manufacturer of the diesel engine:
1. Use softened water.
  2. Add corrosion inhibitor to the softened water.
  3. Add permanent type glycol anti-freeze liquid to protect the cooling system from the lowest temperature recorded by the U.S. Weather Bureau for the construction site during the preceding 10 years with minimum 50:50 for corrosion protection.

## 2.7 AIR INTAKE AND EXHAUST SYSTEMS:

- A. Shall have the following features:

1. Shall be located so the exhaust gases will not contaminate the fresh air intake.
2. Where turbo-charges are required, they shall be engine-mounted, driven by the engine gases, securely braced against vibration and adequately lubricated by the engine's filtered lubrication system.
3. Exhaust Muffler:
  - a. Shall be approved for hospital areas.

**Paragraph 2.7.A.3.b – Delete this paragraph. [Add6-15.d]**

~~b. Shall be a critical grade type capable of the following noises attenuation:~~

<del>Octave Band Hertz (Mid Frequency)</del>	<del>Minimum db Attenuation (.0002 Microbar Reference)</del>
<del>31</del>	<del>5</del>
<del>63</del>	<del>10</del>
<del>125</del>	<del>27</del>
<del>500</del>	<del>37</del>
<del>1000</del>	<del>31</del>
<del>2000</del>	<del>26</del>
<del>4000</del>	<del>25</del>
<del>8000</del>	<del>26</del>

4. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine-generator set while it is delivering 110 percent of its specified rating.
  5. Diameter of engine exhaust pipe, from the connection point at the engine to the connection point at the muffler, shall be as recommended by the engine manufacturer.
  6. Connection of the engine exhaust outlet to the exhaust piping system shall be made with a flexible exhaust section. Provide bolted type pipe flanges welded to each end of the flexible section.
- B. Provide drain valves at both the muffler and drip leg for maintenance of the exhaust system.
- C. Exhaust Piping: Black steel pipe. Fed. Spec. WW-P-404, standard weight with welded fittings.

2.8 ENGINE STARTING SYSTEM, ELECTRIC TYPE: Shall have the following features:

- A. Shall start the engine at any position of the flywheel.
- B. Electric cranking motor:
  1. Shall be engine-mounted.
  2. Shall crank the engine via a gear drive.
  3. Rating shall be adequate for cranking the cold engine at the voltage provided by the battery system, and at the required RPM during five

consecutive starting attempts of 10 seconds cranking each at 10-second intervals, for a total of 50 seconds of actual cranking without damage.

**4. Provide 45A-charging alternator. [Add6-15.e]**

**2.9 GENERATOR:** Shall have the following features:

- A. Shall have the following features:
1. Synchronous, bracket-bearing, rotating-field type connected directly to the engine.
  2. Lifting means.
  3. Designed for convenient connection to and removal from the engine at the construction site.
  4. Integral poles and spider, or individual poles dove-tailed to the spider.
  5. Designed for good wave shape and low noise level.
  6. Amortisseur windings.
  7. Insulation shall be as required for the ambient temperature and other requirements designated in the paragraph, DIESEL ENGINE-GENERATOR SET-GENERAL, in this section.
  8. A self-ventilating system.
  9. Shall withstand short circuit currents in conformance with NEMA Standards.
  10. Shall withstand 125 percent of the RPM specified for the set without damage.
  11. Telephone influence factor shall conform to NEMA Standards.
  12. Permanent magnet, brushless excitation system or static-exciter-regulator assembly.
  13. Nameplates attached to the generator and exciter shall show the manufacturer's name, equipment identification, serial number, voltage ratings, field current ratings, KW/KVA output ratings, power factor rating, time rating, temperature rise ratings, RPM ratings, full load current rating, number or phase and frequency.
  14. The neutral shall be electrically isolated from equipment ground and terminated in same junction box as the phase conductors.

