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| Version | Date | Description of Revisions |
| 1 | August 30, 2006 | Approved final document. |
| 2 | February 19, 2010 | Modified ‘Related Sources’ and approved suppliers |
| 3 | July 15, 2013 | Final Draft – Consolidated Comments Spec Update Project. Incorporation of new Commissioning and Computerized Maintenance Management System Data Requirements Specification cross references. Incorporated several enhancements from Newfoundland Labrador Specifications. |
| 4 | August 6, 2014 | Changes to reflect renaming of commissioning specification and final review (AV) |
| **5** | **February 4, 2015** | **Updated, Finalized Specification – Reference eDOCS #5630498 v9 (AV)** |
| 6 | December 5, 2016 | Added cross reference to Section 01561 – Environmental Protection to ensure MOECC NPC-300 Guideline is applied (AV) |
| 7 | February 10, 2017 | Revised the Acceptable Manufacturers list for all listed products (AV)  Updated Reference Standards (CSA B139 Series 15, CSA C22.2 No. 94.2-15, C22.2 No. 30-M1986 (R2016), C282-15, ANSI/NEMA MG 1-2016, NFPA 110, 2016, CAN/ULC-S601-14 R2015, CAN/ULC-S603-14) (AAM) |

NOTE:

This is a CONTROLLED Document. Any documents appearing in paper form are not controlled and should be checked against the on-line file version prior to use.

**Notice:** This Document hardcopy must be used for reference purpose only.

**The on-line copy is the current version of the document.**

# GEneral

## General

### Provide, an automatic, unattended, emergency power supply system consisting of:

#### Liquid cooled low voltage diesel electric generating unit with combined engine/generator controls.

#### Accessories and equipment specified in this Section.

### Provide the design, fabrication, testing, transportation, demonstration and guarantee of the equipment.

### Operational requirements of the diesel electric generating unit(s) are such that the unit(s) may lay idle for periods up to one month and then be required to start and assume the full rated load within the specified (15 seconds) time period. Emergency power generated by these units may power critical facility equipment and devices that are required to maintain regulatory compliance, minimum service levels, water quality and other essential aspects of departmental operations. Generators must reliably allow the start of and operation of all required equipment (including variable frequency drives) under the existing conditions without damaging or compromising such equipment. Any additional electrical devices that may be required to reliably and effectively operate existing equipment under diesel generator operation at peak design conditions shall be provided at the expense of the Contractor.

### *[Consultant to ensure that maximum acoustic levels are defined in this Section in a new or existing Specification Section based on design criteria defined in the Process Narratives and Contract Documents. Consultant to create and place such acoustic level requirements including any test reports and verification methods that are required to be provided by the Contractor]*

## Related Sections

### [Under "Related Sections", identify other Sections that are related to, and/or dependent on, the work results or information specified elsewhere. The list should be limited to Sections with specific information that the reader might expect to find in this Section, but is specified elsewhere. For example, if hardware for aluminum entrances is specified in the aluminum entrance Section, a cross-reference would be appropriate in the finish hardware Section. The purpose of this cross-referencing is for information only, to aid in finding those other requirements—not to define the scope of the Section.

### Cross-referencing here may also be used to coordinate assemblies or systems whose components may span multiple Sections and which must meet certain performance requirements as an assembly or system.

### Contractor is responsible for coordination of the Work. Contractor is responsible for being familiar with and incorporating all required elements of cross-referenced Specifications cited.

### This Section is to be completed/updated during the design development by the Consultant. If it is not applicable to the Section for the specific project it may be deleted.]

### [List Sections specifying installation of products supplied but not installed under this Section and indicate specific items.]

### [List Sections specifying related requirements.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: [Optional short phrase indicating relationship].

### Section 01025 – Measurement and Payment

### Section 01561 – Environmental Protection

### Section 01250 – Substitutions

### Section 01300 – Submittals

### Section 01425 - Computerized Maintenance Management System Data Requirements

### Section 01430 – Operation and Maintenance Data

### Section 01600 – Materials and Equipment

### Section 01810 – Equipment Testing and Facility Commissioning

### Section 01820 – Demonstration and Training

### Section 16010 – Electrical General Requirements

### Section 16234 - Diesel Electric Generator Information Form

### Division 1 – General Requirements

### [Division 13 – SCADA and Instrumentation - insert applicable specifications]

### Design Guidelines Section 17 – Operation Manual Guideline.

### Product requirements for [item]... for installation under this Section.

## References

*[Delete .1 if Section 01060 – Regulatory Requirements is included in Contract Documents.]*

### Comply with the latest edition of the following statutes, codes, standards and all amendments thereto:

#### Canadian Standards Association (CSA).

##### CSA B139 Series 15, Installation Code for Oil Burning Equipment

##### CSA C22.2 No. 94.2-15 Enclosures for Electrical Equipment, Environmental Considerations (Tri-National Standard, with NMX-J-235/2-ANCE-2015 and UL 50E).

##### C22.2 No. 30-M1986 (R2016), Explosion-Proof Enclosures for Use in Class I Hazardous Locations.

##### C282-15, Emergency Electrical Power Supply for Buildings

#### Electrical and Electronic Association Manufacturers of Canada (EEMAC).

##### [Note: EEMAC standards are outdated but may be considered if there are no current equivalent applicable standards available. If EEMAC standards are to be applied, the Consultant will review the standards and approve any references to EEMAC standards in order to meet the Region’s energy efficiency objectives.]*[Consultant to delete and replace EEMAC references with NEMA equivalent standards if possible]*

#### American Petroleum Institute (API) (see ANSI/API STD 650)

#### National Electrical Manufacturers Association (NEMA)

##### ANSI/NEMA MG 1-2016, Motors and Generators

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

##### ANSI/API STD 650, Standard for Welded Tanks for Oil Storage, 12th Edition.

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

##### [Consultant to specify applicable IEEE standards]

#### American Society of Mechanical Engineers (ASME).

##### [Consultant to specify applicable ASME standards]

#### American Society for Testing and Materials (ASTM).

##### ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

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

##### [Consultant to specify applicable SAE standards]

#### National Fire Protection Association (NFPA)

##### NFPA 110, 2016 edition: Standard for Emergency and Standby Power Systems

#### International Standards Organization (ISO)

##### ISO 3046-1:2002, Reciprocating Internal Combustion Engines - Performance - Part 1: Declarations of Power, Fuel and Lubricating Oil Consumptions, and Test Methods.

#### MOECC

##### Standard Specifications for diesel engine generator sets.

##### NPC-300 Environmental Noise Guideline - Stationary and Transportation Sources - Approval and Planning

#### Ontario Building Code

##### Building Code Act, 1992, Ontario Regulation 332/12 - Building Code

#### Underwriters' Laboratories of Canada (ULC)

##### CAN/ULC-S601-14 R2015, Standard for Shop Fabricated Steel Aboveground Tanks for Flammable and Combustible Liquids.

##### CAN/ULC-S603-14, Standard for Steel Underground Tanks for Flammable and Combustible Liquids.

#### International Organization for Standardization (ISO)

##### ISO 3046-1:2002, Reciprocating Internal Combustion Engines – Performance Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods – Additional requirements for engines for general use.

##### ISO 3046-4:2009, Reciprocating Internal Combustion Engines – Performance – Part 4: Speed Governing.

#### FED-SPECS

##### Federal Standard 595C Paint Spec.

#### Technical Standards and Safety Act, 2000

##### O Reg. 215/01 Fuel Industry Certificates.

##### O Reg. 213/01 Fuel Oil.

##### O Reg. 217/01 Liquid Fuels.

## Measurement and Payment

*[Choose one of the following payment language provisions that best suits the individual project.*

*If this Section is not specifically referenced by an item in the Bid Form, please use the following language:*

### The work of this Section will not be measured separately for payment. All costs associated with the work of this Section shall be included in the Contract Price.

*OR If this Section is specifically referenced in the Bid Form, use the following language and identify the relevant item in the Bid Form:*

### All costs associated with the work of this Section shall be included in the price(s) for Item No(s). \_\_\_ in the Bid Form.

*If the work of this Section is to be measured and paid for by several different methods, please amend the standard wording given above to reflect the different methods of measurement and payment.*]

## Design Criteria

### Design equipment suitable to meet the following criteria:

#### Generator set minimum prime rating [\_\_\_\_\_]kW, [\_\_\_\_\_] kVA.

#### Total design load: [\_\_\_\_\_] kW.

#### Motor load: [\_\_\_\_\_] kW.

#### Largest motor: [\_\_\_\_\_] kW, inrush [\_\_\_\_\_] kVA.

#### Voltage: [\_\_\_\_\_] V.

#### Frequency: [\_\_\_\_\_] Hz.

#### Phase/Wire: [\_\_\_\_\_][\_\_\_\_\_]

#### Power factor: [0.8].

#### Load harmonic content: [5%] THD.

#### Maximum rotational speed: [1800] rpm.

#### Interrupting capacity: [\_\_\_\_\_] MVA.

#### Duty rating: full load continuous plus 10% overload for 1 h in every 12 h period.

#### Performance: automatic.

#### Elevation above sea level: [152 m].

#### Ambient temperature: [40]°C.

#### Relative humidity: [60%].

### The unit shall be designed to start and attain settled voltage and frequency limits and accept 100% rated load with voltage and frequency settling to the specified steady state bands, all within 15 seconds for any temperature between 0°C to 40°C. Refer to Division 13 –SCADA and Instrumentation Process Narratives, which are included in the Contract’s SCADA appendices, for additional information. [*Consultant to ensure Process Narratives are included in the Contract Documents]*

### Within 10 Working Days of the date of the Region’s written notice to commence the Work, complete and submit the Diesel Electric Generator Information Form (included in Section 16234 - Diesel Electric Generator Information Form) for approval by the Consultant prior to the preparation and submittal of shop drawings.

