

SECTION VII ENGINE GENERATOR SET

PART 1 GENERAL

1.1 Scope of Work

- A. It is the intent of this specification to secure an engine-driven generator set that has been prototype tested, factory built, production-tested, and site-tested together with all accessories necessary for a complete installation as shown on the plans and drawings and specified herein.
- B. Any and all exceptions to the published specifications shall be subject to the approval of the engineer.
- C. The power system shall be furnished by a single manufacturer who shall be responsible for the design, coordination, and testing of the complete system. The entire system shall be installed as shown on the plans, drawings, and specifications herein.
- D. The equipment shall be produced by a manufacturer who has produced this type of equipment for a period of at least 10 years and who maintains a service organization available twenty-four hours a day throughout the year.
- E. The equipment shall be produced by a manufacturer who is ISO 9001 certified for the design, development, production and service of its complete product line.

1.2 General Requirements

- A. It is the intent of this specification to secure a generator set system that has been tested during design verification, in production, and at the final jobsite. The generator set and automatic transfer switch will be a commercial design and will be complete with all of the necessary accessories for complete installation as shown on the plans, drawings, and specifications herein. The equipment supplied shall meet the requirements of the National Electrical Code and applicable local codes and regulations.
- B. All equipment shall be new and of current production by a national firm that manufactures the generator sets and controls, transfer switches, and switchgear. There will be one-source responsibility for warranty, parts, and service through a local representative with certified factory-trained servicemen.
- C. The generator set described herein is a Kohler model 45REOZT4, and it is with the price of this equipment that the contractor of this section shall enter with his proposal. Any alternate shall be submitted for approval to the consulting engineer at least 10 days prior to bid date. Alternate bids shall include a line-by-line clarification of the specification marked with "D" for deviation; "E" for exception, and "C" for comply. If the bidder wishes to propose equivalent equipment, it is to be submitted in a separate document. All additional costs associated with re-engineering and mechanical & electrical modifications to the installation will be at the contractor's expense. The contractor must also supply the details listed below with his

equivalent proposal:

- The associated credit
- Any deviations from the specifications in a line by line format
- The weight & outline dimensions

Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be allowed or included in the certification.

1.3 Submittal

- A. The 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 interconnection between the generator set, the transfer switch, and the remote annunciator panel if it is included elsewhere in these specifications.

1.4 Codes and Standards

- A. The generator set shall conform to the requirements of the following codes and standards:
1. CSA C22.2, No. 14-M91 Industrial Control Equipment.
 2. EN50082-2, Electromagnetic Compatibility-Generic Immunity Requirements, Part 2: Industrial.
 3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
 4. IEC8528 part 4, Control Systems for Generator Sets.
 5. IEC Std 61000-2 and 61000-3 for susceptibility, 61000-6 radiated and conducted electromagnetic emissions.
 6. IEEE446 Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 7. NFPA 70, National Electrical Code, Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 8. NFPA 99, Essential Electrical Systems for Health Care Facilities.
 9. NFPA 110, Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed

on a complete and functional unit. Component level type tests will not substitute for this requirement.

1.5 Testing

- A. To ensure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer's local representative shall be responsible for three separate tests: design prototype tests, final production tests, and site tests.
- B. 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 because the tests are potentially damaging. Rather, similar design prototypes and preproduction models shall be subject to the following tests:
1. Maximum power (kW).
 2. Maximum motor starting (kVA) at 35% instantaneous voltage dip.
 3. Alternator temperature rise by embedded thermocouple and/or by resistance method per NEMA MG1-32.6.
 4. Governor speed regulation under steady-state and transient conditions.
 5. Voltage regulation and generator transient response.
 6. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
 7. Three-phase short circuit tests.
 8. Alternator cooling air flow.
 9. Torsional analysis to verify that the generator set is free of harmful torsional stresses.
 10. Endurance testing.
- C. Final Production Tests. Each generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include:
1. Single-step load pickup
 2. Transient and steady-state governing
 3. Safety shutdown device testing
 4. Voltage regulation
 5. Rated Power @ 1.0 PF
 6. Maximum power

