

## **SECTION VIII**

### **(Sub-Section 472)**

#### **Diesel Engine Driven Generator With Weatherproof Enclosure**

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**DIESEL ENGINE DRIVEN GENERATOR  
WITH WEATHERPROOF ENCLOSURE  
SUB-SECTION 472**

**1.0 GENERAL**

**1.1 SCOPE OF WORK**

- 1.1.1 Furnish all labor, materials, equipment, and incidentals required to install, put into operation, and field test the weatherproof diesel engine driven generator units and appurtenances as shown on the Drawings and specified herein.
- 1.1.2 These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, the shop testing, and delivery and complete installation and field testing, of all materials, equipment and appurtenances for the complete units as herein specified, whether specifically mentioned in these Specifications or not.
- 1.1.3 For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. This installation shall incorporate the highest standards for the type of service shown on the Drawings. The CONTRACTOR is responsible for field testing of the entire installation and instruction of the regular operating personnel in the care, operation and maintenance of all equipment.

**1.2 DESCRIPTION OF SYSTEMS**

- 1.2.1 The engine-generator set shall be mounted as shown on the Drawings and shall be arranged for automatic starting and stopping, and load transfer upon failure of the normal source of power. The unit control shall provide for automatic exercising on a weekly basis.

### 1.3 QUALIFICATIONS

- 1.3.1 The engine-generator set shall be the standard product, as modified by these specifications, of a MANUFACTURER regularly engaged in the production of this type of equipment. The unit to be furnished shall be of proven ability and shall be designed, constructed, and installed in accordance with best practices and methods. To qualify as a MANUFACTURER, the engine must be the principal item manufactured and the completed engine generator set shall be supplied by the Manufacturer's authorized dealer only. The dealer shall have a minimum of ten (10) years experience in the field of power generation.
- 1.3.2 It is the intent of this specification to secure an emergency generator system that has been prototype tested, factory built, production tested, site tested and of the latest commercial design, together with all accessories necessary for complete installation as shown on the plans and drawings, and specifications herein. The equipment supplied and installed shall meet the requirements of the NEC, along with all applicable local codes and regulations. All equipment shall be new, of current production of a national firm which manufactures the engine/generator and controls, transfer switch and switch gear, and assembles the emergency generator system as a matched unit so that there is a one-source responsibility for warranty, parts, and service through a local representative with a factory-trained serviceman.
- 1.3.3 The unit must be of such physical dimensions as to make a good installation in the opinion of the ENGINEER, in the space provided as indicated on the Drawings.
- 1.3.4 The unit shall be assembled in the U.S. with over 50% of the components such as the engine, generator, auxiliary equipment, etc., manufactured in the U.S. by a MANUFACTURER currently engaged in the production of such equipment.
- 1.3.5 The unit shall be shipped to the job site by an authorized engine dealer having a parts and service facility with a 250 mile radius of the job site. In addition, and in order not to penalize the OWNER for unnecessary or prolonged periods of time for service or repairs to the emergency system, the bidding generator set supplier must have no less than eighty percent (80%) of all engine replacements parts locally available at all times. Certified proof of this requirement shall be furnished to the ENGINEER upon request.

- 1.3.6 All materials and parts comprising the unit shall be new and unused, of current manufacture, and of the highest grade, free from all defects of imperfections. Workmanship shall conform to the best modern practices. Only new and current models will be considered. The unit offered under these Specifications shall be the product of a firm regularly engaged in the production of engine-generator equipment and shall meet the requirements of the Specifications set forth herein. Major exceptions to Specifications will be considered sufficient cause for rejection of the machines.
- 1.3.7 The Engine/Generator Unit shall be as manufactured by Caterpillar, Cummins, or Detroit Diesel.

#### 1.4 SUBMITTALS

- 1.4.1 Submittal shall include prototype test certification and specification sheets showing all standard and optional accessories to be supplied, schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required for interconnection between generator set, the transfer switch, and the switch gear panels included elsewhere in these Specifications.
- 1.4.2 The successful bidder shall submit to the ENGINEER for review in accordance with other sections, complete sets of installation drawings, schematics and wiring diagrams, which shall show details of installation and connections to the work of other Sections, including foundation drawings showing location and size of foundation bolts for the spring type vibration isolators and brochures covering each item of equipment.
- 1.4.3 In the event that it is impossible to conform with certain details of the Specifications due to different manufacturing techniques, describe completely all nonconforming aspects.
- 1.4.4 The submittal data for each engine/generator set and weatherproof enclosure shall include, but not necessarily be limited to the following:
  - 1.4.4.1 Installation drawings showing plan and elevations of the complete generator unit; foundation plan; exhaust silencer; starting battery; battery charger; weatherproof enclosure and base mounted fuel tank.