**2.10 BATTERY SYSTEM:**

- A. Shall have the following features:
1. Batteries:
    - a. Batteries shall be lead acid.
    - b. Each battery cell shall have electrolyte minimum and maximum level indicators, and flip top flame arrestor vent cap.
    - c. Batteries shall have connector covers for protection against external short circuits.
    - d. With the charger disconnected, the battery system shall have sufficient capacity so that the total system voltage does not fall below 85 percent of nominal system voltage with the following demands:

- 1) Five consecutive starting attempts of 10 seconds cranking each at 10 second intervals for a total of 50 seconds of actual cranking (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).
  - 2) 12 hours operation of the control and supervisor panels.
  5. Batteries shall be provided with jacket heaters.
2. Battery racks shall be metal with an alkali resistant finish, and secured to the skid inside the weatherproof enclosure.
- B. Battery Charger:
1. The charger shall maintain one percent voltage regulation from no load to full load for line voltage variation of 10 percent and frequency variation of 3 Hz from 60 Hz.
  2. The charger shall maintain a nominal float voltage of 1.4 vpc and a nominal equalizing voltage of 1.6 vpc.
  3. The charger shall be capable of continuous operation in an ambient temperature of 40 degrees C (104 degrees F) without derating. The charger shall be convection cooled and housed in a NEMA type 1 ventilated enclosure. The charger shall have a hinged front door and all equipment shall be accessible from the front.
  4. Provide both AC and DC transient protection. Charger shall be able to recharge a fully discharged battery without tripping AC protective devices. AC circuit breaker shall not trip under any DC load condition including short circuit on output terminals.
  5. The charger shall be capable of supplying the following demands simultaneously and shall have a 10 ampere, 24 volt output:
    - a. Recharging in 12 hours a fully discharged battery.
    - b. Supervisory panel and control panel.
  6. The charger shall have fused AC input and shall have DC output protection.
  7. The charger shall not discharge the batteries when AC power fails.
  8. The charger shall have the following accessories:
    - a. On-Off control switch with pilot light.
    - b. Hand adjustable 0 to 24 hour equalize charge timer.
    - c. AC power failure alarm light.
    - d. High DC voltage alarm light.
    - e. DC voltmeter - 5% accuracy.
    - f. DC Ammeter - 5% accuracy
    - g. The charger shall be mounted inside of the generator enclosure.
  9. The charger shall be mounted inside of the generator enclosure.

## 2.11 ENGINE GENERATOR CONTROL:

The generator set shall be provided with a microprocessor-based control system which is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring, and control of the generator set, and remote monitoring and control as described in this specification. The generator set control shall be vibration isolated. All switches, lamps and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The controls shall meet or exceed the requirements of Mil-Std 461C part 9, and IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE587 for voltage surge resistance. The generator set mounted control shall include the following features and functions:

1. Starting and Stopping Controls:
  - a. A three position, maintained-contact type selector switch with positions marked "AUTOMATIC", "OFF" and "MANUAL". Provide flashing amber light for "OFF" and "MANUAL" Positions.
  - b. A momentary contact pushbutton switch with positions marked "MANUAL START" and "MANUAL STOP".
  - c. Automatic: Selector switch AUTOMATIC position shall cause the engine to start automatically when a single pole contact in a remote device closes. When the generator's output voltage increases to not less than 90 percent of its rated voltage, and its frequency increases to not less than 58 Hz, the remote devices shall transfer the load to the generator. An adjustable time delay relay, 0 to 30 minute range, shall cause the set to continue operating without any load after completion of the period of operation with load. Upon completion of the additional 0 to 30 minute period, the set shall stop.
  - d. Selector switch OFF position shall prevent the engine from starting either automatically or manually. Selector switch MANUAL position shall cause the engine to start when the manual start pushbutton is also depressed momentarily.
  - e. With selector switch MANUAL position, depressing the MANUAL STOP pushbutton momentarily shall stop the engine with cool down period.
  - f. A maintained contact, red mushroom head pushbutton switch marked "EMERGENCY STOP". This switch will cause the engine to stop without a cool down period independent of the position of the selector switch.
2. Engine Cranking Controls: **Controls meeting NFPA 99 and NFPA 110 shall be acceptable. [Add6-15.f]**
  - a. The cranking cycles shall be controlled by timer that will be independent of the battery voltage fluctuations.