7. A certified test record shall be sent at time of shipment.

D. Site Tests. The manufacturer's local representative shall perform an installation check, startup service, and provide customer training prior to acceptance of equipment. The engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test to assure that the system functions as specified. If generator set fails to fulfill the performance requirements of this specification, take corrective action and retest the system to assure full compliance. Include all expenses associated with the field tests, including any corrective action, and retesting as part of the scope of work of this section. Before conducting the site tests, submit a copy of the proposed test data log sheet and the operation and maintenance manuals for the engineer's approval. The site tests shall include:

1. Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present and expected.
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 chargers, alternator strip heaters, remote annunciators, etc.
3. Generator set startup under test mode to check for exhaust leaks, path of exhaust gases outside the building or enclosure, cooling air flow, movement during starting and stopping, vibration during operation, normal and emergency line-to-line voltage and frequency, and phase rotation.
4. Generator set startup 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 operation, normal and emergency line-to-line voltage and frequency, and phase rotation.
5. Automatic start by means of a 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 set voltage, amperes, and frequency shall be monitored throughout the test.

1.6 Warranty and Maintenance

- A. The generator set shall include a three-year 3000-hour warranty to guarantee against defective material and workmanship in accordance with the manufacturer's published warranty from date of startup. Optional warranties shall be available upon request.
- B. The generator set manufacturer and its local distributor shall maintain a 24-hour parts and service organization. The local distributor shall have factory

trained service technicians certified to work on the generator set specified.

- C. The local distributor shall regularly engage in maintenance contract programs to perform preventive maintenance and service on equipment similar to that specified. A service agreement shall be available and shall include system operation under simulated operating conditions; adjustment to the generator set, transfer switch, and switchgear controls as required, and certification in the owner's maintenance log of repairs made and function testing performed on all systems.

PART 2 - PRODUCTS

2.1 Engine Generator

A. Equipment

- 1. The generator set shall be rated a minimum of 35 kW / 35 kVA at 240 volts, 1 phase, 60 Hz, using a Standby 130°C rating when operating in an ambient temperature condition of less than or equal to 104°F and a maximum elevation of 1500 feet above sea level.
- 2. Motor starting performance and voltage dip determinations shall be based on the complete generator set. The generator set shall be capable of supplying 60 LRKVA for starting motor loads with a maximum instantaneous voltage dip of 35%, as measured by a digital RMS transient recorder in accordance with IEEE standard 115. Motor starting performance and voltage dip determination that does not account for all components affecting total voltage dip i.e. engine, alternator, voltage regulator and governor will not be acceptable. As such, the generator set shall be prototype tested to optimize and determine performance as a generator set system.
- 3. Vibration isolators shall be provided between the engine-alternator and heavy-duty steel base.

B. Engine

- 1. The engine shall have a minimum displacement of 152.5 cubic-inches and shall deliver a minimum of 63 HP at a governed speed of 1800 rpm. The engine shall be equipped with the following:
 - a. Electronic isochronous governor capable of 0.5% steady-state frequency regulation.
 - b. 12-volt positive-engagement solenoid shift-starting motor
 - c. 80 Ampere automatic battery charging alternator with solid-state voltage regulation.
 - d. Positive displacement, full-pressure lubrication oil pump, cartridge oil filters, dipstick, and oil drain.
 - e. Dry-type replaceable air cleaner elements for normal applications.