### Use the engine manufacturer's standard, published continuous (prime) kW (horsepower) rating in assessing engine capacity and de-rate this rating for the specified conditions and engine driven accessories in accordance with ISO 3046-1:2002.

### Description of generating set operation:

#### Overall emergency power system control philosophy is referenced in Section 13 – Standby Power (Design Standards and Guidelines).

#### Overall description of emergency power generation system is described in the Division 13 – SCADA and Instrumentation Process Narratives. Also refer to Division 13 – SCADA and Instrumentation for the control philosophy of paralleling diesels, synchronization, redundancy etc.

#### The Consultant will provide details of the ATS operation with respect to open/close transitions. Refer to the Contract Drawings.

#### Control of the generators shall be by Multilin 489 *[Consultant to amend as required – dependent on size of genset]* with communication by Modbus IP and linked to SCADA and other LANs for device access.

#### Automatic starting on abnormal or loss of normal voltage: voltage sensing relays shall sense all three phases of the hydro supply. If the voltage on any one phase should drop below preset limits (adjustable) for an adjustable period of time, the engine start contact shall close and cause the engine to start. Operation of generator sets (gensets) shall not compromise the operation of existing equipment utilizing VFDs.

#### When the emergency supply has reached the settled voltage and frequency preset limits (adjustable), the transfer switch will transfer the load to the emergency supply.

#### The set will continue to supply the load until the hydro supply returns or the set is shut down manually or under failure conditions.

#### On hydro restoration, confirmed by three phase sensing of voltage above an adjustable preset, for a time period in excess of three minutes (adjustable), the transfer switch will transfer the load to the hydro supply. Provide a dead bus timer to allow motor starters to drop out and motors to stop prior to connecting to hydro.

#### An adjustable time delay relay shall allow the engine to run unloaded to cool down and subsequently to shut down, ready for the next cycle.

#### The engine shall be equipped with a key switch with the following positions: auto-off-crank-start, key removable in auto position only.

#### Automatic shut down on:

##### Over-cranking

##### Over-speed

##### High engine temperature

##### Low lubricating oil pressure

##### Over and under frequency

##### Emergency breaker failure

##### Electrical fault lock-out on short circuit and generator over and under voltage.

### Design, fabricate and assemble the equipment to provide electrical standby power. This includes:

#### Diesel engine directly connected to a generator, all mounted on a common base plate.

#### Free standing control panel for the generator, all mounted on a common base plate.

#### Ancillary equipment (including, but not limited to, fuel oil tanks, batteries, charger, exhaust muffler and exhaust insulation).

### Ensure that the components are suitably matched to operate with each other to provide satisfactory performance be of robust nature and be designed for long life, including, but not limited to, the following components:

#### Engine and speed governor.

#### Engine and generator.

#### Generator and voltage regulator.

#### Engine safety and control devices rigidly mounted to prevent improper functioning of related equipment.

#### Engine instruments isolated from vibrations with anti-vibration mountings.

### Ensure that the model and type of engine is of proven design for the class of service required for the Work.

#### Upon request, submit a list of approximately five recent installations in Canada and related contact information, preferably in Ontario, where similar equipment has been in service over two years. Also indicate the engine model and type.

### Ensure that the generator set shall:

#### Be assembled in Canada (if possible) and of new material.

#### Be comprised of components made in or stocked (over three units) in Canada and of current manufacture.

#### Have components CSA approved where applicable and comply with the requirements of ESA.

## Quality Assurance

### All work shall meet the requirements of [Consultant to determine the Quality Standard that will apply – equivalent to the withdrawn standard CSA Z299.3-85 (R2006)].

## Location of Project

### Project to be located at the Site, specified in Division 1 – General Requirements.

## Shop Drawings and Final Shop Drawings Binders

### Submit shop drawings to the Consultant for review and approval.

### Shop drawings and specifications shall include, but not be limited to, the following:

#### Engine: make, model, rating and performance curves.

#### Automatic transfer switch, make model.

#### Control Panel.

#### Starter motor, make model.

#### Generator: make, model and rating complete with generator saturation curves, heat damage curves, reactive capability and special data.

#### Voltage regulator: make, model, type.

#### Governor: type, model.

#### Battery: make, type, voltage, capacity.

#### Charger: make, model, input and output rating.

#### Submit a general outline drawing of the complete assembly showing the engine, radiator and generator mounting, exhaust, recirculating and intake air louvre arrangement, exhaust gas silencer and pipe arrangement, locations of fuel and lubricating oil filters, fuel supply and return line connections, lubricating oil drain valve, radiator and coolant drain valves, air cleaner, engine instrument panel, starting motor, power and control junction boxes, engine and generator mounting feet. Indicate on the general outline drawings horizontal and vertical dimensions, minimum door opening required for moving the unit, head room required for removal of piston and connecting rod, and weight of engine, generator, baseplate, radiator and exhaust silencer. *[Consultant to amend the detail requirements and need for a general outline drawing. Consultant to ensure that the building and door openings and head room dimensions are sufficient for installation and future maintenance of potential diesel electric generating units for the facility]*

#### Baseplate construction details and materials.

#### Outline and layout of all panels.

#### Schematic and wiring diagrams of engine, generator, control panel, automatic transfer isolation and bypass panels complete with interconnecting wiring diagrams.

#### Single line diagram showing all breakers, switches, metering and protective relays.

#### Field wiring diagrams.

#### Complete bill of materials, including manufacturer's name, catalogue numbers and capacity.

### Express all dimensions and data in metric units and symbols followed by, in brackets, imperial units and symbols wherever applicable.

### The Device Numbering System shall be in accordance with industry standards with respect to metric practice and graphic symbols and designations used in technical documentation.

### Final Shop Drawings Binders shall be submitted prior to the start of commissioning. Refer to Section 01025 – Measurement and Payment for details on the payment schedule relating to the receipt of Final Shop Drawings Binders and Section 01810 – Equipment Testing and Facility Commissioning.

## Maintenance Data and Instruction Manuals

### Provide, but not be limited to, the following in for incorporation into instruction manuals:

#### Factory test data of engine, generator, exciter, control logic, metering and all other pertinent test data.

#### Maintenance and operation manuals and bulletins for:

##### Engine and Accessories

##### Generator

##### Voltage Regulator and Accessories

##### Exciter

##### Permanent magnet generator if installed

##### Battery charger

##### Speed Governor

##### Starting Motor

##### Batteries

##### Ventilating Equipment

##### Timers, Relays, Meters

##### Power Circuit Breakers

##### Controller, Contactors

##### Other Accessories

#### If brochures are submitted, these shall be originals; photocopies are not acceptable. Brochures shall contain all technically relevant data.

#### Complete sequence of system operation.

#### Complete bill of materials including nameplate data of equipment and accessories.

#### All required equipment information specified in Section 01425 - Computerized Maintenance Management System Data Requirements.

#### Refer to Section 01430 – Operation and Maintenance Data for data requirements, Maintenance Summary Forms, Lubricant Lists and Recommended Spare Parts for the Region’s Inventory List.

### Provide to the Consultant, within 10 Working Days prior to the factory tests, one copy of the instruction manual for each unit of different ratings.

### Provide to the Consultant, within 10 Working Days after the factory tests, three copies of instruction manuals (including the synchronization test reports of multiple generating units, if applicable), with updated drawings, for each unit of different ratings. Submit one set of sepias along with the manuals. Where more than one unit of identical ratings is supplied on the same purchase order, provide three copies for the first unit, two copies per unit for each succeeding unit, up to a total of six units, one copy per unit for each additional unit above this amount.

### Crate with each unit, one copy of instruction manual, with updated drawings, plus one extra loose set of drawings all in protective cover.

### Bind in 25 cm x 30 cm, vinyl hard covered, 3 D ring loose leaf binders. Provide an electronic copy of the materials in addition to aforementioned hard copies.

### Enclose a title sheet containing the Contract number, project name, date and list of contents.

# PRODUCTS

## Assembly

### Provide the following items plus such other items as necessary to make the unit complete as implied or intended:

#### Diesel engine.

#### Diesel engine accessories.

#### Baseplate and drip pan.

#### Vibration isolators.

#### Governor.

#### Engine exhaust system.

#### Engine cooling system.

#### Engine ventilating system.

#### Starting motor(s).

#### Batteries and rack.

#### Multilin 489 Generator Protection System

#### Communications system to link Multilin 489 to SCADA and independent LAN for device access utilizing EnerVista software *[Consultant to amend as required – dependent on size of genset]*.

#### Battery Charger.

#### Generator and Exciter.

#### Voltage Regulator and Accessories.

#### Spares and Accessories.

#### Weather and Sound Enclosures.

## Mounting

### Connect engine flywheel housing rigidly to generator stator housing with SAE adapter. Mount unit on a common, heavy duty fabricated steel baseplate. Design and materials of baseplate must be approved by engine manufacturer and the Consultant.

### The baseplate shall be of sufficient rigidity to maintain alignment of engine-generator shafts and frames under all conditions incident to shipping, installation and service.

### Machine engine-generator feet and baseplate sole plates parallel and true. Shimming to be steel type and only permitted underneath the generator feet.

### Support the baseplate on spring type isolating fixtures from welded side brackets located in such a manner that bottom of baseplate will be approximately 25 mm above supporting floor. Isolators shall have cast iron housings and be complete with leveling bolts, adjustable oil proof snubbers and minimum 6 mm thick sound pads. Isolation efficiency to be not less than 95%.

