

**PART 1      General**

**1.1          SYSTEM DESCRIPTION**

- .1 This specification defines the requirement for the emergency standby generating control system, consisting of one (1) standby generator and associated equipment.
- .2 All materials, equipment and parts comprising the unit specified herein shall be new and unused, of current manufacture and of highest grade.
- .3 Equipment furnished under this section shall be guaranteed against defective parts or workmanship for one year after acceptance.
- .4 The manufacturer shall be capable of maintaining and servicing this equipment without causing the Owner either to carry expensive parts, or to be subject to the inconvenience of long periods of interrupted service because of lack of available parts.
- .5 Three (3) sets of complete operating, maintenance and parts manuals, drawings, and a sequence of operation covering all equipment for the standby generator control panel, transfer switches, etc., shall be provided. Complete operating instructions shall be installed in a suitable frame, and mounted on a wall adjacent to the generator control panel.
- .6 The standby generator and associated equipment (as shown on the drawings) shall be supplied by one manufacturer.
- .7 The engine shall be in-line of 'V' configuration and directly connected to the generator by a suitable coupling. Vibration caused by misalignment or imbalance will not be accepted. Documentation shall be provided indicating actual vibration levels for the assembled standby generating set.
- .8 The standby generator set shall be suitable for operation at 600m above sea level, and in a maximum ambient temperature of 45°C. Furthermore, the standby plant shall start reliably, without any delay or manual priming, at an ambient temperature of 15°C, and shall deliver full output within 10 seconds from normal commercial power failure.

**1.2          SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Before fabrication and/or assembly of the generator set, shop drawings and complete wiring diagrams shall be submitted to the Consultant for review. As part of the shop drawings, provide complete ladder logic diagram showing in detail the control scheme for the system.

**1.3          CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for diesel generating units for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

- .2 Three (3) sets of complete operating, maintenance and parts manuals, drawings, and a sequence of operation covering all equipment for the standby diesel generator, transfer switches, etc., shall be provided. Complete operating instructions shall be installed in a suitable frame, and mounted on a wall adjacent to the generator control panel.

#### **1.4 WARRANTY**

- .1 Contractor hereby warrants generating unit, equipment, and accessories against defects and malfunction in accordance with General Conditions, for one year.

#### **1.5 QUALITY ASSURANCE**

- .1 Do work in accordance with CAN3-Z299.3.

#### **1.6 MAINTENANCE - EXTRA MATERIALS**

- .1 Provide conclusive evidence that local distributor has been established and will stock in Saskatchewan spare parts likely to be required during normal life of engine.
- .2 Provide the following:
  - .1 Provide generator unit with standard set of engine manufacturer's spare parts for one year normal operation of minimum 500 operating hours.
  - .2 Spares to include:
    - .1 Six fuel filter elements for each type of fuel filter/water separator.
    - .2 Three air cleaner elements.

### **PART 2 Products**

#### **2.1 MATERIALS**

- .1 The generator set shall operate at 347/600 volt, 3 phase, 4 wire, 60 cycle and shall be sized as shown on the drawings.
- .2 The rated net H.P. of the engine at the generator synchronous speed with all accessories attached, shall not be less than that required to produce the kilowatt rating specified. The H.P. rating shall take into account generator efficiency losses, and accessories such as air cleaners, lubricating oil pump, fuel pump, jacket water pump, governor, etc.
- .3 The entire standby generator set, including engine, shall be capable of delivering rated power at existing site conditions without exceeding the maximum temperature rise, maximum voltage drop or maximum frequency variation. Voltage drop shall not exceed 15%.
- .4 These ratings must be substantiated by manufacturer's standard published curves. Special ratings or maximum ratings are not acceptable.