- f. Engine-driven or electric fuel-transfer pump including fuel filter and electric solenoid fuel shutoff valve capable of lifting fuel.
 2. The turbocharged engine shall be fueled by diesel.
 3. The engine shall have a minimum of 4 cylinders and be liquid-cooled by a unit mounted radiator for an ambient air temperature of 122°F/50°C.
 4. The engine shall be EPA certified from the factory, and shall not require a site performance test.
- C. Alternator
1. The alternator shall be salient-pole, brushless, 2/3-pitch, 12 lead, self-ventilated with drip-proof construction and amortisseur rotor windings and skewed for smooth voltage waveform. The ratings shall meet the NEMA standard (MG1-32.40) temperature rise limits. The insulation shall be class H per UL1446 and the varnish shall be a fungus resistant epoxy. Temperature rise of the rotor and stator shall be limited to Standby 130°C. The excitation system shall be of brushless construction controlled by a solid-state voltage regulator capable of maintaining voltage within $\pm 2.0\%$ at any constant load from 0% to 100% of rating. The AVR shall be capable of proper operation under severe nonlinear loads and provide individual adjustments for voltage range, stability and volts-per-hertz operations. The AVR shall be protected from the environment by conformal coating. The waveform harmonic distortion shall not exceed 5% total RMS measured line-to-line at full rated load. The TIF factor shall not exceed 50.
 2. The alternator shall have a single maintenance-free bearing, designed for 4000 hour B10 life. The alternator shall be directly connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.
 3. The generator shall be inherently capable of sustaining at least 250% of rated current for at least 10 seconds under a 3-phase symmetrical short circuit without the addition of separate current-support devices.
- D. Controller
1. Push button Master Control buttons. The buttons shall have an indicator light to initiate the following functions:
 - a. Run Mode. When in the run mode the generator set shall start and run continuously.
 - b. Off/Reset Mode. When in the Off/Reset mode the generator set shall stop, the reset shall reset all faults, allowing for the restarting of the generator set after a shutdown.
 - c. Auto Mode. When in Auto the mode the generator set shall be

ready to accept a signal from a remote device.

2. Push Button/Rotary Selector dial. This dial shall be used for selection of all Menus and sub-menus. Rotating the dial moves through the menus, pushing the dial selects the menu and function/features in that menu.
3. Graphical Display. The graphical display shall have back lighting for ease of operator use in high and low light conditions. The display shall also display any engine faults. While the generator set is running the display shall scroll all important information across the screen for ease of operation use. The scroll can be stopped by pushing the rotary dial. The display lighting shall fall asleep when the generator set is not running and will wake-up when the generator set starts or the rotary dial is turned.
4. Fault Light. The controller shall have an annunciator fault light that glows red for faults and yellow for warnings. These faults and warnings shall be displayed in the digital display. The fault light will also glow yellow when not in AUTO.
5. Alarm Horn. The controller shall provide an alarm horn that sounds when any faults or warnings are present. The horn shall also sound when the controller is not in the AUTO mode.
6. Alarm Silence/Lamp Test Button. When this button is depressed it shall test all controller lamps. This button will also silence the alarm horn when the unit is not AUTO or the horn is sounding for an alarm.
7. Dedicated user inputs. The controller shall have dedicated inputs for remote emergency stop switch, remote 2 wire maintained start contacts for transfer switch and auxiliary shutdown
8. The controller shall have resettable circuit protection integral on the circuit board.
9. Controller Engine control features and functions
 - a. Cyclic cranking - the controller shall have programmable cyclic cranking.
 - b. The control system shall include time delay for engine start and cool down.
10. Controller Alternator control features and functions
 - a. Integrated hybrid voltage regulator. The system shall have integral microprocessor based voltage regulator system that provides +/- 0.5% voltage regulation, no-load to full load with three phase sensing. The voltage regulator shall be adjustable at that controller with maximum +/- 10% adjustable of nominal voltage.
 - b. AC output voltage regulator adjustment. The system shall

allow for adjustment of the integral voltage regulator with maximum of +/- 10% adjustment of the system voltage.

- c. Alternator thermal overload protection. The system shall have integral alternator overload and short circuit protection matched to each alternator for the particular voltage and phase configuration.
 - d. Power metering. The controller digitally displays power metering of kW and kVA.
11. Generator Set Warning, Shutdown Alarm and Status. The generator set shall have alarms and status indication lamps that show non-automatic status and warning and shutdown conditions. The controller shall indicate with a warning lamp and alarm and on the digital display screen any shutdown, warning or engine fault condition that exists in the generator set system.
12. Emergency Stop Button. The emergency stop button shall be red in color with a "mushroom" type head. Pressing the stop button will immediately stop the generator set and lockout the generator set for any automatic remote starting.
13. Modbus® RTU communications shall be available.