1.4.4.2 Engine Data:

- A. MANUFACTURER
- B. MODEL
- C. Number of Cylinders
- D. RPM
- E. Bore x stroke
- F. BMEP at full rated load
- G. Piston speed, FPM
- H. Make and model and descriptive literature of electric governor (where required)
- I. Fuel consumption rate curves at various loads
- J. Engine continuous pump drive duty rating (without fan) HP
- K. Gross engine horsepower to produce generator standby rating (including fan and all parasitic loads) HP

1.4.4.3 Generator Data:

- A. MANUFACTURER
- B. Model
- C. Rated KVA
- D. Rated SKVA
- E. Rated kw
- F. Voltage
- G. Temperature rise above 40 degree C ambient
  - 1) Stator by thermometer
  - 2) Field by resistance
  - 3) Class of insulation
- H. Generator efficiency including excitation losses and at 80 percent power factor.
  - 1) Full load
  - 2) 3/4 load
  - 3) 1/2 load

1.4.4.4 Generator Unit Control Data:

- 1.4.4.4.1 Actual electrical diagrams including schematic diagrams, and interconnection wiring diagrams for all equipment to be provided. Standard preprinted sheets are not acceptable.

1.4.4.4.2 Legends for all devices on all diagrams.

1.4.4.4.3 Sequence of operation explanations for all portions of all schematic wiring diagrams.

1.4.5 Engine/Generator Unit and Weatherproof Enclosure: Dimensional data shall be given for the Engine/Generator set and for the weatherproof enclosure.

- a. Weight of skid mounted unit
- b. Overall length
- c. Overall width
- d. Overall height
- e. Exhaust pipe size
- f. CFM of air required for combustion and ventilation
- g. Heat rejected to jacket water and lubricating oil BTU/hr.
- h. Heat rejected to room by engine and generator BTU/hr.
- i. Weatherproof enclosure details and certification of manufacturing method per specifications.
- j. Base fuel tank, venting fuel connection points and fill cap location
- k. Data on all miscellaneous items supplied.

1.4.6 Optional System Service Contract

a. Equipment Supplier Company

Name  
Address  
City/State  
Phone Number

b. Attach the number of copies required of System Service Contract to submittal

1.4.7 Furnish the number of copies required of the MANUFACTURER's certified shop test record of each complete engine driven generator unit.

1.4.8 Warranty information

1.4.9 Submit to the ENGINEER operating and maintenance data.

1.4.10 Submit to the ENGINEER the equipment MANUFACTURER's Certificate of Installation, Testing and Instruction.

1.4.11 Submit to the ENGINEER the written warranty as required in Paragraph 3.06 below.

1.5 TESTING: To assure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer and local representative shall be responsible for three separate tests: design prototype tests, final production tests, and site tests.

1.5.1 Design Prototype Tests: Components of the emergency system such as the engine/generator set, transfer switch, and accessories shall not be subjected to prototype tests since the tests are potentially damaging. Rather, similar design prototypes and pre-production models, which will not be sold, shall have been used for the following tests. Prototype test programs shall include the requirements of NFPA 110 and the following:

- 1.5.1.1 Maximum power (KW)
- 1.5.1.2 Maximum motor starting (KVA) instantaneous voltage dip.
- 1.5.1.3 Alternator temperature rise by embedded thermocouple and by resistance method per NEMA MG1-2240 and 16.40.
- 1.5.1.4 Governor speed regulation under steady-state and transient conditions.
- 1.5.1.5 Voltage regulation and generator transient response.
- 1.5.1.6 Fuel consumption at 1/4, 1/2, 3/4, and full load.
- 1.5.1.7 Harmonic analysis, voltage waveform deviation, and telephone influence factor.
- 1.5.1.8 Three-phase shore circuit tests.
- 1.5.1.9 Alternator cooling air flow.
- 1.5.1.10 Torsional analysis testing to verify that the generator set is free of harmful torsional stress.
- 1.5.1.11 Endurance testing.

1.5.2 Final Production Tests: Each generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include:

1.5.1.1 Transient and steady-state governing.

1.5.1.2 Safety shutdown device testing.

1.5.1.3 Voltage regulation.

1.5.1.4 Rated power.

1.5.1.5 Maximum power.

1.5.1.6 Upon request, arrangements to either witness this test will be made, or a certified test record will be sent prior to shipment.

1.5.3 Site Tests: An installation check, start-up and building load test shall be performed by the manufacturer's local representative. The Engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include:

1.5.3.1 Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present and expected.

1.5.3.2 Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. These shall include: block heaters, battery charger, generator strip heaters, remote annunciator, etc.

1.5.3.3 Start-up under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage, and phase rotation.

1.5.3.4 Automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator voltage, amperes, and frequency shall be monitored throughout the test. An external load bank shall be connected to the system if sufficient building load is unavailable to load the generator to the nameplate KW rating.



## 1.6 SPECIAL TOOLS AND SPARE PARTS

- 1.6.1 Furnish one (1) set of all special tools required for normal operation and maintenance of the equipment being furnished. Furnish suitable tool chests complete with locks and duplicate keys
- 1.6.2 The MANUFACTURER shall furnish two (2) complete spare replacement sets of all filter elements required for each generator unit.