- .5 The engine shall be water cooled in-line or Vee type four stroke cycle compression ignition diesel. It shall meet full load when operating on No. 2 or No. 1 domestic burner oil. The engine shall be capable of operating at idle or light loads for extended periods of time.
- .6 Flexible fuel, coolant, exhaust and electrical lines shall be installed on the standby generator in order to absorb the initial vibration caused by engine starting and the normal vibration of the engine under load.
- .7 The engine shall be equipped with a suitable electronic governor to maintain frequency within limits as specified below, by controlling engine and generator speed. Governor shall be electronic, fully enclosed, and capable of providing accurate speed control within 1/2% of rated speed. The speed control shall be designed to limit speed over-shoot on engine starts to less than 102% of rated speed.
- .8 The speed of the engine shall not exceed 1800 r.p.m. at rated output.
- .9 The gear type lubricating oil pump shall supply oil under pressure to the main bearings, crank pin bearings, pistons, timing gears, crankshaft bearings, and valve rocker mechanism. Effective full flow lubricating oil shall be continuously filtered, except during periods when oil is by-passed to protect vital parts such as when filters are clogged. Replaceable resin impregnated cellulose type filter elements shall be accessible and easily removable. The filter system shall be equipped with a spring loaded bypass valve as an insurance against stoppage of lubricating oil circulating in the event filters should become clogged.
- .10 A suitable water-cooled engine mounted lubricating oil cooler shall be provided.
- .11 Provide engine jacket coolant heater complete with immersion type thermostat. Size heater to maintain coolant at required temperature in an ambient temperature found in exterior weatherproof enclosures. Obtain circulation of heated coolant on thermosyphon principle. However, if this does not provide sufficient circulation to avoid hot spots in the system, provide electrical motor driven circulating pump to operate automatically when heater is energized. Motor shall be 120 volt, single phase, splashproof type.
- .12 Fuel system shall be equipped with replaceable fuel filter elements which may be easily removed without breaking any fuel line connections or disturbing the fuel pump, or any other part of the engine. The engine fuel system shall be equipped with a water separator installed at the engine.
- .13 All hot and rotating equipment shall be guarded.
- .14 Provide one or more engine mounted dry type air cleaners of sufficient capacity to protect engine working parts from dust and grit.
- .15 Cooling and combustion air requirements shall be adequately sized to allow the generator set to supply full rating continuously at 40°C ambient.
- .16 The standby generator set shall be mounted on a common channel iron base, which in turn shall be set on a concrete foundation. Rubber or spring type isolators shall be provided between the channel iron base and the enclosure.

**GENERATOR REPLACEMENT**

---

- The rubber isolators shall be resilient to oil and other petroleum products, and shall be manufactured by the Stiles Rubber Company or approved equal.
- .17 The engine shall be equipped with the following gauges:
- .1 Oil pressure
  - .2 Coolant Temperature
  - .3 Fuel Pressure
- .18 The engine shall be equipped with a 24 V.D.C., electrical start system of sufficient capacity to crank at a speed which will start the engine under normal operating conditions. The starting pinion shall disengage automatically when the engine starts. Heavy duty lead acid storage batteries with sufficient capacity to crank the engine for at least two (2) full cranking cycles at firing speeds, and with capacity for starting the engine a minimum of three (3) times, shall be provided. Necessary stranded battery cable and connections shall be furnished and installed. The batteries shall be located adjacent to the standby unit, enclosed in a heavy gauge poly-resin container with removable lid. The battery box shall be supported by a stand constructed from angle iron. Battery leads shall be equipped with compression type lugs, which in turn shall be bolted to the battery posts and engine starter. The batteries shall not be contained outside of the emergency generator shell.
- .19 Crank control with time delay relays shall provide at least three (3) cranking periods. Each cranking period shall be at least fifteen (15) seconds long and the cranking attempt shall be separated by fifteen (15) second rest periods. Total cranking cycle shall not be less than seventy-five (75) seconds. A speed sensing device shall automatically disconnect the starting circuit when the engine has started. If engine has not started, at completion of the starting program, the overcranking alarm shall activate, the engine starting control shall be locked out, and no further starting attempts shall take place until the alarm has been manually reset.
- .20 The alternator shall be a 4 pole, brushless synchronous alternator designed in accordance with NEMA MG1, Part 32 and CSA Standard C282. Construction shall be of a fabricated steel or cast iron frame with cast end plate and coupling adapter. Machine construction shall be drip proof to 30 degrees from horizontal, air ventilated with cast aluminum fan. The alternator shall also comply full with applicable standards as specified by CSA, CEMA, IEC and BS5000, part 99.
- .21 The alternator shall be fitted with a large, terminal box with removable side and top covers. A bus bar terminal board shall be provided inside the terminal box and, where necessary, additional bus bar connecting links shall be provided for re-connection. The machine shall be fitted with long life sealed bearings.
- .22 The stator shall be NEMA Class H insulated and all windings impregnated in a triple dip, thermo setting, moisture, oil and acid resisting Class H varnish.
- .23 The rotor shall be of salient pole form, layer wound with expanding wedges utilized to support the windings. The rotor shall be NEMA Class H insulated, utilizing a solvent-free epoxy system providing high mechanical strength at temperatures of 155°C. and above. A final coat of anti-tracking varnish shall be applied to all wound and unwound components for added moisture protections. The stator and rotor shall have a temperature rise of 105°C. over a 40°C. ambient at an altitude of 1000 metres when operating at 100% load at 0.8 PF and nominal voltage.