- b. Shall crank the engine through one complete cranking cycle, which shall consist of three starting attempts of 10 seconds cranking each and 10 seconds between each attempt.
  - c. Total actual cranking time for the complete cranking cycle shall be 40 seconds during an 70 second interval.
  - d. Cranking shall terminate when the engine starts so the starting system will not be damaged. Termination of the cranking shall be controlled by self-contained, speed-sensitive switch. The switch shall prevent re-cranking of the engine until after the engine stops.
  - e. After the engine has stopped the cranking control shall reset.
3. Supervisory Controls: ***Controls meeting NFPA 99 and NFPA 110 shall be acceptable. [Add6-15.g]***
- a. Overcrank - When the cranking control system completes one cranking cycle, three starting attempts, without starting:
    - 1) OVERCRANK signal light shall be energized.
    - 2) Cranking control system shall lock-out and shall require a manual reset.
    - 3) The audible alarm shall be energized.
  - b. Coolant Temperature:
    - 1) When the temperature rises to the predetermined first stage level, the HIGH COOLANT TEMPERATURE - FIRST STAGE signal light and the audible alarm shall be energized.
    - 2) When the temperature rises to the predetermined second stage level, which shall be low enough to prevent damage to the engine and high enough to avoid unnecessary engine shutdowns, the HIGH COOLANT TEMPERATURE - SECOND STAGE signal light and the audible alarm shall be energized and the engine shall stop.
    - 3) Difference between the first and second stage temperature settings shall be approximately 10 degrees F.
    - 4) Permanently indicate the temperature settings near the associated signal light.
    - 5) When the coolant temperature drops to below 70 degrees F, the LOW COOLANT TEMPERATURE signal light and the audible alarm shall be energized.
  - c. Low Coolant Level: when the coolant level falls below the minimum level recommended by the manufacturer, the low coolant level signal light and audible alarm shall be energized.
  - d. Lubricating Oil Pressure:
    - 1) When the pressure falls to the predetermined first stage level, the OIL PRESSURE - FIRST STAGE signal light and the audible alarm shall be energized.
    - 2) When the pressure falls to the predetermined second stage level, which shall be high enough to prevent damage to the engine and low enough to avoid unnecessary engine shutdowns, the OIL PRESSURE - SECOND STAGE signal

- light and the audible alarm shall be energized and the engine shall stop.
- 3) Difference between the first and second stage pressure settings shall be approximately 15 percent of the oil pressure.
  - 4) Permanently indicate the pressure settings near the associated signal light.
- e. Overspeed:
- 1) When the engine RPM exceeds the maximum RPM recommended by the manufacturer of the engine, the engine shall stop.
  - 2) Simultaneously, the OVERSPEED signal light and the audible alarm shall be energized.
- f. Low Fuel - Main Storage Tank Signal Light:
- 1) Shall be energized when the fuel oil level in the storage tank decreases to less than 1/3 of total tank capacity.
  - 2) Simultaneously, the audible alarm shall be energized.
4. Generator Set Metering:  
The generator set shall be provided with a metering set with the following features and functions:
- 1) 2.5-inch, 90 degree scale analog voltmeter, ammeter, frequency meter, and kilowatt (KW) meters. These meters shall be provided with a phase select switch and an indicating lamp for upper and lower scale on the meters.
  - 2) Digital metering set, 0.5% accuracy, RMS type, to indicate generator voltage, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line to neutral or line to line simultaneously).
5. Generator Set Alarm and Status Indication:  
The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel:
- low oil pressure (alarm)
  - low oil pressure (shutdown)
  - oil pressure sender failure (alarm)
  - low engine temperature (alarm)
  - high engine temperature (alarm)
  - high engine temperature (shutdown)
  - engine temperature sender failure (alarm)
  - low coolant level (alarm or shutdown -- selectable)