## 2.0 PRODUCTS

### 2.1 RATINGS

- 2.1.1 The standby rating of the generator sets shall not exceed the Manufacturer's published prime rating by more than 10%. The gross engine horsepower required to produce the standby rating shall not exceed the Manufacturer's published continuous duty rating by more than 150 percent. Continuous duty rating shall be defined as in BS649 or DIN6270 but in no case shall it exceed the MANUFACTURER'S published continuous duty rating for the engine as used in continuous rated pump drive applications. The gross engine horsepower required for the generator set standby rating described above shall include all parasitic demands such as generator inefficiencies, fuel pumps, water pumps, radiator fan (for fan cooled models) and all accessories necessary to unit's proper operation while operating at rated load and at a rotative speed not to exceed 1800 rpm.
- 2.1.2 The diesel engine driven generator set shall be capable of producing the specified standby kw rating for continuous electrical service during interruption of the normal utility source and shall be certified to this effect by the MANUFACTURER for the actual unit supplied.
- 2.1.3 The Diesel Engine/Generator Unit shall be rated as determined by the project engineer, but shall not be less than 125% of start-up load.

### 2.2 ENGINES

- 2.2.1 The engine shall be full compression ignition, four cycle, single acting, solid injection engines, either vertical or "V" type. Speed shall not exceed 1800 revolutions per minute at normal full load operation. Multi block engines are not allowed. The engine governor shall be electronic type with a +/- 0.5 percent accuracy. Governor shall be by Woodward, Barber Coleman or Cummins EFC.

- 2.2.2 The engine shall be capable of satisfactory performance on No. 2 fuel oil (ASTM Designation D396). Diesel engines requiring a premium fuel will not be considered.
- 2.2.3 The engine shall be capable of operating at light loads for extended periods of time and shall provide a means to reduce carbonization. Periodic cleaning of exhaust ports shall not be required.
- 2.2.4 The engine shall be equipped with fuel filters, lube oil filters, intake air filters, lube oil cooler, fuel transfer pump, fuel priming pump, service meter, engine driven water pump, and unit mounted instruments. Unit mounted instruments shall include a fuel pressure gauge, water temperature gauge, and lubrication oil pressure gauge. The engine shall be provided with low oil pressure, high water temperature, low coolant level and overspeed safety shutdowns of the manual reset type. Additional instruments and safety shutdowns shall be provided as a noted herein.
- 2.2.5 Injection pumps and injection valves shall be a type not requiring adjustment in service and shall be of a design allowing quick replacement by ordinary mechanics without special diesel experience. The engine shall have an individual mechanical injection pump and injection valve for each cylinder, any one of which may be removed and replaced from parts stock. Fuel injection pumps shall be positive action, constant-stroke pumps, activated by a cam driven by gears from the engine crankshaft. Fuel lines between injection pumps and valves shall be a heavy seamless tubing.
- 2.2.6 The fuel system shall be equipped with fuel filters having replaceable elements. Filter elements shall be easily removable from their housing for replacing without breaking any fuel line connections, or disturbing the fuel pump, or any other part of the engine. All fuel filters shall be conveniently located in one accessible housing, ahead of the injection pumps so that the fuel will have been thoroughly filtered before it reaches the pump. No screens or filters requiring cleaning or replacement shall be used in the injection pump or injection valve assemblies. The engines shall be equipped with a built-in gear-type, engine-driven fuel transfer pump, capable of supplying fuel through the filters to the injection pump at constant pressure.
- 2.2.7 In addition to the standard fuel filters provided by the engine MANUFACTURER, there shall also be installed a primary fuel filter and a water separator in the fuel inlet line to the engine.

- 2.2.8 The engine shall be provided with removable wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness as required for maximum liner life. The cylinder block shall be a one piece stress relieved gray iron casting.
- 2.2.9 The engine shall have a gear-type lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, piston pins, timing gears, camshaft bearings, valve rocker mechanism and governor. Effective lubricating oil filters shall be provided and so located and connected that all oil being circulated is continuously filtered and cleaned. Filters shall be accessible, easily removed and cleaned and shall be equipped with a spring-loaded by-pass valve as an insurance against stopping of lubricating oil circulation in the event the filters become clogged. The engine shall have a suitable water cooled lubricating oil cooler.
- 2.2.10 The engine shall be provided with one or more engine mounted dry type air cleaners of sufficient capacity to protect effectively the working parts of the engine from dust and grit.
- 2.2.11 During each initial start of the engine, a system shall be provided to pre-lube at low idle speed. When the internal oil pressure reaches a predetermined safe value, the engine will then increase to generator set operation speed.
- 2.2.12 Mounting: The unit shall be mounted on a structural steel sub-base and shall be provided with spring type vibration isolators.