- .24 A fully connected damper winding shall be included and all stator windings shall utilize a 2/3 pitch winding to eliminate 3rd, 9th, and 15th harmonics on the line-neutral waveform.
- .25 The generator control system shall be based on a permanent magnet generator (PMG) which provides excitation power via the automatic voltage regulator to the main exciter. The PMG shall be axially mounted on the main generator shaft. The main exciter output shall be fed into the main rotor windings via a three (3) phase, bridge rectifier incorporating a surge suppressor to protect the diodes against voltage transients, heavy load surges, i.e. short circuits or out-of-phase paralleling.
- .26 The automatic voltage regulator (AVR) shall maintain voltage regulation within  $\pm 1\%$  of nominal voltage from no load to full load and vice-versa, including cold to hot variations at any power factor between 0.8 lagging and unity inclusive of speed variations of  $4\frac{1}{2}\%$ . The regulation shall be based on the average of the three phase voltages. The AVR shall be self-protecting against over-excitation caused by internal or external fault and shall protect the output leads between the generator and the main breaker. The circuit shall collapse the excitation system when a fault occurs. The time of collapse shall be dependent on the severity of the overload. The circuit shall be automatically reset when the generating set is shut down. The AVR shall incorporate an adjustable frequency sensitive circuit providing a voltage characteristic which falls off with reduction in speed of the prime mover.
- .27 Generator controls shall be provided for voltage level and voltage gain controls that are easily accessible for normal operation and adjustments. Voltage adjustment instructions and generator schematic wiring diagrams shall be provided, permanently attached on the inside of the exciter assembly.
- .28 The PMG shall have sufficient capacity to sustain a short circuit at not less than 300% of full load current for not less than 10 seconds without damage to the generator under the following conditions:
- .1 Three phase symmetrical fault
  - .2 Phase to phase fault
  - .3 Phase to ground fault
- Generator decrement and heat damage curves shall be submitted to show fault current sustaining ability.
- .29 The AVR shall be provided with an external fine trimmer with a maximum range of  $\pm 5\%$ .
- .30 Upon application of full load at 0.8 PF, the generator shall recover to within  $\pm 3\%$  of nominal voltage in 0.35 seconds. Total voltage waveform distortion with open circuit between phases, or between phases and neutral shall be in the order of 2%. On a three phase balanced harmonic free load, the distortion shall be in the order of 3.5%. The T.I.F. factor shall be 50 or less, per NEMA MG1, Part 32. All ratings and components shall be based on a maximum allowable voltage of 300 volts.

**GENERATOR REPLACEMENT**

- .31 The engine and generator components shall be shielded or suppressed for the suppression of radio frequency interference to meet requirements of MIL-1-11683.
- .32 The generator drive shall be free from critical torsion vibration within the range of operating speed.
- .33 Positive ground shall exist:
  - .1 Between generator frame and base through mounting pads, and
  - .2 Between generator and engine.
- .34 Overall efficiency of generator shall not be less than 92%.
- .35 The generator and engine shall be oversized as required to facilitate the powering of the loads. The generator shall be oversized to accommodate non linear loads. Increase amount of oversizing to accommodate non-linear loads listed above if required. Provide information as part of the shop drawing submission from the generator manufacturer to substantiate the ability of the system to power the above loads without wave form or other system degradation.
- .36 Cool-down time delay shall be provided to keep engine running for up to five minutes after load has been removed. This time shall be field-programmable.
- .37 The generator shall be protected by a moulded case circuit breaker. The moulded case circuit breakers shall have adjustable trip unit. As part of the shop drawing, submit circuit breaker time current characteristics and generator heat damage curves to demonstrate that circuit breaker is providing suitable protection.