### Determine quantity and location of isolators in such a manner that each isolator will carry equal proportion of weight and to ensure that the pressure exerted on the floor by each isolator does not exceed 345 kPa.

### Isolators shall be shipped loose for installation at the Site.

## Diesel Engine

### Provide full diesel, heavy duty, cold start, liquid cooled, vertical in-line or vee diesel engine, current manufacture of a type and size that has been in service as a prime mover for electric power generation for a minimum of two years. The turbo supercharged engine’s acceptable providing brake mean effective pressure (BMEP) at rated output shall not exceed 1,800 kPa. Mechanically driven superchargers are not acceptable.

### Engine shall have a minimum of four cylinders.

### Engine with auxiliary starting aids (including, but not limited to, glow plug assist start) shall not be acceptable.

### Equip engine air intakes with dry type heavy-duty air cleaners located close to the inlet manifold. Cleaner element to be directly replaceable with elements of Canadian manufacture.

### Provide engine wiring in liquid-tight conduit and fittings with insulated bushings. Use stranded, minimum No. [\_\_\_\_\_] AWG, TEW 105°C and coloured coded wires. Terminate wiring with coded, insulated terminals flanged fork type. Terminal blocks shall be heavy duty, screw type. Wire markers of slip on oil proof type. [Junction boxes on unit shall be liquid-tight type]. Maximum of two wires per terminal block.

### Provide high quality lubricating oil pressure gauge, lubricating oil temperature gauge, coolant temperature gauge, thermocouple exhaust pyrometer and other standard gauges and instruments. Calibrate and scale gauges and Instrument in both metric and imperial units and symbols. Oil temperature sensors shall be mounted on engine full flow pressure line. Hoses or tubing for gauges shall be high pressure reinforced type.

### Mount unit accessories, including gauges, instruments, and protective sensors, in such a manner that machine vibrations are isolated or damped.

### Dynamically balance complete engine-flywheel generator arrangement after assembly. Ensure that there are no torsional or other harmful vibrations within 10% above or below rated speed of unit, when operating unloaded or connected to any load within its rating. Cyclic irregularity shall be no greater than 1/250.

### Provide engine flywheel with graduated marking around its periphery to facilitate fuel injection and valve timing.

#### The unit must not experience vibration or displacement greater than 6 mils or a velocity greater than 1.0 cm/sec measured over a spectrum of 100 HZ to 10,000 HZ. Measurements shall be taken at Nominal Load, 25%, 50%, 75%, and 100% full load.

### Provide removable wet type cylinder liners. Furnish cylinder head with removable valve seat insert and guides.

### Provide personnel safety guards for exposed moving parts and exhaust manifolds. Provide platform for servicing upper part of engine where applicable.

### Acceptable Manufacturers:

#### Caterpillar Inc.

#### Kohler Co.

#### Wajax Corporation

#### Approved Equivalent.

## Jacket Water Cooling System

### This assembly shall cover a locally mounted radiator situated on the engine base with an engine driven fan and a totally enclosed water system, and shall include the items specified below:

#### Pusher fan driven from the engine with V-belt(s).

#### Radiator, mounted on set base, amply sized to cool the engine under full load and overload conditions in an ambient of 30°C complete with radiator inlet cowling and outlet ducting flange.

#### Flexible canvas boot for mounting on the front of the radiator, flanged on both sides, and have a minimum length of 100 mm.

#### Engine driven water circulating pump.

#### Temperature regulating valve with bypass feature, located in cylinder head water outlet.

#### Water pipes, flexible hoses, etc., drain cocks shall permit the complete system to be drained.

#### Safety protection guards around all moving parts.

#### First filling of water/antifreeze suitable for -40°C.

## Remote Radiator

### Remote RAD Design/Construction

#### Design parameters:

##### Coolant: 50% ethylene glycol

##### Design inlet temperature: 94°C

##### Design outlet temperature: 88°C

##### Maximum design temperature: 104°C

##### Jacket Water - Flow rate: [\_\_\_\_\_] L/min

##### Header Size: [\_\_\_\_\_] mm, flanged.

### Radiator Construction

#### Vertical Air Flow.

#### Aluminium fin on copper tube.

#### Tube wall [\_\_\_\_\_] mm minimum.

#### Tube diameter [\_\_\_\_\_] mm minimum.

#### Double core shall be suitably mounted in frame to accommodate thermal expansion and contraction.

#### Flanged fittings.

#### Drains and vents shall be provided and easily accessible.

#### 344 kPa pressure test.

### Fan Motor

#### TEFC 600V, 3 phase with internal self-resetting thermal overload protection.

#### Fan kW shall not exceed 1.5 kW. Use multiple fan units for required cooling.

### Fans

#### Bottom mounted push type with die cast aluminium blades.

#### Direct drive via square key and key way or roll pins. If using keys, the fan shall be fixed to the motor shaft by two Allen cup point cap screws. One shall hit the key, the second, at 90°C, shall hit the motor shaft in a counter bore such that the screws do not damage the shaft and make blade removal difficult.

#### The fan and motor assembly shall be balanced and guarded.

### Radiators shall be mounted on self-supporting stands a minimum of 1,200 mm off grade.

## Fluids

### Engine Jacket Water

#### The Contractor shall supply all necessary ethylene glycol/water at a 50/50 concentration by volume until equipment is commissioned.

#### Engine Jacket Water Coolant Long life ethylene glycol c/w additives.

#### Ethylene glycol shall suitable for use with the engine comprising the genset package. MSDS for all engine coolants shall be provided to the Consultant prior to Site delivery.

## Lubrication System

### Provide a full pressure lubricating system complete with duplex filters and oil cooler.

### MSDS for all engine lubricants shall be provided to the Consultant prior to Site delivery.

### Oil pump shall be engine driven gear type complete with strainer.

### Equip filters with automatic by-pass valve and full flow filter elements conveniently located for servicing and directly replaceable with elements of Canadian manufacture. Cooler shall have sufficient capacity to maintain oil temperature within 93°C with unit operating at rated load under the conditions specified in the Contract Documents.

### Equip the engine oil sump with an oil drain pipe, gate valve and pipe cap. Permit complete drainage in a convenient manner. Extend 75mm beyond the base plate.

### The lubrication system shall include an oil level dip-stick.

### Operational requirements are such that unit may lay idle for periods up to one month and then be required to start and assume full rated load within the specified (15 seconds) time period. To protect the service life of engine components, provide an electrical motor driven, integrally mounted, gear type oil priming pump with interval timer and breaker type combination starter. The starter shall be mounted in the control panel. The lubrication oil pressure switch shall stop priming pump when the engine is running. Where a pump is not being provided, submit a letter with the shop drawings certifying that oil pump are not required for these conditions and will not detract from the service life of engine components.

### All gensets rated greater than 750 kW shall have pre-lube pumps and fuel coolers.

### All metallic oil hoses shall be of the steel reinforced rubber type with crimped or swaged end fittings.

### First on-Site replacement of lubricating oil shall be shipped loose in containers. Upon completion of commissioning, the engine oil shall be replaced. Used oil shall be disposed by the Contractor at the Contractor’s expense.

### Provide surplus lubricant of sufficient quantity to permit two years of routine maintenance in accordance with the manufacturer’s recommendations. Lubricants shall be properly stored and labeled.

### Provide basic lubricant testing kits as detailed in the Contract documents.

## Fuel System *[Consultant to select appropriate fuel system and amend this subsection as required]*

### Provide a complete fuel system including fuel lift pump and duplex filters. Filter elements shall be directly replaceable with elements of Canadian manufacture.

### The fuel pump shall have minimum suction lift capability of [1.0 m]. *[Consultant to add additional appropriate details]*

### Bring fuel supply and return lines to the extreme forward part of baseplate with drop ear elbows to be affixed thereto. Connect the other end of each elbow with 1.0 m of flexible neoprene hose.

### Flexible connectors, bronze corrugated type for the suction and return lines, located in a horizontal plane and secured at one end to the engine base. Equal to “US Hose Corp. USA” type BA or Approved Equivalent.

### All non-metallic fuel hoses shall be of the steel reinforced rubber type with crimped or swaged end fittings.

### Fuel system shall include a fuel filter/water separator, Parker Hannifin Corp, Racor Division products or Approved Equivalent.

### All fuel piping to be schedule 40, carbon steel with welded and/or threaded construction.

### Bi-Fuel System for Diesel Engine: [Subsections regarding bi-fuel system below to be deleted by Consultant if not applicable to the Contract Work]

#### Bi-Fuel System shall be rated for the [\_\_\_\_\_] KVA generator, and shall 100% keep up with the generator’s requirements.

#### The heavy-duty diesel engine shall also be provided with a Bi-Fuel System (Natural Gas) to substantially reduce the operating cost and also to lower emissions. This will be achieved by substituting diesel fuel with lower cost, cleaner burning natural gas.

#### The Bi-Fuel System shall be comprised of patented technologies that allow engines to safely operate on gas percentages ranging from 50% to 85% of the total fuel requirement. The engine efficiency, stability and load acceptance shall not be reduced when converted to Bi-Fuel System.

#### The key feature of the Bi-Fuel System shall be its ability to switch fuel modes without interruption in the engine power output.

#### Through the Bi-Fuel System controls, it shall be feasible to switch between gas and diesel modes either manually or automatically while maintaining speed and load.

#### The Bi-Fuel System shall utilize a state-of-the-art electronic control and monitoring system. The control panel shall monitor critical engine and Bi-Fuel System parameters and activate or deactivate gas mode according to programmed limits.

#### When the monitored parameters exceed the allowable limits, the controller shall switch the engine to 100% diesel mode and electronically log the fault for diagnostic purposes.

#### The control panel shall be housed in a NEMA rated weatherproof enclosure and is approved for class 1, Division 2 environments.