### 2.3 COOLING SYSTEMS

- 2.3.1 The engine shall be furnished with a unit mounted radiator-type cooling system having sufficient capacity for cooling the engines when the diesel generator set is delivering full rated load in an ambient temperature not to exceed 110 degrees F. The engine shall be provided with a thermostatic valve placed in the jacket water outlet between the engine and the cooling source. This valve shall maintain the proper jacket water temperature under all load conditions. Total air restriction from the radiator shall not exceed 0.5 inches of water at both inlet and outlet. A flexible connecting section shall be provided between the radiator and discharge louver frame.
- 2.3.2 Closed circuit jacket water systems shall be treated with a rust inhibitor as recommended by the engine MANUFACTURER.

2.3.3 Provide one (1) or two (2) unit mounted thermal circulation type water heaters incorporating a thermostatic switch shall be furnished to maintain engine jacket water at minimum of 70 degrees F. The heaters shall be 240 volt, single phase, 60 Hertz, size as required to achieve above noted ambient.

2.3.4 The expansion tank of the radiator shall be fitted with a low water level switch and wired into safety shutdown system of the unit.

## 2.4 GENERATOR, EXCITER AND ACCESSORIES

2.4.1 Rating: The generator shall be rated as determined by the project engineer as to the required kw and as follows:

The kw rating at 0.8 p.f., 1800 RPM 3 phase, 60 Hertz, 120/240 volts, 4 leads, with a maximum temperature rise of 130 degrees C (both armature and field) by resistance at full rated load in ambient air of 40 degrees C. The generator shall conform to NEMA Standard MG-1. The engine/generator set shall be capable of starting the specified pumps and motors of the submersible type. Starting method shall be assumed to be soft start, solid state type.

2.4.2 Performance: The instantaneous voltage dip shall not exceed 30 percent of rated voltage when full load, at rated power factor, is suddenly applied. Recovery of stable operation shall occur within 5 seconds. Steady state modulation shall not exceed +1/2 percent.

2.4.3 Construction:

2.4.3.1 The generator and exciter shall be dripproof, with split sleeve, or ball race bearings. A shaft-mounted brushless exciter shall be a part of the assembly. The stator core shall be built up of high grade silicon steel laminations precision punched, and individually insulated. Armature lamination follower and frame ribs shall be welded integral with the frames for support of the stator core. A directional blower shall be mounted on the unit to draw cooling air from the exciter and over the rotor poles and through louvered openings on the opposite ends.

2.4.3.2 The exciteer shall be a fast response type, with a rotating 3-phase full-wave bridge. The exciter shall have a low time constant and large capacity to minimize voltage transients under severe load changes.

2.4.3.3 Generator stator and exciter stator windings shall be a full Class H insulated system vacuum impregnated with epoxy resin which after curing shall have additional treatment epoxy for resistance to an environment of moisture and salt air. Generator coils shall be random or machine wound, and precision made, with turn-to-turn and ground insulation of glass yard and mica materials. The average di-electric strength for the form wound coils of the ground and end turn insulation shall not be less than 400 volts per mil. Spacers shall be tightly secured between end turns, and the end turn assembly securely lashed to the support rings.

2.4.3.4 Generator rotor poles shall be built up of individually insulated silicon steel punchings. Poles shall be wound and bonded with high strength epoxy resin. Cage connections to the amortisseur rings shall be brazed for strong construction and permanent electrical characteristics. Each pole shall be securely bolted to the rotor shaft with bolts sized for centrifugal forces on the rotor. Generator windings shall be braced for full line to ground fault currents, with solidly grounded neutral system.

#### 2.4.4 Accessories and Attachments

2.4.4.1 Low Voltage Terminal Boxes: The generator shall have separate AC and DC low voltage terminal boxes with suitably numbered terminal strip for required connections.

2.4.4.2 Space Heaters: Space heaters shall be installed on the generator frame to maintain temperature of the entire generator above the dew point while not in use. Power supply shall be 120 volts single phase. Heaters will be automatically disconnected when engine starts. The magnetic starter for the heaters shall be mounted in the terminal box. Furnishing and installation of control and starter to be by engine/generator supplier.

#### 2.4.5.1 Voltage Regulator:

2.4.5.1.1 The generator MANUFACTURER shall furnish a hermetically sealed, silicon controlled rectifier type voltage regulator employing a zener reference with a +1 regulation for the generator. The regulator shall include a 3-phase voltage sensing, automatic short circuit protection and shall include automatic under-frequency protection to allow the generator to operate at no load less than synchronous speed for engine start-up and shutdown procedures. Switches and/or fuses shall not be used to provide this protection. An over-voltage sensing module with manual reset shall be furnished with the regulator. A volts per Hz., sensing module shall be provided as part of the regulation system.

2.4.5.1.2 A voltage adjustment rheostat for 5 percent voltage adjustment on the unit shall be provided.

2.4.5.1.3 High voltage step-down potential transformers shall be provided for the voltage regulator power input and sensing circuits if required.