**2.2 FUEL TANK**

- .1 The generator unit shall receive its fuel from an existing adjacent exterior above ground fuel tank.
- .2 The electrical contractor shall be responsible for supplying all fuel required for testing of diesel generator unit, as well as fuel supply to leave exterior fuel tank full upon completion of testing. Provide twisted shielded pair Teck cable from the fuel tank level contacts to the generator controller.
- .3 The fuel tank will have an inner tank leak alarm that shall be connected to the generator control panel by the electrical contractor that shall annunciate a warning signal and illuminate a fault light. Provide twisted shielded pair Teck cable from the fuel tank alarm contacts to the generator controller. Fuel alarm signal shall also be sent to existing Metasys building management system.
- .4 The owner shall be responsible for providing enough fuel to initially fill the tank. The electrical contractor shall be responsible for providing all fuel associated with the required testing and then for leaving the tank full once all testing and training has been completed.

**2.3 EXTERIOR WEATHERPROOF ENCLOSURE**

- .1 The generator supplier shall supply and install the generator unit and all other equipment within a custom built generator enclosure. The enclosure shall be

sized to allow continuous operation of the generator unit without derating of the generator unit. The enclosure shall contain all interconnecting fuel lines, heaters, battery charger, 12 volt trouble light, batteries, circuit breaker, generator controller, and other related and required equipment within. The electrical contractor shall be responsible for supplying all fuel required for testing of diesel generator unit, as well as fuel supply to leave the fuel tank full upon completion of testing.

- .2 The enclosure shall have the following characteristics:
  - .1 Skin-tight, insulated and suitable for local environmental conditions.
  - .2 Walls and roof insulated and covered with suitable aluminum shell.
  - .3 Exhaust openings c/w rain shield.
  - .4 Muffler supports provided in the roof.
  - .5 Sound attenuation for enclosure to 75 dB(A) @ 7 metres in a free field condition.
  - .6 A viewing window for external viewing of generator control panel.
  - .7 Two (2) double doors with “D” ring type recessed, lockable door hardware, bulb type weather seals and drip edge.
  - .8 Doors to provide complete access to the generator circuit breaker and control panel, enclosure combination panel and engine compartment
  - .9 Exhaust penetration complete with rain shield.
  - .10 Drip mouldings around enclosure penetrations.
  - .11 Provisions for lifting, dragging, and securing unit to ground to ensure stability.
- .3 For enclosure ventilation purposes, the intake air shall enter via lined weather/snow hood with bird screen, insulated (R8) aluminum volume control damper, 120V damper motor. (Spring open / power close). The discharge shall occur through insulated aluminum volume control damper, 120V damper motor, lined weather/snow hood with galvanized bird screen.
- .4 The basic electrical provisions shall be as follows:
  - .1 One (1) 12 circuit, 60 amp, 120/240V, 1 phase, 3 wire panel with branch breakers as required.
  - .2 120 volt incandescent/LED lights
  - .3 12VDC incandescent/LED light
  - .4 One (1) 15 amp GFCI Duplex receptacle
  - .5 Required heaters with integral thermostat
  - .6 Alternator heater with integral thermostat wired to the panel
  - .7 120 volt battery warming plates.