### Bi-Fuel Components:

#### The Bi-Fuel System consists of the following components, including, but not limited to:

##### Gas Intake

##### Gas Filtration System

##### Gas Regulator

##### Gas Valve Controls

##### Shut-off Control Valve

##### Power Valve

##### Air Intake

##### Air Filters

##### Gas Mixer

##### Turbo-Charger

##### Gas Train

##### Controller

##### Control Panel

### Bi-Fuel System Controller

#### The Engine Control System shall be based on proven technology and provide state-of-the-art engine control and safety shutdown monitoring. The system shall monitor a number of pressure and temperature points and should any parameter deviate from its normal range, the system shall return the engine to 100% diesel operation.

#### The Monitoring System consists of the following components, including, but not limited to the following parameters:

##### Gas Supply Pressure

##### Regulator Output Pressure

##### Air Filter Vacuum

##### Manifold Air Pressure

##### Manifold Air Temperature

##### Exhaust Gas Temperature

##### Engine Vibration

##### Arrangements for RS-232/ RS-485 Remote Monitoring: Communication network to be provided for link to SCADA and an independent LAN for device access in accordance with Division 13 – SCADA and Instrumentation. Refer to the process narratives detailed in Division 13- SCADA and Instrumentation for a description of the operation and data requirements for the genset system.

### Bi-Fuel Supply Line:

#### Review the location of the incoming natural gas line indicated on the Drawings. Coordinate the work related to the natural gas line with the applicable gas utility company, Subcontractor(s), supplier of the diesel generator/ Bi-Fuel System/ Walk-in Enclosure, and authorities having jurisdiction over the location of the gas line and opening requirements. Use qualified Subcontractor(s) to extend the gas line to the walk-in enclosure and connections and include all associated costs in the Contract Price.

### Coordination:

#### The Contractor shall coordinate the work of this Section with the required Subcontractors and Consultant.

## Exhaust System

### Provide a complete exhaust system including a combustion exhaust silencer with condensate drain, plug and flanged couplings; stainless steel, corrugated expansion joints, of suitable length, to absorb both vertical and horizontal expansion; all flanges, bolts, gaskets, adjustable hangers and pipe and pipe-thimble to permit projection of pipe 1.0 m beyond wall. Exhaust tail pipe end shall be cut at 45 degree angle and terminate in bird screen. All interior exhaust piping and silencer shall be insulated.

### Arrange the exhaust system to suit openings. Where the Contract Drawings do not indicate the location of the opening, arrange the exhaust run in a manner best suited to the engine.

### Provide exhaust pyrometers located on the common exhaust manifold or two pyrometers on separate manifolds. The pyrometer range shall include temperature at 110% load.

### Exhaust piping shall be schedule 10, Type 304L, stainless steel. *[Consultant to confirm the required grade of steel.]*

### All pipe connectors shall be Vanstone-type flanges with 57 kg to 68 kg backing rings and 143° C (290°F) gaskets.

### Inside piping shall be security supported from the ceiling. Hangar bolts shall be positively locked to prevent coming loose through vibration and creating load on the turbocharger.

### Flexible connection at engine

#### Exhaust flexible connection, T321 stainless steel, bellows type 600 mm length, ANSI flanges for connecting to the exhaust manifold.

#### Exhaust silencers (2)

##### Two silencers in series shall be provided to attenuate both high and low frequency noise.

##### Silencers shall be rated for 510°C temperature.

##### Silencers shall be provided with flanges and port orientation as shown on the Drawings.

##### Silencer No. 1

###### Super critical grade providing attenuation of 30-35 dBA across the audible range of the frequency spectrum 63 Hz to 600 Hz.

###### Silencer shall be constructed of plate steel and be of a welded design.

###### Provide a 12 mm drain piped to a discharge point using copper tubing. Tubing shall be terminated with a ball valve as directed by the Consultant.

###### Finish: 510°C high temperature aluminium paint.

###### Approved Suppliers/Manufacturers: [Consultant to list acceptable suppliers/manufacturers and Approved Equivalent ]

##### Silencer No. 2

###### Acoustical grade providing attenuation of 30-35 dBA across the audible range of the frequency spectrum 600 Hz to 4000 Hz.

###### Silencer shall be constructed of plate steel and be of welded design.

###### Finish: 650°C high temperature aluminium paint.

###### Approved Suppliers/manufacturers: [Consultant to list acceptable suppliers/manufacturers and Approved Equivalent]

##### Silencers shall be designed for noise attenuation to levels defined in the Contract Documents.

### Insulation

#### Interior exhaust piping and silencers to be insulated with 50 mm of calcium silicate insulation to limit surface temperature of the insulation to 82°C at an ambient room temperature of 27°C.

#### Insulation to be moulded for pipe application and furnished in sectional lengths.

#### Insulation temperature limit: 650°C.

#### Outer covering: Aluminized sheet metal shell.

#### .5 Approved Suppliers/manufacturers: *[Consultant to list acceptable suppliers/manufacturers and Approved Equivalent]*

### Wall sleeve

#### Wall sleeve shall be ULC listed for exhaust pipe transition through the building wall construction being used.

#### .2 Approved Suppliers/manufacturers:

#### *[Consultant to list suppliers for the Region’s approval].*

#### Approved Equivalent

### Exhaust stack

#### *[Consultant to specify stack requirements.]*

### Installation

#### Provide all necessary labour, equipment, tools, supports, etc., for complete installation.

#### All piping shall be installed in plumb and aligned horizontal and vertical orientation.

#### Coordinate exhaust pipe routing with building framing and other equipment both inside and outside of the plant facility.

#### Exhaust pipe supports shall be provided from roof trusses.

#### Adjust piping to remove weight from bellows-type flexible connection at engine.

#### All piping shall be sloped to draw away from the silencer.

#### Provide flanges on piping as required.

## Jacket Coolant Heater

### Provide engine jacket coolant heater(s) complete with 20 °C to 60°C adjustable immersion type thermostat. Size heater(s) to maintain coolant at 40 °C in an ambient temperature of 0 ° C.

### Obtain circulation of heated coolant on thermo-syphon 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 to be 120 V single phase splash-proof type complete with breaker type combination starter. Starter in wall-mounting enclosure mounted in control panel.

## Speed Governor

### Provide full electronic governor with speed changer and dry type actuator. Governing system shall be in accordance with ISO 3046-4.

### Governor shall provide the following features:

#### Ten turn locking type manual speed adjustment.

#### Speed regulation, steady state, no-load to full load and vice versa: +/-0.25%.

#### Transient peak, no-load to full-load and vice versa +/- 10%.

#### Recovery time to steady state condition on application of full load from no load shall not exceed 3 seconds.

#### Frequency shall be externally adjustable from zero to 5% while the engine is running.

#### Class A accuracy.

## Starting System

### Provide a complete starting system, 24V DC, including cranking starting motor(s), batteries, battery stand, heavy-duty battery cables and battery charger.

### Provide positive engaging type cranking motor(s). Cranking motor and flywheel ring gear arrangements which may permit tooth to tooth abutment are not acceptable.

### Provide lead acid battery, type 8D with sufficient capacity in an ambient room temperature of 0°C to crank the unit at the engine manufacturer's recommended cranking starting speed for a period of 3 minutes. The voltage measured at starting motor terminals at the end of 3 minutes cranking, with cranking current flowing, shall be a minimum of 1.75 V per cell. Size battery on the basis of engine and battery manufacturer's published data. Batteries shall be [dry charged, specific gravity of electrolyte 1.22 when fully charged at 27ºC]. Battery termination shall be bolt-on or study type. Terminals and all exposed electrical connections shall be protected from accidental short circuit by falling conductive objects on the battery. Such protection shall be transparent.

### Provide battery stand coated with acid resistant paint and fabricated from angle irons with 20 mm plywood bottom and heavy duty casters for ease of movement.

### Provide battery charger with 120 V AC input and output equal to 1.20 of the ampere-hour capacity of the battery based on an 8 hour rate. Output voltage ripple shall be 3% or less. Provide an AC input circuit breaker and a 24 h terminating equalizer timer with approximately 4 m of connecting cord and permanent connectors for connecting to battery terminals. Provide 5 spare fuses inside the charger panel. Charger shall be CSA approved.

### Provide necessary heavy duty, maintenance-free battery cables and connectors. Select cable wire size on the basis of allowing not more than 5% voltage drop at time of peak load. Cable length shall be sufficient to allow battery to be located on either side of the engine.

## Generator

### Provide generator, drip proof, single bearing and close coupled to engine with SAE housing. The generator shall have a full amortisseur winding, direct connected brushless exciter with easily removable bolt-on diodes with surge protection, and meet or exceed NEMA MG1-22 (see subsection 1.3.1.2) and current IEEE Standards.

### Maximum deviation of open circuit terminal voltage waveform shall not exceed 5%.

### Provide a permanent magnet generator (PMG) for generator short circuit sustaining capability not less than 2.4 times rated current.

### Generator winding insulation shall be Class F; winding temperature rise shall not exceed 80 °C as measured by resistance in an ambient temperature of 40°C.

### Identify generator windings with metal tags. Bring windings to [insulated terminals in] a metal junction box mounted on the side or top of the generator. Size the junction box to permit the mounting of the engine and generator low voltage controls and wiring terminals blocks. Provide a barrier in the junction box to separate low and high voltage wiring.

### Design the equipment to minimize radio frequency interference (RFI) under all operating conditions. Balanced telephone influence factor (TIF) to meet or better requirements of NEMA Standard MG1-22.43 *[Consultant to provide an equivalent NEMA standard for all references to EEMAC and amend as required*] [(see subsection 1.3.1.2)].