- fail to crank (shutdown)
- overcrank (shutdown)
- overspeed (shutdown)
- low DC voltage (alarm)
- high DC voltage (alarm)
- weak battery (alarm)
- low fuel-daytank (alarm)
- high AC voltage (shutdown)
- low AC voltage (shutdown)
- under frequency (shutdown)
- over current (warning)
- over current (shutdown)
- short circuit (shutdown)
- over load (alarm)
- under frequency (alarm)

In addition, provisions shall be made for indication of two customer-specified alarm or shutdown conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

6. Engine Status Information:

The following information shall be available from a digital status panel on the generator set control:

- engine oil pressure (psi or kPA)
- engine coolant temperature (degrees F or C; Both left and right bank temperature shall be indicated on V-block engines.)
- engine oil temperature (degrees F or C)
- engine speed (rpm)
- number of hours of operation (hours)
- number of start attempts
- battery voltage (DC volts)

The control system shall include sender failure monitoring logic, which is capable of discriminating between failed sender or wiring components, and an actual failure condition.

7. Alternator Control Functions:

The generator set shall include an automatic voltage regulator. The voltage regulator shall be immune from misoperation due to load-induced voltage waveform distortion. The 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 limit overshoot. The

regulator shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 59 HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. The regulator shall include provisions reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.

Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 5 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.

Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.

Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

An AC over/under voltage monitoring system shall be provided which initiates shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or instantaneously when voltage exceeds 130%. Under voltage shall be indicated when the output voltage of the alternator is less than 85% for more than 10 seconds.

A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.

8. Power switching and overcurrent protection shall be accomplished with a molded case circuit breakers or a generator that is inherently protected.
  - a. Molded Case Circuit Breaker shall have the following features:
    - 1) Solid state adjustable trip type circuit breakers.
    - 2) Shall be in accordance with UL 489 and NEMA AB-1.
    - 3) Trip units shall have field adjustable tripping characteristics as follows:
      - a) Ampere setting.
      - b) Long time band.
      - c) Instantaneous trip point.
    - 4) Trip setting shall be as indicated on the drawings.
    - 5) Shall be 100 percent rated.
    - 6) Electrically and mechanically trip free.

- 7) Manual operating handle with lock-open padlocking provisions, and position indicators on the front of the breaker.
  - 8) Rear stud connection for both line and load sides.
  - 9) Shall include type "a" and "b" auxiliary contacts for interfacing with controls.
9. Automatic Voltage Regulator: (May be engine mounted with proper vibration isolation).
    - a. Shall maintain the generator's output voltage within plus or minus one percent for load variations between no load and full load.
    - b. Shall correct voltage fluctuations rapidly and restore the output voltage to the predetermined level with a minimum amount of hunting.
    - c. Shall include voltage level rheostat located inside the control cubicle.
  10. Governor: See paragraph, GOVERNOR FOR DIESEL ENGINE.
  11. Incorporate devices and circuits to protect the voltage regulator and other components of the auxiliary electrical power system during operation of the diesel engine-generator set at speeds other than the rated RPM while performing maintenance.

#### 2.12 REMOTE ANNUNCIATOR PANEL:

A remote annunciator panels shall be installed as required by code and/or by the Fire Marshall.