2.4.5.2 Sustained Short Circuit: A permanent magnetic exciter shall be provided on the unit for sustaining a current of 300 percent during a short circuit, permitting the generator breaker to trip on overload. To prevent possible overheating of the armature windings, appropriate relaying shall be supplied to limit the fault to ten seconds. All current transformers required shall be supplied by the switch gear MANUFACTURER.

## 2.6 WEATHER-PROTECTIVE ENCLOSURE

2.6.1 The intent of this Specification is to provide a weatherproof type generator set enclosure complete in every detail and requiring no additional in-field modifications or assembly, except where specifically allowed by these Specifications. The enclosure is to be accurately dimensioned so as to be in compliance with the National Electrical Code (NEC), and the National Fire Protection Association (NFPA) for clearance of all specified items included therein, and all applicable fire codes for a structure and application of this type.

2.6.2 The enclosure shall be of steel construction. The design and construction shall be modular in that the side panels, doors, and louvers shall be a minimum thickness of 14 gauge for all component parts. The roof of the enclosure shall meet or exceed the minimum gauge requirements specified but, in addition shall be strengthened in such a manner as to support the largest commercially available exhaust silencer recommended by the MANUFACTURER for this application.

2.6.2.1 Construction – All steel used in the construction of the enclosure shall be galvanized with painted finish. This sequence of metal forming, and final assembly of the enclosure must be noted on the drawings submitted for approval and a factory certification of this manufacturing process shall accompany the “as-built” drawings provided to the OWNER. Walls shall be a minimum 14 gauge and the roof shall be a minimum 12 gauge.

2.6.2.2 Doors – All doors on the enclosure shall be strategically located in areas as to allow ease of maintenance on the generator set and allow good access to and visibility of instruments, control, engines gauges, etc. The doors shall be fitted with bolt-on, stainless steel hinge pins of a diameter not less than 0.25-inch (1/4-inch). Each door shall be fitted with flush-mounted, adjustable, key-lock latches. Enclosure shall be rated for 140 MPH constant wind. Certified calculations shall be provided.

2.6.2.3 Louvers – All louvers fixed and drainable with bird screen and shall be designed to prevent the entrance of driving rainwater, but shall have sufficient free area to allow for 120% of the total engine/generator cooling air requirements used in this application. Maximum air velocity shall be 700 CFM. MANUFACTURER shall submit to air calculations to engineer for review.

- 2.6.2.4 Components – All components of the enclosure shall be assembled utilizing 0.375-inch minimum stainless steel bolts, nuts, and lock washers. In addition, watertight neoprene flat washers shall be used on all roof bolts.
- 2.6.2.5 The MANUFACTURER of the enclosures shall provide mounting brackets for the exhaust silencer specified. In addition, a tail pipe extension shall be provided, terminating in a horizontal plane and cut at a 45° angle to prevent the entrance of the water. Stainless steel, seamless flexible exhaust tube and all necessary bolts, flanges, and gaskets to mate with the engine and the exhaust silencer shall be provided. The length of the flexible tubing shall be such that additional solid metal nipples or sections shall not be required to be provided as spacers between the engine exhaust port or the exhaust silencer.
- 2.6.2.6 Oil and Water Drains – All necessary fittings, hoses, shut-off valves, etc., shall be provided by the MANUFACTURER of the enclosure to facilitate lube oil and water drain at the exterior of the enclosure. In addition, engines equipped with crank-case breather tubes shall have this tube terminate at the exterior of the enclosure directly under the radiator air discharge louver.
- 2.6.2.7 Enclosure – The enclosure shall be rigidly mounted to generator support rails.
- 2.6.2.8 Under no circumstances shall the floor area or any of its parts be considered for cooling air intake or discharge requirements of the generator set or its associated equipment, nor shall its properties as a “heat sink” or heat dissipating medium be utilized in any manner whatsoever in this application.
- 2.6.2.9 All items specified herein shall be supplied and pre-wired and/preinstalled including, but not limited to the following:



- 2.6.2.9.1 Rain dress for exhaust pipe and tail pipe extension. Rain dress shall prevent the entrance of rain and allow the expansion and vibration of the exhaust piping without stress to the exhaust system. Rain dress shall be stainless steel and provided by the enclosure supplier.
- 2.6.2.9.2 Coordination between CONTRACTOR and Supplier is mandatory and the equipment Supplier's instructions will be adhered to without exception.

## 2.7 FUEL SYSTEM

- 2.7.1 Base and Mounting – The generator sets and enclosures shall be mounted and shipped to the job site on the formed steel sub-base manufactured by Chillicothe Metal Company or approved equal. Provisions for crane unloading of the complete package shall be designed into the base of the unit. The base and enclosures assembly shall allow room within the package to mount and maintain the specified battery charger, engine starting batteries, racks, and cables, main line circuit breaker, and engine-generator control panel, and other items as specified or as shown on the drawings.
- 2.7.2 The enclosure assembly shall allow room within the package to mount and maintain the following:
  - Not less than a 100 amp, 120/240 volts, 1-phase, 3-wire load center.
- 2.7.3 The weight of the entire unit consisting of generator set, base, enclosure, and all other specified items including all liquids (i.e., fuel oil, lube oil, and cooling water) shall be calculated by the MANUFACTURER. The base of the unit shall be designed and manufactured as a heavy duty, formed steel construction with four(4) point lifting provision to support the calculated weight. Details and MANUFACTURER's certification of the base construction shall be included with the drawings submitted for approval as well as all weight calculations.