**GENERATOR REPLACEMENT**

---

- .8 Electric engine block heater complete with immersion type thermostat controlled to maintain manufacturers recommended engine coolant temperature to meet start-up requirements of NFPA-99 and NFPA-110, Level 1.
- .9 Battery charger wired to panel
- .10 Damper motor wiring
- .11 All electrical devices and wiring shall be CSA approved
- .12 All wiring shall be in surface mounted EMT conduit.
- .5 The enclosure shall have suitable clearance on the sides of the genset rails and radiator. The Generator Control panel and circuit breaker shall be installed to face to the side of the engine/generator.
- .6 The painting of the enclosure shall be as follows:
  - .1 The enclosure shall be factory painted and shall perform to meet the requirements of the environment.
- .7 It is the manufacturer's responsibility to ensure that insulation provided for this remote application must be sufficient in order to avoid the prolonged continuous operation of the thermostatically controlled device heaters and to ensure that the generator unit will start when required to do so.
- .8 Factory standard isolators are acceptable. Manufacturer shall be responsible for any problem issues resulting from any specified product deviation.
- .9 The generator enclosure shall include the requirement for recirculating air dampers. The enclosure shall be designed for winter conditions and shall employ factory approved strategies for ensuring that the genset performs as required under the conditions to which it will be exposed.
- .10 Factory standard enclosures are acceptable with the condition that the enclosure provides adequate insulation sufficient to avoid the prolonged continuous operation of the thermostatically controlled device heaters and to ensure that the generator unit will start when required to do so. Variations in insulation and exterior wall metal gauges are acceptable.

**2.4 VENTILATION AND EXHAUST**

- .1 An engine mounted radiator with blower type fan shall be sized to maintain safe operation at 40°C. maximum ambient temperature. The radiator shall be equipped with a duct adapter flange. Air flow restriction from the radiator shall not exceed 125 Pa. Cooling and combustion air requirements shall be adequately sized to allow generator set to supply full rating continuously at 40°C. ambient. The engine cooling system shall be filled with a solution of 50% ethylene glycol and water. The engine shall be equipped with an engine driven pump for circulating water through the cooling system.
- .2 Exhaust piping of suitable material shall connect the exhaust manifold of the engine to a Hospital grade class silencer. The muffler shall provide attenuation



**GENERATOR REPLACEMENT**

---

- .14 When battery charging is not occurring, the batteries shall be constantly monitored when battery voltage drops below 24.5 volts, an alarm indicating light on the generator control panel shall be activated along with alarm signal. This monitoring system shall be fully independent of the battery charger and shall monitor the batteries regardless of whether the battery charger is energized.

**2.6 SHUTDOWN AND ALARMS**

- .1 In the building, provide an emergency shutdown pushbutton complete with a safety guard. This should take precedence over the master switch on the diesel control panel. This pushbutton shall shutdown the engine by interrupting the power to the engine controls and by dumping the engine air box or by shutting off the fuel supply. The engine air box and its configuration if utilized for shutdown shall be designed to facilitate an emergency shutdown without damage to either the engines or the air box.
- .2 Provide the following engine automatic shutdown devices, complete with red indicating light on the generator control panel:
  - .1 High coolant temperature
  - .2 Low oil pressure
  - .3 Engine over speed
  - .4 Over crank
  - .5 Low coolant level
  - .6 Over vibration (use of Murphy switch)

The low oil pressure protection system shall be locked out until the engine speed reaches 90% of rated speed and for a period of twenty (20) seconds after engine start.
- .3 Provide the following advisory alarms complete with alarm indication on the generator control panel (signals shall be sent to the existing Metasys system and be backnet compatible):
  - .1 Low battery voltage
  - .2 Abnormal selector switch position
  - .3 Under frequency
  - .4 Low fuel
  - .5 Low coolant temperature
  - .6 Ready to start
  - .7 Unit running
  - .8 Battery charger fault
  - .9 Fuel Tank Leak
  - .10 Auxiliary fault (field selectable)

**2.7 CONTROL PANEL**

- .1 Provide a unit mounted digital control panel. The control panel shall be as detailed on the drawings and shall include, but not be limited to, the following:
  - .1 Voltmeter with phase selection
  - .2 Hour meter

**GENERATOR REPLACEMENT**

---

- .3 Frequency meter
- .4 Ammeter with phase selection
- .5 Engine and electrical automatic shutdown indicator lights
- .6 Advisory alarm indicator lights
- .7 Emergency stop
- .8 In addition to point 2.6.3 provide: six (6) programmable contact inputs; (7) Contact outputs: (3) 30A dc and (4) programmable 2A dc rated contacts
- .9 RUN/ OFF – RESET/AUTO
- .10 Backnet compatible
- .2 All system controls shall be microprocessor based. Relays and relay based logic will not be permitted. The controller shall be powered from the stand-by generator batteries in an appropriate fashion so as to ensure reliable operation under normal and emergency conditions.
- .3 Provide connection from the generator control panel to the BMS system to display alarms & conditions.
- .4 The electronic governor and control scheme shall be capable of operating with isochronous cross current compensation.
- .5 The entire diesel electric set shall be supplied by Finning (Kramer Tractor), Wajax Power Systems, Generac, or Cummins.