- A. The annunciator shall indicate alarm conditions of the emergency or auxiliary power source as follows:
  1. Individual visual signals plus a common audible alarm shall warn of the following:
 

High Battery Voltage	Battery voltage too high (over charging)
Low Battery Voltage	Battery voltage too low (charger failure)
Normal Battery Voltage	Battery voltage ok
Generator Running	Generator has output voltage
Normal Utility Power	Utility power supplying the load
EPS Supplying Load	Genset supplying the load
Pre-Low Oil Pressure	Oil pressure approaching low limit
Low Oil Pressure	Engine has shut down due to low oil pressure
Pre-High Coolant Temp	Temperature of coolant approaching high limit
High Coolant Temp	Genset has shutdown due to high coolant temp
Low Engine Temp	Engine has malfunctioned
Overspeed	Engine has shut down due to overspeed
Overcrank	Engine failed to start
Not in Auto	Engine control switch not in AUTO position
Battery Charger Malfunction	Charger is signaling a failure
Low Fuel	Fuel level below preset minimum

Low Coolant Level      Engine coolant below minimum level  
Customer Faults (3)    Customer preselcted condition

- B. The annunciator shall also have the following features:
1. One pushbutton momentary contact switch. Label switch "LAMP - TEST". Initiating this switch shall momentarily actuate the alarm buzzer and all the indicating lamps.
  2. Audible Alarm: There shall be an audible alarm, rated for 85 dB at 10 feet, which shall become actuated whenever an alarm condition occurs. A momentary-contact acknowledge pushbutton shall silence the audible alarm, but not clear the alarm lamp. Elimination of the alarm condition shall automatically release the seal-in circuit for the audible alarm and extinguish the alarm lamp.

### 2.13 TRANSFER SWITCH EQUIPMENT:

#### 2.13.1 Transfer Switch Equipment:

Complete factory assembled transfer equipment with electronic control designed for surge voltage isolation, voltage sensors on all phases of both sources, linear operator, manual handles, positive mechanical and electrical interlocking, and mechanically held contacts. Equipment rated 1200 amps and less shall include quick-make, quick-break contact mechanisms for manual transfer under load.

#### 2.13.2 Project Drawings:

Refer to the project drawings for specifications on the sizes and types of transfer switch equipment, number of poles, voltage and ampere ratings and enclosures.

All transfer switches and accessories shall be UL listed and labeled, tested per UL Standard 1008, and CSA Approved.

#### 2.13.3 Ratings:

Main contacts shall be rated for 600 Volts AC minimum.

Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure.

Transfer switches shall be continuously rated in ambient temperatures of -40 to +50 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet.

Transfer switch equipment shall have a withstand and closing rating (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the drawings.

#### 2.13.4 Construction:

Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishment. Arc chutes shall have insulating covers to prevent interphase flashover.

Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

Transfer switches shall be supplied with a switched neutral pole (4-poles). The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Equipment using add-on accessory overlapping contacts are not acceptable.

Transfer switches shall be mounted in NEMA 1 enclosures. The cabinet shall provide required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

#### 2.13.5 Automatic Controls:

Control shall be solid-state demonstrated by test to IEEE Standard 587-1980. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs.

Solid-state undervoltage sensors shall simultaneously monitor all phases of both sources. Pick-up and drop-out settings shall be adjustable. Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase. Voltage sensors shall have field calibration of actual supply voltage to nominal system voltage.

Controls shall be provided with a solid-state over and under frequency sensor to monitor both sources. Pickup bandwidth shall be adjustable from a minimum of  $\pm 4\%$  to a maximum of  $\pm 20\%$  of nominal frequency. Dropout shall be  $\pm 5\%$  of nominal wider than pickup frequency bandwidth. Adjustable time delay shall be from 0.1 to 15 sec.

Automatic controls shall signal the engine-generator set to start upon signal from normal source sensors. Solid-state time delay start, adjustable from 0 to 5 seconds (factory set at 2 seconds) shall avoid nuisance start-ups. Battery voltage starting contacts shall be gold, dry type contacts factory wired to a field wiring terminal block.

The switch shall transfer when the emergency source reaches the set point voltage and frequency. Provide a solid-state time delay on transfer, adjustable from 0 to 120 seconds.