### [\_\_\_\_\_] V, [\_\_\_\_\_] phase, [60] HZ, [1800] RPM.

### Approved suppliers/manufacturers: [Consultant to list acceptable suppliers/manufacturers and Approved Equivalent]

## Voltage Regulator

### Provide a voltage regulation system complete with auto/manual control module. Voltage regulator shall be capable of withstanding continuous vibration, 15 shock and temperature up to 50°C while maintaining accuracy to plus/minus 1%.

### Steady-state voltage regulation not to exceed 1%. Transient voltage regulation, when full load is applied or removed, shall exceed 10% when measured by oscilloscope or high speed strip chart recorder with recovery time to steady-state less than 3 seconds.

### The AVR to have following features:

#### Regulation: ± 1.0%, steady state, NL to FL.

#### Sensing: single phase, [\_\_\_\_\_] V AC, 60 Hz.

#### External voltage adjust range: ±10% of nominal voltage.

#### Built in EMI interface suppression and built in under frequency control for 60 Hz operation.

##### Under frequency roll off which shall reduce output voltage in proportion to frequency below a threshold of 54 Hz.

#### Operating Temperature: -40°C to 60°C.

#### The AVR shall be located in a control cubicle. NOTE: If additional field resistance is required, locate resistor in switchgear/control cubicle.

#### Recovery time from load change to steady state regulation shall be less than two seconds for the following: NL to 25% load NL to 50% load NL to 75% load NL to 100% load

## Panel - General

### Panel shall be of indoor, free-standing, dead front, metal-enclosed steel construction complete with lifting eye bolts. Doors shall have formed edges, be reinforced by stiffeners and complete with lockable handles.

### Design and construct panel to withstand strains, jars, vibrations and other conditions incident to shipping, storage, installation and service.

### Build the control panel with the following features:

#### CSA enclosure 2, with upper side ventilation, free standing, constructed of #14 gauge steel, rigidly braced, suitable for locating the back and/or sides against a wall. Minimum size 500 mm W. x 450 mm D. x 1,800 mm H., equal to "Hammond Manufacturing" #1418W18 NEMA 12 enclosure.

#### Front door, single, continuous hinge type to open over 120º for full inside access and with keyed automotive handle and three-point latch.

#### Mounted sub-bracket for generator circuit breaker, arranged to permit the handle to project through a slot in the door (but not located on the door).

#### Components, if fitted to the rear or side panels, secured by tapped holes or captive nuts only.

### Panel shall be CSA certified. Mount a nameplate bearing the CSA monogram in a prominent position on the panel.

### Identify all instruments and controls with lamacoid or metal engraved nameplates fastened by rivets or screws for permanent identification. All items mounted on the door shall also be identified with nameplates. Nameplates shall not be attached to removable items such as relays and wire-way covers.

### Provide panel with bolted rear covers or removable side panels.

### Factory wire panel completely. Use stranded, minimum No. 14 AWG, TEW 105°C and coloured for control wiring. Use No. 10 AWG for CT secondary connections:

#### Blue - DC control.

#### Red - AC control.

#### Black - PT secondary connections.

#### Orange - CT secondary connections.

#### Green - non-current carrying ground.

#### White - current carrying ground.

#### Yellow - interlocks.

#### Brown - generator excitation system.

### Code wiring at each wire end with permanent, non-aging slip on markers. Support and run wiring neatly. Protect wiring from mechanical damage by grommets and shields.

### Terminal blocks shall be coded, clamp type, serrated for positive grip and of tough, non-brittle, unbreakable nylon, MTE size 3,453/0 or equivalent. For current transformer secondary circuits, provide terminals blocks of dual connector type:

#### *[Consultant to list suppliers for the Region’s approval].]*.

#### Approved Equivalent.

### Provide test block for current transformer secondary connections.

### Provide door detent mechanism to maintain hinged door at the open position.

### Supply loose two sets of wiring markers for each external wiring connection. Markers shall be contained in a plastic bag and secured inside the panel.

### Use a wiring duct for interconnection within the panel.

### Direct inter-panel connection shall not be permitted, use terminal blocks.

## Control Panel

### Provide a control panel for controlling the engine generator unit.

### Provide hinged front door.

### Electrical connection of components to be as shown in solid lines on the Contract Drawing.

### Mount terminal blocks on common mounting strips for interconnection wiring between the following:

#### Sub-panel and panel door.

#### Sub-panel and external wiring from diesel generator unit circuits.

#### Sub-panel and external indicating circuits.

#### Sub-panel and secondary circuits of power sub-cubicle.

#### Sub-panel and external wiring from power transfer panel.

### Provide a 1 cm x 4 cm horizontal copper ground bus for the whole length of the enclosure, and two ground lugs; one at each end. The lug shall be capable of accepting grounding conductor of range from No. 8 to No. 2/0 AWG.

### Terminal blocks shall be CSA approved, clamp type, serrated for positive grip and of tough, non-brittle unbreakable nylon material. Maximum two wires per terminal block. Use factory made terminal block jumpers wherever necessary.

### Provide circuit breakers for equipment protection: fuses shall only be used where breakers are not applicable.

### Provide top and bottom entry for power and control cables. Bottom plate shall be removable and sized 0.45 m by 0.15 m.

## Engine/Generator Controller

### The engine generator controller shall be microprocessor based and shall contain the following basic features: automatic and manual start/stop control modes, monitoring and control of essential engine generator set parameters and automatic shutdown and/or alarm status of specified protection fault circuits.

### The Generator Protection System shall be the Multilin 489 *[Consultant to amend as required – dependent on size of genset]* type device and will augment/complement other proprietary protective devices. Refer to the Process Narratives detailed in Division 13 – SCADA and Instrumentation (included in the Contract’s SCADA appendices) for requirements regarding monitoring, IP connectivity, interfaces to existing SCADA and facility PACs. The automatic operation mode shall have provisions for accepting an automatic starting/stopping signal from a remote device. The alarm and shutdown fault circuits provided shall meet the requirements of CSA C282-15, Ontario Building Code and NFPA 110 level 1 regulatory standards. The alarm and shutdown fault circuits to be provided shall include, but not be limited to, the following:

#### Low Oil Pressure - Shutdown

#### High engine Temperature - Shutdown

#### Low Coolant level - Shutdown

#### Low Fuel Level - Alarm

#### Over-crank - Shutdown

#### Over-speed - Shutdown

#### Loss of speed - Shutdown

#### Low battery voltage - Alarm

#### High battery voltage - Alarm

#### Weak battery - Alarm

#### Low oil pressure - Alarm

#### High engine temperature - Alarm

#### Low engine temperature - Alarm

#### Reverse power - Shutdown

#### Under-voltage - Shutdown

#### Over-voltage - Shutdown

#### Under-frequency - Shutdown

#### Over-frequency - Shutdown

#### Breaker Tripped - Shutdown

#### Fail to Sync - Alarm

#### Emergency Stop - Shutdown

#### Switch not in auto - Alarm

#### Spare - Shutdown

#### Spare - Shutdown

### Individual contacts shall be provided for each alarm/shutdown fault circuit. Contacts shall be user configurable for open or close upon initiation of the fault. Fault contacts shall be factory configured for “close on fail”. Contacts shall be rated 0.5Amperes alternating current, 120 Volts alternating current, 1.0Amperes direct current, 30 Volts direct current resistive, maximum.

### The microprocessor based engine generator controller shall include a security password system for access to all programming functions. Specific password levels shall be provided for “read only”, “read/write” and “master”. All programming set points for voltage, frequency and time delays shall be software programmable from the front panel mounted keypad, and all parameters shall be displayed in alpha numeric format.

### The microprocessor based engine generator controller shall include an operator interface, liquid crystal display (LCD) screen which is door mounted. The following parameters shall be displayable:

#### Generator AC digital metering (3 phase V, A, F)

#### Timer countdown display

#### Operating status /switch position

#### Alarm/Shutdown fault display

#### Engine Hour-meter

#### Engine Oil Pressure (kPa)

#### Engine Coolant Temperature (°C)

#### Engine RPM (Tachometer)

#### Battery Voltage

### Generator AC digital metering shall be integral to the engine generator controller and the multifunction generator protection relay (they shall have an accuracy of +/-1%). The digital metering shall be fully programmable from the front panel display. Programming for voltage and current PT/CT ratios and software calibration shall be provided for all input ranges. The following generator output AC parameters shall be monitored and displayed:

#### AC Voltage -3 phase (line to line and average)

#### AC Current -3 phase (individual phases and average)

#### AC frequency (resolution to 0.1 Hz)

### The digital display of engine parameters shall be provided by the engine generator controller. The engine oil pressure and engine temperature shall be monitored and displayed in metric or imperial engineering units. Oil pressure and temperature senders shall be supplied by the Contractor for mounting on the engine generator set.