E. Accessories

- 1. Customer Connection Panel
 - a. Emergency Stop Button. The emergency stop button shall be red in color with a "mushroom" type head. Pressing the stop button will immediately stop the generator set and lockout the generator set for any automatic remote starting.
 - b. Shore Power receptacle, rated at 120V, 15 amp, for on-site power for the block heater and battery charger.
 - c. Qty of 5, #6-350MCM, 400 amp load lugs located behind lockable controller door and secondary panel.
 - d. Two 15-amp 120 V, 1 phase, GFCI duplex receptacles each with its own circuit breaker.
 - e. Three 50-amp 120/240 V, twistlock receptacles each with its own circuit breaker.
 - f. One set of quantity 5, 400 Amp, color coded cam-lock connectors.
 - g. Remote start/stop connection for transfer switch and auxiliary shutdown.
- 2. Main Line Circuit Breaker. The generator shall come with a primary, factory installed, 100% rated line circuit breaker of 150 amperes that is field adjustable. Line circuit breakers shall be sized for the rated

current of the generator set. Load side lugs shall be provided from the factory.

3. Standard Air Cleaner. The air cleaner shall provide engine air filtration which meets the engine manufacturer's specifications under typical operating conditions
4. Battery Charger. 6-ampere automatic float to equalize battery chargers each having the following features:
 - a. 12 VDC output
 - b. Voltage regulation of 1% from no to full load over 10% AC input line voltage variations.
 - c. LED lamps for change of state indication
 - d. Temperature compensated for ambient temperatures for -40°C to 60°C
 - e. Short circuit and reverse polarity protection
 - f. UL 1236 listed
5. Battery Rack and Cables. Battery rack and battery cables capable of holding the manufacturer's recommended batteries shall be supplied.
6. Block Heater. An engine block heater that can be connected to a power source that is energized when the generator set is not running. The block heater shall be thermostatically controlled and sized to maintain manufacturers recommended engine coolant temperature to meet the start-up requirements of NFPA 99 and NFPA 110, Level 1.

F. Double Wall Secondary Containment Sub Base Fuel Tank

1. The sub base fuel tank used in conjunction with a diesel powered generator set shall contain at least 77 gallons of fuel to support the generator set for a period of at least 24 hours at 100% rated load.
2. Primary Tank. It will be rectangular in shape and constructed in clam shell fashion to ensure maximum structural integrity and allow the use of a full throat fillet weld.
3. Steel Channel Support System. Reinforced steel box channel for generator support, with a load rating of 5,000 lbs. per generator mounting hole location. Full height gussets at either end of channel and at generator mounting holes shall be utilized.
4. Exterior Finish. The exterior coating has been tested to withstand continuous salt spray testing at 100 percent exposure for 244 hours to a 5 percent salt solution at 92-97° F. The coating has been subjected to full exposure humidity testing to 100 percent humidity at 100° F

for 24 hours. Tests are to be conducted in accordance with The American Standard Testing Methods Society.

5. Venting. Normal venting shall be sized in accordance with the American Petroleum Institute Standard No 2000, Venting Atmospheric and Low Pressure Storage Tanks not less than 1-1/4" (3 cm.) nominal inside diameter.
6. Emergency Venting. The emergency vent opening shall be sized to accommodate the total capacity of both normal and emergency venting and shall be not less than that derived from NFPA 30, table 2-8, and based on the wetted surface area of the tank. The wetted area of the tank shall be calculated on the basis of 100 percent of the primary tank. The vent is spring-pressure operated: opening pressure is 0.5/psig and full opening pressure is 2.5 psig. The emergency relief vent is sized to accommodate the total venting capacity of both normal and emergency vents.
7. Fuel Fill. There shall be a 2" NPT opening within the primary tank and lockable manual fill cap.
8. Fuel Level. A direct reading, UL listed, magnetic fuel level gauge with a hermetically sealed vacuum tested dial shall be provided to eliminate fogging.
9. Low Fuel Level Switch. Consists of a 30 watt float switch for remote or local annunciation of a (50% standard) low fuel level condition.