- 2.7.4 Base Tank – The unit shall be equipped with a double wall in-base fuel tank and shall be supplied with a lockable, exterior located fill cap. All necessary fuel and vent lines for proper engine performance shall be provided as well as a means to readily detect the fuel level in the tank without the use of a measuring stick. Fuel tanks to be sized as follows:  
Furnish a 200-gallon minimum capacity.
- 2.7.5 The fuel tank base dimensions shall be full size of the generator base and be formed from steel of a minimum metal thickness of 0.25-inch (1/4-inch) and shall be fitted with low fuel level inner wall leak alarm contact for local and remote annunciation.
- 2.7.6 Filter/Separator-In-addition to the standard fuel filters provided by the engine MANUFACTURER, there shall also be installed a primary fuel/filter/water separator in the fuel inlet line to the engine. The filter shall be a Racor simplex or duplex Model 1000, as required for proper fuel flow. It shall be supplied and installed by the enclosure supplier.

## 2.8 EXHAUST SYSTEM

- 2.8.1 Exhaust Silencer – A critical type, side inlet, end outlet, Maxim M-21, or Silex JB silencer and a flexible stainless steel exhaust fitting properly sized shall be furnished and installed according to the Manufacturer's recommendation. Mounting shall be provided by the CONTRACTOR as required. The silencer shall be mounted so that its weight is not supported by the engine nor will exhaust system growth due to thermal expansion be imposed on the engine. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine MANUFACTURER. So called "spiral" or truck mufflers are disallowed and will be considered as equal to the industrial quality silencers specified above.
- 2.8.2 The silencer shall be fitted with a tail pipe extension terminating at a 45° angle to prevent the entrance of rainwater. It shall also be fitted with an expanded metal bird screen.
- 2.8.3 Rain Skirt – At the point where the exhaust pipe flexible tubing penetrates the roof of the enclosure, a suitable "rain skirt" and collar shall be provided by the MANUFACTURER. It shall be designed to prevent the entrance of rain and allow for expansion and vibration of the exhaust piping without chafing or stress to the exhaust system. This detail must appear on the drawings submitted for approval.

## 2.9 AUTOMATIC STARTING SYSTEM

- 2.9.1 Starting Motor – A DC electric starting system with positive engagement shall be furnished for the generator. The motor voltage shall be 24 volts.
- 2.9.2 Automatic Control – Fully automatic engine start-stop controls in the generator control panel shall be provided. Controls shall provide shutdown for low oil pressure, high water temperature, overspeed, overcrank, and loss of engine coolant. Alarms for approaching high water temperature and impending low oil pressure shall also be included. Controls shall include a 45-second single cranking cycle limit with lockout or cyclic crank system with lockout and overcrank protection.
- 2.9.3 Batteries – A lead-acid storage battery set of the heavy duty diesel starting type shall be provided. Battery voltage shall be 24 volts, and the battery set shall be rated no less than 225 ampere hours. Necessary cables and clamps shall be provided.
- 2.9.4 Battery Tray – Battery tray shall be provided for the batteries and shall conform to NEC 480-7(b). It shall be constructed of fiberglass and so treated as to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil-over of battery electrolyte shall be contained within the tray to prevent a direct path to ground.
- 2.9.5 Battery Charger – A current-limiting, automatic 24 volt DC charger shall be furnished to automatically recharge batteries. Charger shall float a 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 suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120 volts, single phase. Amperage output shall be no less than ten (10) amperes. Charger shall be wall mounting type in NEMA 1 enclosure, and U.L. listed as an industrial control panel. The charger shall be manufactured by LaMarche per NFPA 110 and U.L. 508. The charger shall be mounted and wired within the enclosure for the generator set by enclosure manufacturer.

## 2.10 MAIN LINE CIRCUIT BREAKER

- 2.10.1 Type – Main line, molded case circuit breaker mounted upon and sized to the output of the generator shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching functions and automatically during overload and short circuit conditions.
- 2.10.2 The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit conditions.
- 2.10.3 Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.
- 2.10.4 Circuit breaker shall have battery voltage operated shunt trip wired to safety shut downs to open the breaker in the event of engine failure.
- 2.10.5 Each circuit shall be equipped with an auxiliary contact for remote annunciation of breaker position.
- 2.10.6 The rating of each circuit breaker shall allow the starting of full generator SKVA.
- 2.10.7 The circuit breaker enclosure, together with all specified circuit breakers, shall be designed for the specific generator set specified and be equipped with an isolated neutral conductor bus, rear copper stabs, or load cable lugs and be finish painted to match the generator set.