### Long life LED type pilot lights shall be provided on the engine generator controller to indicate the following general operating conditions:

#### Indicating lights to have Push to test feature

#### Common Alarm (Flashing-Amber)

#### Common Shutdown (Flashing-Red)

#### System Ready (Green)

#### Speed Signal Present (Green)

### The engine generator controller shall contain the following protective functions utilizing analog input signals:

#### Protective functions to be programmed into the Multilin 489 Generator Protection System device *[Consultant to amend as required – dependent on size of genset]*. Protective parameters shall include, but not be limited to, the following items listed below:

#### (27/59) Three-phase under/over voltage protection shall be provided for the engine generator. The under/over voltage protection function shall be programmable as follows:

##### Under voltage pick-up 70-100% of nominal, factory set at 90%.

##### Under voltage dropout 70-100% of nominal, factory set at 80%.

##### Under voltage delay 0 - 10 seconds, factory set at 3 seconds.

##### Over voltage pick-up 100-130% of nominal, factory set at 110%.

##### Over voltage dropout 100-130% of nominal, factory set at 108%.

##### Over voltage delay 0 - 10 seconds, factory set at 2 seconds.

#### (81 O/U) Over/under frequency protection shall be provided for the engine generator. The over/under frequency protection function shall be programmable as follows:

##### Under-frequency set-point 70-100% of nominal, factory set at 90%.

##### Under-frequency delay 0 - 10 seconds, factory set at 5 seconds.

##### Over-frequency set-point 100-130% of nominal, factory set at 110%.

##### Over-frequency delay 0 - 10 seconds, factory set at 2 seconds.

#### (51) Three phase over current alarm protection shall be provided for the engine generator. The over current protection function shall be programmable as follows:

##### Over-current set-point 100-150% of nominal, factory set at 110%.

##### Over-current delay 0 - 10 seconds, factory set at 5 seconds.

#### Low/High battery voltage protection shall be provided for the control system. The protection function shall be programmable as follows:

##### Low battery voltage set point 50-100% of nominal, factory set at 12.8Vdc (12Vdc systems) or 25.6Vdc (24Vdc systems).

##### Low battery voltage delay 0-300 seconds, factory set at 120 seconds.

##### High battery voltage set point 100-130% of nominal, factory set at 15.2Vdc (12Vdc systems); 30.4Vdc (24Vdc systems).

##### High battery voltage delay 0-300 seconds, factory set at 10 seconds.

#### Weak battery sensing shall be provided to detect a low capacity engine starting battery system. This function shall be programmable as follows:

##### Weak battery set point 50-100% of nominal, factory set at 8.0Vdc (12Vdc systems) 18.0Vdc (24Vdc systems).

##### Weak battery transient delay 0-300 seconds, factory set at 3 seconds.

### Diagnostic LEDs shall be provided on the rear of engine generator control module to allow simple visual indication of operating status or mode. Individual LEDs shall be provided for the following functions:

#### Watchdog (CPU running)

#### Remote start signal activated

#### Crank output energized

#### Run output energized

#### Common fail alarm activated

### The engine generator controller shall have an audible alarm feature to signal shutdown and alarm conditions.

### The engine generator controller shall include the following operator control functions:

#### Operation Mode (Auto/Off/Manual/Load Test)

#### Programming (Enter/Exit/Value Increment/Decrement)

#### Lamp Test

#### Fault Reset

#### Alarm Horn Silence

#### Emergency Stop

### The engine generator controller shall provide cycle cranking control logic with programmable number of crank attempts (Adjustable (“Adj.”) 1-99, factory set at 3 attempts) crank period time (Adj 0 - 99 sec, factory set at 15 sec) and rest period time (Adj 0 - 99 sec, factory set at 10 sec).

### Engine control logic shall include the following sensing and protection circuits:

#### Loss of speed signal sensing shutdown

#### Starter re-engage sensing control (to re-engage starter motor upon initial failure to engage).

#### Run output fail safe selection (to prevent engine starting if speed signal is not present).

### Programmable output function contacts shall be provided by the engine generator controller. Contacts shall be type Form C, rated 10A, 240Vac, 30Vdc resistive, maximum. The following programmable output control functions shall be available for specific system applications:

#### Energize to stop

#### Overcurrent

#### Cycle lube

#### Engine run

#### System ready

#### Oil bypass delay expired

#### Air flap

#### Common fail

#### Preheat

#### Common alarm

#### ATS test

#### Switch not in auto

#### Common shutdown

### A time delay on engine start shall be provided to delay the engine start signal. The time delay shall be programmable 0 - 60 seconds, factory set at 2 seconds.

### A time delay for engine cool-down shall be provided which delays engine stopping. The time delay shall be programmable 0 - 30 minutes, factory set at 5 minutes.

### The engine generator controller shall provide a lamp test function to test all LED lights and the LCD display.

### The engine generator controller shall have the ability for remote communication of all status points (alarms, shutdowns, switch position) and all measured analog values. Remote control and configuration of all switch functions and setups shall be supported. Communication shall be via RS422/485 port located on the engine generator controllers. The RS422/485 shall allow all engine controllers to be interconnected and form a common communication link. Provide a common communication module for communication to all connected engine controllers. The communication module shall support Modbus IP protocol for interconnection into the Region’s SCADA system. Communication to a separate LAN shall be provided for access to devices via EnerVista or other approved software system (Multilin 489 and similar devices) *[Consultant to amend this subsection to accurately reflect the devices and software systems employed].*

### AC Metering

#### Analog metering shall be provided to monitor the output of each engine generator. Metering shall be 100 mm, 250 degree movement with 1% accuracy and scaled to suit the specific application. The following meter types shall be provided:

##### AC Voltmeter c/w phase selector switch (line to line)

##### AC Ammeter c/w phase selector switch

##### Frequency Meter

##### Kilowatt Meter

##### Power Factor Meter

#### Potential and current metering transformers shall be provided of adequate burden and thermal ratings to meet the specified metering accuracy. Potential transformers shall be provided with primary side fusing of adequate rating.

## Engine Wiring and Terminal Box

### Provide heat and oil resistant wire from the safety switches and control devices. Run the wire neatly in a harness, secure to the engine and terminate at the engine terminal box.

### Provide a CSA enclosure 5 for the engine terminal box with a numbered terminal strip to correspond with the schematic diagram. Provide a separate junction box for the 120 V and 24V DC circuits.

## Engine Gauges

### Provide the following engine gauges:

#### Lube oil pressure gauge.

#### Lube oil temperature gauge.

#### Jacket water temperature gauge.

#### Pyrometer (Dual scale for V type engines)

## Tools

### Supply a suitable engine barring device and the battery manufacturer's standard set of tools for battery service. Battery service tools shall include as a minimum, hydrometer, one plastic bottle for topping up purposes and one insulated battery terminal wrench.

### Provide a complete set of specialized tools required for the proper care, adjustment and maintenance of the equipment supplied. Refer to Section 01430 – Operation and Maintenance Data.

## Signs

### Provide a lamacoid or metal engraved identification nameplate at the front top of each panel and on each generator junction box.

## Finishing and Painting

### Properly clean, finish and paint equipment with a smooth and durable finish. Use grey gloss 501.108, except the inside of the panel shall be painted with white gloss 513-101 in accordance with Fed-Specs, Fed Std 595C Paint Spec schedule of paint colours.

### Provide one half pint can of grey gloss 501.108 paint.

### Paint the complete equipment, except for the finished and machined parts also special items listed below:

#### One coat of primer, red lead, iron oxide, oil alkyd, heat resistant 0.04 - 0.05 mm dry.

#### One top coat of enamel, light equipment grey, alkyd gloss, heat resistant, 0.05 - 0.08 mm minimum.

#### Protect data labels on all equipment while painting and ensure labels are legible.

#### Coat liberally, all finished and machined parts with petroleum or wax base, temporary protective coating.

#### Paint protective guards on the set red.

#### Finish the control panel white on the inside and light gray on the outside unless otherwise noted on the Contract Drawings.

#### Finish the exhaust silencer and flexible connector with aluminum silicone alkyd paint, heat resistant to approximately 650°C.

#### A manufacturer’s standard paint and finishes may be used as an alternative if the full details and the adjustment in Contract Price is approved by the Consultant.

## Workmanship

### Manufacture and construct the equipment with new materials.

### Ensure that the work is free from blemishes, defects, burrs and sharp edges; ensure the accuracy of dimensions and marking of parts and assemblies; and ensure the thoroughness of welding, brazing, painting and wiring, alignment of parts and tightness of assembly screws and bolts.

## Fuel Day Tank(s)

### Provide the following for indoor Site installation by the Contractor:

#### Fuel tank, domestic floor mounted type with tapped connections for fill, vent, supply, return and drain pipes, UL/ULC approved.

#### Provide [one], [\_\_\_\_\_] litre fuel tank.

#### Supply and install tanks of capacity as indicated in the Contract Documents.

#### Provide a fuel tank monitoring system, including a water sensor.

#### Construction (tanks inside buildings): CAN/ULC-S602-07.

#### Connections: [As shown on the Drawings]

#### Approved suppliers/manufacturers:

##### [Consultant to list suppliers for the Region’s approval].].

##### Approved Equivalent.

#### Tank level gauge and indicator: Mechanized direct reading device with 150 mm dial.

#### Gauge and gauge openings to be protected against liquid overflow and possible liquid vapour release.

#### All fuel piping to be schedule 40 A53 in accordance with ASTM A53/A53M-12 standard with malleable iron fittings.

#### Provide tank supports as shown on drawings.

#### Provide a minimum clearance of 150 mm between the condensate drain and floor.

#### Fuel supply accessories shall include a manual gate shut-off valve and primary fuel filler with sedimenter and all nipples.

#### Tank accessories shall include the following:

##### Full tank alarm annunciator.

##### Levelometer.

##### Condensate drain cock and plug.

##### Fittings as shown on the Contract Drawings.

## Weather-tight “Walk-In” Sound Attenuated Enclosure for the Generator Set

### Scope of Work: This subsection covers the requirement for supply and installation of a walk-in watertight sound attenuated enclosure for a standby diesel engine/ generator.