G. Sound Attenuated Enclosure

1. All enclosures shall be constructed from high strength low alloy steel.
2. The generator set package shall be sound attenuated to have a maximum sound pressure level of less than 67 dB(A) at 23 feet using the logarithmic average of eight equidistant perimeter measurement points in a free field environment.
3. The enclosure shall be finish coated with powder baked paint for superior finish, durability, and appearance. Enclosures will be finished in the manufacturer's standard color.
4. The enclosures shall allow the generator set to operate at full load in an ambient temperature of 40 - 45°C with no additional de-rating of the electrical output.
5. Enclosures shall be equipped with sufficient side and end doors to allow access for operation, inspection, and service of the unit and all options. Minimum requirements are two doors per side. When the generator set controller faces the rear of the generator set, an additional rear facing door is required. Access to the controller and main line circuit breaker shall meet the requirements of the National Electric Code.

6. Doors shall be hinged with stainless steel hinges and hardware and be removable.
7. Doors shall be equipped with lockable latches. Locks shall be keyed alike.
8. The enclosure roof shall be pitched to prevent accumulation of water.
9. A duct between the radiator and air outlet shall be provided to prevent re-circulation of hot air.
10. The complete exhaust system shall be internal to the enclosure.
11. The critical silencer shall be insulated with a tailpipe and rain cap.

H. Trailer

1. The generator shall be equipped with a heavy-duty, single axle trailer that has been designed for highway towing, as well as off-road transportation of the engine generator set, fuel, and all accessories.
2. The single-axle trailer shall have a Gross Vehicle Weight Rating (GVWR) of at least 4,995 lbs. The trailer shall have sufficient rating to carry the engine generator set, fuel, and all accessories.
3. The trailer frame shall be welded 2" x 4" steel tube construction, with 2" x 4" steel tube cross-members located for mounting the engine generator set. Fenders and decking shall be constructed to support 500#s. The trailer shall be painted black over zinc-rich primer to meet ASTM #B-117.
4. ST225/75R15, load range D tires shall be mounted on 6-lug, 15x6 conventional steel wheels.
5. Axles shall be equipped with torsion suspension and fitted with electric brakes on each wheel.
6. The trailer hitch height shall be adjustable and be equipped with a 2 5/16" ball coupler and 3" Lunette eye coupler.
7. The trailer shall be equipped with a tongue jack and two rear stabilizing feet.
8. Heavy-duty safety chains with slip hooks and safety latches shall be provided.
9. A duct between the radiator and air outlet shall be provided to prevent re-circulation of hot air.
10. The trailer incorporates a breakaway switch and battery to actuate the trailer brakes should a trailer breakaway occur.
11. Trailer lighting and reflectors shall meet DOT regulations. Running lights shall be recessed into the frame rails to prevent accidental

breakage. Provide with 7-pin harness and connector for the towing vehicle.

12. Trailer shall be equipped with a factory-mounted, lockable steel tool box containing a 4-way lug wrench, 20-ton bottle jack and fire extinguisher. The lock shall use the same key as the enclosure.
13. Trailer shall be DOT and TC (Transport Canada) compliant per current specifications published by both agencies at time of trailer manufacturer.

PART 3 - EXECUTION

3.1 Installation

- A. Provide the services of a qualified factory representative to check the installation of the generator and automatic transfer switch to ensure a proper installation, perform check-out and start-up services, conduct the field test specified herein, and instruct the Owner's personnel in the operation and maintenance of the equipment.
- B. Installation shall include furnishing all required coolants and lubricants.

3.2 Equipment Startup Services

- A. After installation and manufacturer's representative check of the installed equipment, operate each unit to demonstrate its ability to operate continuously without vibration, jamming, leakage or overheating and to perform specified functions.
- B. Comply with the manufacturer's operating and maintenance instructions during start-up and operation.
- C. Promptly correct improper installation or operation of the equipment.
- D. Cooperate with the supplier of the equipment, at the time of start-up, in making any final adjustments necessary to place the equipment in satisfactory working order. Start-up shall not commence without the presence of the manufacturer's representative.
- E. Perform the site testing as specified in section 1.5 D.

END OF SECTION