## 2.11 GENERATOR CONTROL PANEL

- 2.11.1 Type – A generator-mounted, NEMA 1 type, vibration isolated, 15-gauge steel control panel shall be provided for each generator set. The panel must be capable of facing any direction when mounted upon the generator set. Panel shall contain, but not limited to , the following equipment:
- 2.11.1.1 Frequency meter, 4-1/2", dial type, 55-65 hertz.
  - 2.11.1.2 Voltmeter, 4-1/2", 2% accuracy.
  - 2.11.1.3 Ammeter, 4-1/2", 2% accuracy.
  - 2.11.1.4 Ammeter (4 position) and voltmeter phase selector switches (individual)

- 2.11.1.5 Automatic starting controls as previously specified.
- 2.11.1.6 Voltage level adjustment rheostat with locking knob
- 2.11.1.7 Dry contacts for remote alarms wired to terminal strips.
- 2.11.1.8 Six (6) individual fault indicator lights for fuel tank leak, low oil pressure, high water temperature, overspeed, overcrank, and low water level. All lights to be pressed-to-test type, 1" diameter.
- 2.11.1.9 Four (4) position function switch marked "auto", "manual", "off/reset", and "stop".
- 2.11.1.10 Battery charging voltmeter, running time meter, electric water temperature gauge, all 2" size (nominal).
- 2.11.1.11 Auxiliary relay, 3PDT, operating each time generator runs, 10 amp contacts brought out to terminal strip.
- 2.11.1.12 Two (2) alarms and indicators for approaching low oil pressure and high water temperature. Each light to be press-to-test type, 1" diameter.
- 2.11.1.13 Alarm horn and silence switch with cleared-fault resound circuitry. Alarm shall sound on impending shutdown.
- 2.11.1.14 Governor motor control switch with cleared-fault resound circuitry.
- 2.11.1.15 Panel illumination lights and switch.
- 2.11.1.16 An engraved, identification plate listing dealer's name, address, phone number, etc., as well as unit model and serial number shall be mounted on the panel face in a prominent location and be of a size easily read by maintenance personnel.

2.11.2 Digital or solid state meters or metering devices shall be acceptable as a substitute for the electric mechanical devices specified.

2.11.3 Engraved, screw-on type nameplates will identify each function indicated without abbreviation of function description. So-called international symbols will not be acceptable substitutes for this mandatory requirement.

2.11.4 Timing Functions – All control panel timing functions shall be accomplished by metal encased, solid-state, plug-in timing relays with 2PDT output contacts rated for ten (10) amperes. All solid-state time delay relays shall be reverse polarity protected and shall not function or be damaged by the application of improper polarity. Open printed circuit board type time delay circuits will not be accepted.

2.11.5 Control Relays – All control relays shall be the 3PDT plug-in type with .187QC blade terminals rated for (10) amperes. Each relay shall be equipped with a manual push to operate check button, L.E.D. or neon visual indicator, and see-thru dust cover for contact inspection and protection. Exposed contact and octal base plug-in relays are not acceptable.

2.11.6 Relay Sockets – All relay sockets shall be of thermodesigned thermoplastic type, suitable for snap mounting on standard D.I.N. rail. Relay sockets will have wire clamp type terminals for secure wire connections, and one, 1) piece bus bar connectors between the actual relay blade and wire clamp terminal. Relay sockets shall be rated for fifteen (15) amperes at 300V. Printed circuit board type relay sockets and relay sockets with push-on quick connect terminals are not acceptable.

## 2.12 AUTOMATIC LOAD TRANSFER SWITCH

2.12.1 The ATS shall be a NEMA 1 construction installed inside a NEMA 3R stainless steel vented enclosure. The rating of the automatic load transfer switch (ATS) shall be specified by the project engineer.

2.12.2 The automatic transfer switch shall be mechanically held on both the emergency and the normal side, and rated for continuous outdoor duty in the above described enclosure. The switch shall be solid-state, electronically controlled, double throw with the main contact rigidly and mechanically interlocked to ensure positive switches. A manual operator must be provided to enable one (1) hand manual operation, which, when utilized, can provide a neutral position for servicing operations.

2.12.3 The automatic transfer switch shall be a single motor operated circuit breaker type with interpole barriers and arc chutes. So-called linear actuated or solenoid operated switches are approved only when manufactured by the Generator MANUFACTURER. All elements of the drive system must be replaceable from the front of the switch, and the power switching devices must be replaceable without removal of the connecting cables.