The switch shall retransfer the load to the normal source after a time delay retransfer, adjustable from 0 to 30 minutes. Retransfer time delay shall be immediately bypassed if the emergency power source fails.

Controls shall signal the engine-generator set to stop after a time delay, adjustable from 0 to 10 minutes, beginning on return to the normal source.

Power for transfer operation shall be from the source to which the load is being transferred.

The control shall include latching diagnostic indicators to pinpoint the last successful step in the sequence of control functions, and to indicate the present status of the control functions in real time, as follows:

- Source 1 OK
- Start Gen Set
- Source 2 OK
- Transfer Timing
- Transfer Complete
- Retransfer Timing
- Retransfer Complete
- Timing for Stop

The control shall include provisions for remote transfer inhibit and area protection.

Transfer switches as designated on the drawings, shall be equipped with a field adjustable time delay during switching in both directions, during which time the load is isolated from both power sources, to allow load residual voltage to decay before closure to the opposite source. The delay feature shall have an adjustable range of 0 to 7.5 seconds. Phase angle monitor is not acceptable.

#### 2.13.6 Front Panel Devices:

Provide devices mounted on cabinet front consisting of:

A key-operated selector switch to provide the following positions and functions:

Test - Simulates normal power loss to control for testing of generator set. Controls shall provide for a test with or without load transfer.

Normal - Normal operating position.

Retransfer - Momentary position to override retransfer time delay and cause immediate return to normal source, if available.

#### 2.13.7 Accessory Items:

Transfer switches as shown on the drawings shall be equipped with accessories as follows:

A. Exerciser Clock: Provide solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. Provide a with/without load selector switch for the exercise period.

B. Manual Selector Switch: Provide a manual/automatic retransfer selector switch to provide either automatic retransfer after the retransfer time delay, or a manual retransfer when selected by an operator. Selector to be located on the 600 amp switch serving the operating rooms.

2.14 SOUND ATTENUATED, WEATHER PROTECTED ENCLOSURE AND DOUBLE WALL FUEL TANK:

Enclosure and dual wall fuel tank base will conform to the following specification with no exceptions.

Enclosure and fuel tank combination shall conform to the following limitations.

Entire enclosure and sound hoods to be sound attenuated to meet 85 dba at 3 ft. from enclosure overall average.

~~Enclosure will be all bolt together construction.~~ Custom or welded enclosures are not acceptable. Fuel tank will be warranted ~~for a minimum of 10 years~~ to be free of any defects and leaks. **A 5-year warranty on fuel tank shall be acceptable and fuel tank shall be UL 142 listed. Delete requirement for tank to be bolted together only. [Add6-15.h]**

- A. Surface preparation and shop painting will be as follows for the enclosure and fuel tank. All steel will be chemically cleaned and phosphitized before priming. All enclosure parts must be individually phosphitized, primed and painted. ~~Primer coat will be MIL-P-23377 epoxy polyamide primer.~~ Finish coat will be acrylic enamel with engine manufacturers standard color. **Delete mil spec requirement for primer. [Add6-15.i]**
- B. Dual-wall tank to be same perimeter size as enclosure so that enclosure mounts directly to fuel tank base. Complete assembly will have four point lift.
- C. Folded sheet steel tanks will not be acceptable.
- D. Base tank will have four (4) point lifting lugs of adequate capacity with two (2) located on right side and two (2) located on left side of tank.
- E. Fuel plate will be located next to fuel system and engine plate will be gasketed. Plate is removable for inspection. Fuel plate also contains the following:
  - A. 2" locking fuel fill cap
  - B. Engine fuel suction port
  - C. Engine fuel return port
  - D. Mechanical fuel gauge
  - E. Low fuel level alarm contact to sound alarm for less than three (3) hours remaining fuel supply.
  - F. 1-1/2" vent whistle to prevent overfill situation.
- F.
  - A. Main tank to have 3/4" NPT drain.
  - B. Secondary tank to have 3/4" drain.
  - C. Fuel sensing alarm to be located in secondary tank.