### Description of System: The weather-tight Sound Attenuated Enclosure shall consist of the following but not limited to:

#### Exterior and interior panels

#### Entrance doors

#### Lighting and utility receptacles

#### Air intake assembly

#### Air discharge assembly

#### Fuel assembly

#### Exhaust system

#### Electrical system

#### Rough-in for fire alarm system

#### UL/ ULC listed sub-base fuel tank and accessories

### Shop Drawings:

#### Submit shop drawings in accordance with Section 01300 - Submittals.

#### Include but not limited to:

##### Layout of standby generator inside the walk-in enclosure

##### Bi-fuel system (if applicable)

##### Layout of all accessories

##### Layout of air intake and discharge assemblies

##### Sub-base fuel tank

##### Exhaust system with damper thermostatically controlled

##### Electrical panels and details

##### Control panel

##### Cooling system

##### Entrance doors

##### Foundation for the walk-in enclosure

##### Motorize dampers and actuators

##### Flexible connectors

##### Heating and cooling systems

##### Doors

##### Vertical discharge plenum c/w air baffles, air guides, and removal grills, bird screens

##### Electrical systems – fixtures, receptacles, exit fixtures, power details etc.

##### Mechanical systems

##### Miscellaneous items

### Exterior Sheet Panels (Walls and Roof): All exterior sheet panels (walls and roof) shall be 12 gauge steel painted to the colour and colour code selected by the Consultant.

### Interior Sheet Panels: Interior wall and roof assembly lined with 22 gauge perforated, galvanized steel, complete with galvanized corner trims along the interior perimeter of roof.

### Assembly

#### Bi-fuel standby generator system (if applicable).

#### Bi-fuel kit (if applicable).

#### Acoustic performance objective: 70 dBA at 7 metres from an average perimeter around the enclosure in free field conditions.

#### Wall, roof and door construction designed to meet the acoustic objectivecomplete with high-density fibreglass insulation in panels. All insulation shall be covered in Mylar. *[Consultant to ensure that maximum acoustic levels are defined in this Specification Section based on criteria defined in the Process Narratives and Contract Documents]*

#### Roof construction shall be complete with 14 gauge formed channels for structure at maximum 305mm centres. Roof thickness shall be designed and fabricated to achieve acoustic objective. *[Consultant to ensure that maximum acoustic levels are defined in this Specification Section based on criteria defined in the Process Narratives and Contract Documents]*

#### Use up-capped seams for water tightness and single pitch roof slope of 25.4mm for water run-off.

#### Side and end wall assemblies fabricated with internal galvanized 12 gauge galvanized steel formed channels, on maximum 610mm centres. Wall construction shall be designed to achieve the acoustic objective in accordance with the Contract Drawings. *[Consultant to ensure that maximum acoustic levels are defined in this Specification Section based on criteria defined in the Process Narratives and Contract Documents]*

#### Heavy-duty 51mm deflection spring isolators between genset and base.

#### Installation of all equipment inside enclosure,

#### Vertical discharge assembly.

#### Installation of all equipment inside the enclosure, including but not limited to the genset, exhaust silencer, fuel tank, plumbing works.

### Entrance Doors:

#### Insulated, weatherproof two single entrance doors (915mm x 2134mm X 44.5mm each), complete with the items listed below.

#### Insulated, weatherproof double access doors for “walk-in” enclosures for the removal of big equipment. Doors shall be lockable with drip rain shields above doors.

#### Exterior lockable zinc plated door handle, padlock-style.

#### Each door shall be equipped with stainless steel hinges.

#### Each door shall be equipped with panic door hardware.

#### Exit light fixtures for all doors.

#### Central battery pack of sufficient capacity for exit light fixtures

#### Door framing complete with acoustic / weather tight seals.

#### Door chains against wind pressure.

#### Drip rain shields above each door.

#### Panic door hardware for all doors.

#### Acoustic insulation.

### Air Intake Assembly:

#### Side intake flow configuration.

#### Intake hood with bird screen.

#### Internally mounted motorized aluminum dampers, sized to suit, c/w damper actuators – on/off model, sized to suit.

#### Internally mounted air intake high performance duct silencer, sized to suit.

### Air Discharge Assembly:

#### Flexible connector [\_\_\_\_] mm thick at radiator discharge for genset vibration.

#### Vertical discharge flow configuration.

#### Vertical discharge, double walled, flow configuration c/w air baffles, air guides and removable grill.

#### Internally mounted motorized aluminum dampers, sized to suit, c/w damper actuators – on/off model, sized to suit.

#### Exhaust fan for heat removal c/w insulated damper, on/off actuator, and fixed louver with bird screen.

### Fuel Assembly:

#### Dual wall sub base fuel tank [\_\_\_\_] litres designed and certified to latest ULC 142.18 standards for Safety.

#### Plumbing: vent to exterior of enclosure and provide insect mesh, fuel fills pipes (exterior) and return from genset to fuel tank.

#### Accessories shall include, but not be limited to, a leak detector, mechanical fuel gauge, water sensor and two low level switches for two levels.

#### Provide a mechanical fuel gauge.

#### Electronic fuel monitoring system including leak and water detection capabilities.

### Electrical Equipment: Supply, install, and wire the electrical equipment. The electrical equipment shall also include, but not be limited to, the following:

#### [\_\_\_\_ circuits, \_\_\_\_ A, \_\_\_\_ Ø, \_\_\_\_ wire, \_\_\_\_ V] breaker panel, complete with [\_\_\_\_A, \_\_\_\_ Ø] main breaker.

#### Specification grade - 2 duplex receptacles (120 V) on each side of the container.

#### Quantity [\_]: Fluorescent fixtures [\_\_] lamps [T-8 HO] 1220mm long, complete with electronic ballasts and wire guards.

#### Light switches.

#### Exit light fixtures with the battery pack.

#### Quantity of unit heater (s) [\_\_\_\_W, \_\_\_\_ V, \_\_\_\_ Ø] complete with thermostat: Minimum one unit; additional units may be required. *[Consultant to determine number of unit heaters required for project; Consultant to amend this subsection accordingly]*

#### Wire and supply the following items as required: genset coolant heater, battery charger, damper motors c/w thermostats, exhaust fans, motorized dampers.

#### Rough-in the following items for the fire alarm system: heat detector, manual pull stations, horns (installation of devices and connection to fire alarm panel shall be performed by the [Contractor][electrical Subcontractor]). *[Consultant to define what subsection of this Section the installation work is to be detailed and amend as required]*

### Exhaust System: Exhaust silencer (super critical) shall be installed inside of the enclosure c/w a [\_\_\_\_] mm high flexible connector. Piped from genset exhaust manifold to exhaust silencer intake flange. Insulation wrap (thermal) for exhaust silencer to protect service personnel. Supply and install rain cap and rain shield.

### Plumbing System: Supply and install the plumbing system which shall include, but not be limited to, the following:

#### All plumbing work between genset, fuel tank, fuel fill pipe, vent pipe etc.

#### All plumbing work for fuel tank accessories including low level switches, leak detector, mechanical fuel gauge etc.

#### Miscellaneous plumbing works.

### Coordination:

#### The Contractor shall submit complete shop equipment drawings, slab openings and other coordinated drawings 1 to 2 Working Days after the notice to commence work is issued by the Region.

#### Coordinated shop drawings in [mm] shall clearly indicate all openings required in foundation for mechanical piping, cables, natural gas incoming, electrical feeders etc.

#### Coordinate the work with the Consultant and equipment suppliers.

#### Final approved construction drawings shall contain supplier(s) engineer’s stamp licensed to practice in the Province of Ontario.

## Weathertight “Skin-Tight” Sound Attenuated Enclosure for the Generator Set

### Scope of Work: This subsection covers the requirement for supply and installation of a skin-tight watertight sound attenuated enclosure for a standby diesel engine/ generator.

### Description of System: The weather-tight sound attenuated enclosure shall include, but not be limited to, the following:

#### Side-mounted generator controls

#### Lockable access doors

#### Air intake assembly

#### Flexible and protected connections of exhaust pipes

#### Motorized louvers

#### Pre-wired AC distribution panel

#### Rough-in for fire alarm system

#### UL/ULC listed sub-base fuel tank and accessories

### Shop Drawings:

#### Submit shop drawings in accordance with Section 01300 - Submittals.

#### Shop drawings shall include, but not be limited to, the following information:

##### Layout of standby generator inside the skin-tight enclosure

##### Bi-Fuel System (if applicable)

##### Layout of all accessories

##### Layout of Air Intake and Discharge Assemblies

##### Sub-base Fuel Tank

##### Exhaust System with damper thermostatically controlled

##### Electrical Panels and Details

##### Control Panel

##### Cooling System

##### Access Doors

##### Foundation for the skin-tight enclosure

##### Motorize Dampers and actuators

##### Flexible connectors

##### Heating and Cooling Systems

##### Vertical discharge plenum c/w air baffles, air guides, and removal grills, bird screens

##### Electrical Systems – receptacles, power details etc.

##### Mechanical Systems

##### Miscellaneous Items

### Exterior Sheet Panels (Walls and Roof): All exterior sheet panels (walls and roof) shall be 12 gauge steel painted to the colour and colour code selected by the Consultant.

### Interior Sheet Panels: Interior wall and roof assembly shall be lined with 22 gauge perforated, galvanized steel, complete with galvanized corner trims along the interior perimeter of the roof.

### Assembly

#### Bi-fuel standby generator system (if applicable)

#### Bi-fuel kit (if applicable)

#### Acoustic performance objective: 70 dBA at 7 metres from an average perimeter around the enclosure in free field conditions.

#### Wall, roof and door construction designed to meet the acoustic objective in accordance with the Contract Documents *[Consultant to ensure that maximum acoustic levels are defined in this Specification Section based on criteria defined in the Process Narratives and Contract Documents]* complete with high-density fibreglass insulation in panels. All insulation shall be covered in Mylar.