- 2.12.4 The transfer switch shall be listed under U.L. 1008, in NEMA 1 enclosure, as manufactured by Lexington Switch and Controls, Inc., Lebanon, Ohio, Westinghouse, ONAN, or approved equal.
- 2.12.5 Accessories – The automatic load transfer switch specified shall include the following accessories:
- 2.12.5.1 Full phase protection. Solid-state phase monitor shall be field adjustable, close differential type, with 85-100% pick-up and 75-98% drop-out. A single adjustment shall set phases.
  - 2.12.5.2 Solid-state voltage and frequency monitor on generator output to prevent transfer prior to proper output parameters, adjustable 85-100% of generator rated voltage and frequency, with adjustable drop-out 75-85% of pick-up setting.
  - 2.12.5.3 Adjustable, solid-state, 0.5 to 6 seconds time delay on engine starting to override momentary outages and nuisance voltage dips.
  - 2.12.5.4 Adjustable, solid-state, 2 to 30 minutes time delay on retransfer of load to normal.
  - 2.12.5.5 Adjustable, solid-state, 2 to 30 minutes cool-down timer wherein the generator set runs unloaded after retransfer to line.
  - 2.12.5.6 Motor load decay time delay, pneumatic type, adjustable for 1.5 to 15 seconds and operating on transfer to either source.
  - 2.12.5.7 Adjustable, solid-state, 0.5 seconds to 5 minutes time delay on transfer to emergency source after verification of emergency source voltage and frequency.
  - 2.12.5.8 Test switch to simulate normal power failure, heavy duty, oil tight, pushbutton type with momentary contacts and override circuitry to revert to normal power if emergency source should fail during test.
  - 2.12.5.9 Motor circuit disconnect switch.
  - 2.12.5.10 Three (3) pilot lights, to indicate the normal and emergency position of the transfer switch, and mode selector switch in “off” position.

- 2.12.5.11 Engine starting contacts to provide for generator starting from each unit independent of the other.
- 2.12.5.12 One (1) auxiliary S.P.D.T. contact on emergency breaker and one (1) S.P.D.T. auxiliary contact on normal breaker.
- 2.12.5.13 Plant exerciser to start and run the generator set with or without load (in-field switchable) each of 168 hours for a 30 minute interval.
- 2.12.5.14 Four (4) position mode selector switch marked “test”, “auto”, “off”, and “engine start”.
- 2.12.5.15 Equipment grounding lug.
- 2.12.5.16 Cable connection lugs, cu/al type for all conductors.
- 2.12.5.17 A fully-rated overlapped neutral (make-before-break rocker-blade-type) fourth pole in all switches specified.

### **3.0 EXECUTION**

#### **3.1 SERVICES**

- 3.1.1 Furnish the services of a competent and experienced Manufacturer’s field service technician who has complete knowledge of proper operation and maintenance of the equipment for a period of not less than two (2) days in two separate visits to inspect the installed equipment, supervise the initial test run, and to provide instructions to the maintenance personnel. The first visit will be for checking and inspecting the equipment after it is installed.
- 3.1.2 At least one (1) of the two (2) days shall be allocated solely to the instruction of maintenance personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the OWNER and shall take place during start-up and acceptance by the OWNER.
- 3.1.3 Three final copies of operation and maintenance manuals specified must be delivered to the ENGINEER prior too scheduling the instruction period with the OWNER.



## 3.2 PAINTING

3.2.1 The engine generator set and associated equipment shall be shop primed and finish coated in accordance with the Manufacturer's standard factory load test prior to shipment.

## 3.3 TESTING

3.3.1 The engine-generator set shall be given the Manufacturer's standard factory load test prior to shipment.

3.3.2 Prior to final acceptance of the generator set, all equipment furnished under this Section shall be field tested per NFPA 110 to show it is free of any defects and the generator set can operate satisfactorily under full load testing resistance type load banks (brine tanks not acceptable). Test shall be for four (4) continuous hours. Any defects, which become evident at this time shall be corrected before acceptance.

3.3.3 An all-in-lace static alignment check of all rotating components shall be made prior to first start-up, after unit is secured in place and all final connections are made.

3.3.4 A final alignment check and/or adjustment shall be made after the machine has run four (4) to six (6) hour with its connected load.

## 3.4 SYSTEM SERVICE CONTRACT

3.4.1 The supplier of the standby power system must provide a copy of and make available to the OWNER his standard service contract which, at the Owners option, may be accepted or refused. This contract will accompany documents, drawings, catalog cuts, specification sheets, writing or outline drawings, etc., submitted for approval to the designing, ENGINEER. The contract shall be for the complete services rendered over a period of one (1) year. The first year's service shall be included in the contract price.

### 3.5 WARRANTY

3.5.1 Equipment furnished under this Section shall be guaranteed against defective parts and workmanship under terms of the Manufacturer's and dealer's warranty. But, in no event, shall it be for a period of less than five (5) years (comprehensive) from date of initial start-up of the system and shall include labor, parts and travel time for necessary repairs at the job site. Running hours shall not be a limiting factor for the system warranty either by the MANUFACTURER or the supplying dealer. Submittal data received without written warranties will be rejected in their entirety.

### 4.0 MEASUREMENT AND PAYMENT

The engine generator, complete with all accessories, fuel tank, support structure, controls, transfer switch, enclosure, and all other incidentals and related work, materials and equipment, testing, start-up and placement into satisfactory operation, shall be measured and paid for on a lump sum or unit price basis as provided in the contract proposal quantities.