- G. A. Emergency vent for main tank area.  
B. Emergency vent for rupture tank area.
- H. Bottom flange of base tank will be drilled on left and right side for mounting purposes.
- I. Engine generator set will be bolted to vibration isolator springs. Mounting blocks are to be welded to the base tank structural supports. **Vibration isolation pads shall be acceptable. [Add6-15.j]**
- J. Provide access hole through fuel tank for main power cables.
- K. Diesel fuel storage base tank shall have a capacity to allow for 48 hours full load run.  
  
Fuel tank will be dual wall and require (110%) times the capacity of main tank.
- L. Base tank shall consist of ASTM-A36 wide flange main beams on all four sides. All cross members are to be ASTM-A36 structural wide flange beam, located under all mounting points of complete generator set.
- M. All plate must conform to ANSI/UL 142-93. No less than 10 gauge ASTM-A569 shall be used on rupture floor of tank. Main floor will be reinforced on the inside to prevent flexing. Upper floor plate shall be no less than 7 gauge.
- N. Weatherproof 14 gauge formed cold-rolled steel enclosure. Enclosure will be designed to be tamper-proof and provide weather protection from driving rain. All servicing and operation of generator set shall be accessible from door openings. All equipment and devices within enclosure shall be factory wired and plumbed before shipment. According to local codes.
- O. Load test of proof equal to fifty (50) pounds per square foot. **Test criteria must meet ANSI Standards for geographic area of installation. [Add6-15.k]**
- P. Wind test equal to one-hundred and fifty (150) miles per hour.
- Q. All hardware used will be stainless steel. Enclosure will be fastened together on the interior with no less than grade 5 bolts. Flat washers and locknuts standard. All exposed exterior bolts are carriage bolts for tamper proof protection along with flat washers and locknuts.
- R. Air intake louvers to have bird screens and are to be fixed.
- S. Doors are solid type and have stainless steel continuous piano hinges for smooth workability. All doors to be solid with recessed panels for door handles. All door handles are key locked the same with two point latch system. Door locations are in relation to generator controls, main line circuit breaker, oil and fuel filters, and all service points. Doors will be on left and right side at rear. (Welding hinge to any part is not acceptable.)

- T. Roof will be drip proof design. Provide lockable and hinged radiator access door located over radiator cap for filling.
- U. Conduit or wires will not be allowed to run in the path of walking areas.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION:

- A. Mounting:
  - 1. Support the base of engine-generator set on vibration isolators, each isolator bolted to the floor (pad), base bolted to isolator.
  - 2. Install sufficient number of isolators so that the floor (pad) bearing pressure under each isolator is within the floor (pad) loading specification.
  - 3. Install equal number of isolators on each side of the engine-generator set's base.
  - 4. Locate isolators for approximately equal load distribution and deflection per isolator. Drill the base of the engine-generator set at the factory for the isolator bolts.
  - 5. Isolators shall be shipped loose with the engine-generator set.
  - 6. All connections between the engine-generator set and exterior systems (such as fuel lines electrical connections, engine exhaust system and air exhaust shroud) shall be flexible.
  - 7. Each isolator shall be the spring type with a neoprene acoustical friction pad, a minimum of 1/4-inch thick.
  - 8. Each isolator shall be adjustable for leveling and load distribution.
  - 9. The isolators shall be constrained with restraints capable of withstanding static forces in any direction equal to twice the weight of the supported equipment.
- B. Balance:
  - 1. The peak-to-peak amplitude of vibration velocity in the horizontal, vertical and axial directions shall not exceed 0.65 inch per second at main structural components such as the engine block of the generator frame at the bearings.
  - 2. Balance the engine-generator set statically and dynamically at the factory in order to comply with the maximum specified vibration velocity.
- C. Connect all components of the engine generator power system so that they will continue to be energized by the auxiliary electrical power system during failures of the normal electrical power supply system.
- D. Install piping between diesel engine and remote components of fuel and exhaust systems.