**2.8 WORKMANSHIP**

- .1 Manufacture and construct equipment free from blemishes, defects, burrs and sharp edges; accuracy of dimensions and marking of parts and assemblies; thoroughness of welding, brazing, painting and wiring, alignment of parts and tightness of assembly screws and bolts.

**PART 3 Execution**

**3.1 INSTALLATION**

- .1 Check the site and determine the size and weight of the sections into which the equipment shall be divided for shipment to ensure that they can easily be moved into or out of the electrical rooms, as shown on the drawings. Special arrangements will be required to move the new equipment into the existing building. Protect existing building finishes and repair all damage resulting from installation of new equipment.
- .2 The ground bus shall be connected to the ground network. Refer to Section 260528 and the drawings for further grounding requirements.
- .3 Provide one litre of touch-up paint for each major component color in aerosol cans. Touch up paint finish where required.
- .4 This Division shall supply all fuel for completion of the acceptance tests after which, leave the day tank full.

- .5 Prior to the final acceptance tests, a qualified representative of the manufacturer of the generator control panels shall field verify and correct as necessary, all control circuitry, terminations of field wiring and operation of control systems. The representative shall also provide on site technical assistance to the contractor as required during the course of the installation, and shall also be present during the final acceptance tests. This representative shall visit the site a minimum of three (3) times.
- .6 The final acceptance test shall include, but not necessarily confined to, the following recorded verifications:
  - .1 Engine, generator and control panel nameplate data and operating characteristics.
  - .2 Cooling system, including radiator, piping, motorized louvres and controls.
  - .3 Provide portable meters to facilitate vibration tests. Provide documentation to demonstrate vibration readings are within engine and generator manufacturers tolerances. On completion of the mechanical installation, a complete vibration analysis shall be performed, and a hard copy of the vibration x-y plots provided. The vibration points shall be taken at a minimum of seven points both in the vertical and horizontal plane. All points shall be marked using red paint to ensure that future vibration readings are taken from identical points. Vibration readings shall not exceed 16.5 mm per second at any order within the first five orders of operating speed. The overall vibration reading shall not exceed 0.20 mm filter-out reading.
  - .4 Provide a recording harmonic meter to demonstrate that the generated wave form does not include objectionable harmonic distortion particularly third harmonic.
  - .5 Automatic engine and electrical shutdown protection devices, and all advisory non shutdown alarms.
  - .6 Control panel operation.
  - .7 Battery charger and its operation.
  - .8 Automatic and manual starting, at no load, half load and full load. Voltage, current, frequency, oil pressure, engine water temperature and enclosure temperature shall be recorded.
  - .9 With normal building load, demonstrate automatic start and transfer switch operation. Also demonstrate manual starting.
  - .10 Provide a load bank to demonstrate the unit's capability to carry 100% load continuously for two (2) hours while operating within specified ratings and temperature limits.

- 
- .11 Demonstrate emergency shutdown at 30% load.
- .7 On site testing load banks, temporary wiring, instrumentation and all personnel required to satisfactorily complete these tests shall be the responsibility of this Division. A qualified representative of the equipment manufacturer must also be in attendance to certify all test data.
- .8 Three written reports shall be prepared by the contractor and standby generator supplier, showing all engine gauge readings, all generator meter readings and room ambient temperature during the acceptance test.
- .9 The contractor shall have the installation totally complete and tested for correct operation before the acceptance tests start.
- .10 The Owner's operating and maintenance personnel shall be instructed in the operation of the system for a minimum period of four (4) hours. Written documentation bearing name and signature of Owner's personnel who received the above instructions shall be included in operating instructions and service manuals.
- .11 Connect the generator to the existing fuel tank using steel pipe suitable for diesel fuel with threaded, sealed, flexible connections.
- .12 Exhaust piping to be insulated with aluminum clad insulation.

END OF SECTION