- E. Control and Signal Systems: Furnish, install and connect conduits and wiring devices for complete fully operational control and signal systems. Include interconnections between local control cubicles, remote annunciator panels, remote derangement panels, remote monitoring panels, remote exercising panels and underground fuel storage tanks.

3.2 SPARE PARTS: Furnish the following:

- A. For each engine-generator set:
  - 1. One lubricating oil filters.
  - 2. One primary fuel oil filters.
  - 3. One secondary fuel oil filters.
  - 4. One intake air filters.
- B. For each battery charger:
  - 1. Three complete sets of fuses.
  - 2. One complete set of indicating lamps.
- C. For each control and supervisory panel:
  - 1. Three complete sets of fuses.
  - 2. One complete set of indicating lamps.

3.3 TECHNICAL SERVICES DURING INSTALLATION AND TEST:

- A. At the construction site, provide the services of a competent, factory-trained engineer or technician employed by the manufacturer of the diesel engine-generator set to technically supervise and participate during all of the adjustments and tests for the set and major auxiliaries. Adjustments and test shall be made in the presence of the Architect.
- B. When the complete auxiliary electrical power system has been installed and prior to the final inspection, test all components of the system in the presence of the Resident Engineer for proper operation of the individual components and the complete system and to eliminate electrical and mechanical defects.
- C. Construction Site Tests for the Diesel Engine-Generator Set:
  - 1. Shall include four hours of continuous operation while the set is delivering 100 percent of its specified KW rating:
    - a. If during the 4 hour continuous test a shutdown should occur, to either the diesel engine or to the full KW rating of the load bank, the test is void. Another 4 hour continuous test shall be performed.
  - 2. During the test, record the following data at 30 minute intervals:
    - a. Time of day, also reading of running time indicator.
    - b. KW.

- c. Voltage on each phase.
  - d. Amperes on each phase.
  - e. Engine RPM.
  - f. Frequency.
  - g. Engine water temperature.
  - h. Fuel pressure
  - i. Oil pressure.
  - j. Outside temperature
  - k. Average ambient temperature in the vicinity of the diesel engine.
  - l. Average ambient temperature in the vicinity of the starting batteries.
- 3. Test for Starting System: Demonstrate that the batteries and cranking motor are capable of 5 starting attempts of 10 second cranking each at 10 second intervals with the battery charger turned off.
  - 4. Test local and remote panels: Simulate engine failures while checking for proper operation of each indicating lamp, alarm device and reset button.
  - 5. Demonstrate that the generator will obtain proper voltage, frequency and will accept 100 percent block load within 10 seconds from a cold start after the closing of a single contact.
- D. Furnish a resistance type load for the testing.
    - 1. Test loads shall always include adequate resistance to assure stability of the loads and equipment during all of the testing operations. The test load KW rating:
      - a. Shall not be less than 110 percent of the specified KW rating of the generator set.
- E. At the completion of the construction site test.
    - 1. Furnish the fuel oil, lubricating oil, anti-freeze liquid, water treatment and rust inhibitor for testing of the diesel engine-generator set.
    - 2. When any defects are detected, correct the defects and repeat all or part of the complete four hour continuous test as requested by the Architect at no additional cost to the Owner.

#### 3.4 INSTRUCTIONS AND FINAL INSPECTIONS:

- A. Laminate or mount under plexiglas a set of operating instructions for the system and install instructions within a frame mounted on the wall near the diesel engine-generator set as requested by the owner.
- B. At the final inspection in the presence of a the Owner's representative, demonstrate that the complete auxiliary electrical power system operates properly in every respect.

- C. Furnish the services of a competent, factory-trained engineer or technician for five, 4-hour periods for instruction personnel in operation and maintenance of the equipment, on the dates requested by the.

END OF SECTION