#### Roof construction shall be complete with 14 gauge formed channels for structure at maximum 305mm centres. Roof thickness shall be designed and fabricated to achieve the acoustic objective. *[Consultant to ensure that maximum acoustic levels are defined in this Specification Section based on criteria defined in the Process Narratives and Contract Documents]* Use up-capped seams for water tightness and single pitch roof slope of 25.4mm for water run-off.

#### Side and end wall assemblies shall be fabricated with internal galvanized 12 gauge galvanized steel formed channels, on maximum 610mm centres. Wall construction shall be designed to achieve acoustic objective. *[Consultant to ensure that maximum acoustic levels are defined in this Specification Section based on criteria defined in the Process Narratives and Contract Documents].*

#### Heavy-duty 50.8mm deflection spring isolators between genset and base.

#### Vertical discharge assembly.

#### Installation of all equipment inside the enclosure, including but not limited to the genset, exhaust silencer, fuel tank, and plumbing works.

### Access Doors:

#### Insulated, weatherproof access doors [915mm x 2134mm X 45mm] each shall be complete with the following items listed below.

#### Insulated, weatherproof double access doors for “skin” enclosures for the removal of big equipment. The doors shall be lockable with drip rain shields.

#### Exterior lockable zinc plated door handle, padlock-style.

#### Each door shall be equipped with stainless steel hinges.

#### Each door shall be equipped with panic door hardware.

#### Door framing complete with acoustic / weather tight seals.

#### Door chains against wind pressure.

#### Drip rain shields above each door.

#### Panic door hardware for all doors.

#### Acoustic insulation.

### Air Intake Assembly:

#### Side intake flow configuration.

#### Intake hood with bird screen.

#### Internally mounted motorized aluminum dampers, sized to suit, c/w damper actuators – on/off model, sized to suit.

#### Internally mounted air intake high performance duct silencer, sized to suit.

### Air Discharge Assembly:

#### Flexible connector at radiator discharge for genset vibration.

#### Vertical discharge flow configuration.

#### Vertical discharge, double walled, flow configuration c/w air baffles, air guides and removable grill.

#### Internally mounted motorized aluminum dampers, sized to suit, c/w damper actuators – on/off model, sized to suit.

#### Exhaust fan for heat removal c/w insulated damper, on/off actuator, and fixed louver with bird screen.

### Fuel Assembly:

#### Dual wall sub base fuel tank [\_] litres designed and certified to the latest ULC 142.18 standards for safety.

#### Plumbing: vent to exterior of enclosure and provide insect mesh, fuel fills pipes (exterior) and return from genset to fuel tank.

#### Accessories to include: leak detector, mechanical fuel gauge, and two low level switches for two levels.

#### Provide a mechanical fuel gauge.

### Electrical Equipment: Supply, install, and wire the electrical equipment which shall include, but not be limited to, the following items:

#### [\_\_\_\_ circuits, \_\_\_\_ A, \_\_\_\_Ø, \_\_\_\_ wire, \_\_\_\_ V] breaker panel, complete with [\_\_\_\_A, \_\_\_\_Ø] main breaker.

#### Specification grade - 2 duplex GFI receptacles (120 V) on each side of the container.

#### Battery pack.

#### Quantity of Unit heater [\_\_\_\_W, \_\_\_\_V, \_\_\_\_Ø] complete with thermostat: Minimum one unit, additional units may be required *[Consultant to determine number of unit heaters required for project; Consultant to amend the Section accordingly]*

#### Wire and supply the following as required: genset coolant heater, battery charger, damper motors c/w thermostats, exhaust fans, motorized dampers.

#### Rough-in the following items for the fire alarm system: heat detector, manual pull stations, horns (installation of devices and connection to the fire alarm panel shall be performed by the Contractor and/or its electrical Subcontractor).

### Exhaust System: Exhaust silencer (super critical) shall be installed inside of the enclosure c/w [\_\_\_\_] high flexible connector. Piped from genset exhaust manifold to exhaust silencer intake flange. Insulation wrap (thermal) for exhaust silencer to protect service personnel. Supply and install rain cap and rain shield.

### Plumbing System: Supply and install the plumbing system which shall include, but not be limited to, the following:

#### All plumbing work between genset, fuel tank, fuel fill pipe, vent pipe etc.

#### All plumbing work for fuel tank accessories including low level switches, leak detector, mechanical fuel gauge etc.

#### Miscellaneous plumbing works.

### Coordination:

#### The Contractor shall submit complete shop equipment drawings, slab openings and other coordinated drawings 1 to 2 Working Days after the notice to commence work is issued by the Region.

#### Coordinated shop drawings in (mm) shall clearly indicate all openings required in the foundation for mechanical piping, cables, natural gas incoming, electrical feeders etc.

#### Coordinate the work with the Consultant and equipment suppliers.

#### Final approved construction drawings shall be stamped by a professional engineer licensed to practice in the Province of Ontario.

# EXECUTION

## Packing

### Comply with the requirements of Section 01600 – Material and Equipment.

### Protect the equipment against corrosion, dampness, heavy rain, etc. Also, provide adequate protection against damage or loss of components from the time the equipment leaves the manufacturer's factory until received and accepted at the Site. Ensure that the packing is acceptable to the transportation companies responsible for transporting the equipment.

### Include heavy duty plastic sheet(s) or bags to cover components vulnerable to construction dust. Tag this packing to instruct the Contractor to leave this protection in place (where practical) until the construction and clean-up is complete.

### Arrange the engine for shipment and suitably tagged with warning labels.

#### Tag the engine sump to indicate that the lube oil to be replaced at commissioning.

#### Tag the radiator, etc., to indicate that the coolant includes antifreeze.

### Provide in each manual a complete inventory of all spare parts, tools and accessories. A copy shall accompany the shipment and a copy shall also be forwarded to the Consultant.

### Do not ship the equipment from the plant except with the prior written consent of the Consultant and the Region.

### Arrange the shipment on the transport to facilitate off-loading by the Contractor's crane or skids at the Site.

## Warranty

### Provide a written guarantee/warranty (for complete parts and labour and all incidental charges including overhead and profit) signed and issued in the name of the Region stating that the complete assembly consisting of the diesel generator unit and all equipment and accessories is guaranteed against defects and malfunction for a period of two years from the date of Total Performance of the Work, .Provide a maintenance product warranty issued in the name of the Region stating that the generating set is warranted against defects in material and workmanship for a period of two years from the date of Total Performance of the Work.

## Extended Warranty

### Provide an extended written guarantee/warranty signed and issued in the name of the Region stating that the written guarantee/warranty detailed in subsection 3.2.1 above is extended for up to [five (5) or ten (10)] years from the date of factory delivery. The cost of the extended warranty shall be included in the Estimated Contract Price.

## Spares

### For panels, provide the following:

#### One spare control circuit breaker per rating.

#### Twenty four spare indicating light bulbs per rating.

#### One spare control relay and socket per rating and contact arrangement.

#### One spare contactor operating coil.

### Provide, for the generator unit, a standard set of engine manufacturer's spare parts for one year of normal operation (equivalent to 1,000 operating hours). Spare parts shall include as a minimum:

#### Six fuel filter elements for each type of fuel filter/water separator.

#### Six lubricating oil filter elements.

#### Three air cleaner elements.

#### One injector assembly.

#### One set of drive belts.

### Where metric size nuts and bolts are used, provide one set of sockets complete with ratchet handle and set of combination wrenches, to fit all sizes used.

### Provide conclusive evidence that a Canadian distributor has been established and will stock Canada spare parts likely to be required during the normal life of the engine.

### In the event a Canadian distributor is not available, provide conclusive evidence that spare parts are available from a distributor that will send parts by mail or courier service on a [24]-hour response time basis.

## Factory Acceptance Tests (FATs)

### General: Before acceptance, assemble and set up the unit, complete with specified equipment, for tests at the supplier's plant. Tests shall be witnessed by the Consultant on a mutually agreed upon date. Provide a suitable test area with adjustable loading facilities. The Contractor shall ensure that the engine has run in sufficiently prior to load test, all test forms filled in, system debugged and recorders connected.

### Examination of Product: Perform a complete mechanical and electrical examination to determine compliance with Contract Documents and Drawings with respect to materials, workmanship, dimensions and marking.

### Non-operational tests and checks: Perform the following test and checks before starting the unit:

#### Shaft alignment, end float, angular and parallel.

#### Cold resistance of generator windings.

#### Belt tensioning.

#### Equipment grounds.

#### Electrical wiring.

#### All grease lubricating points.

#### Personnel safety guards.

#### Air cleaner.

#### Coolant.

#### Lubricating oil type and level.

#### Type of fuel.

#### Vibration isolator adjustment.

#### Temperature and pressure sensors.

#### Engine exhaust system.

#### Tools.

#### Spares.

### Operation test and check: Upon completion of the tests and checks listed in subsection 3.5.3 above, start the unit cold. Provide a multi-channel recorder and record the following:

#### Time for unit to start and reach settled voltage and frequency.

#### Time from initiation of start to full load application, with voltage and frequency settled.

#### Voltage and frequency transient and steady state limits for full load to no load, 4/4 load to no load, 3/4 load to no load, 1/2 load to no load, 1/4 load to no load and vice versa. Measure machine vibration levels under the same load conditions.

#### Record battery voltage drop during cranking.

### Protection and control demonstration: on completion of Site Acceptance Tests and prior to commissioning, demonstrate the following:

#### Overheat protection.

#### Low oil pressure protection.

#### Cranking cut out.

#### Over-crank protection (3 tries).

#### Over-speed protection.

#### Under and over frequency.

#### Under and over voltage.

#### Electrical fault protection:

##### Failure to close breaker.

##### Failure to build up voltage.

#### All control functions.

### Load tests: Load test the unit for 4 hours at full rated load and a further 1 hour at 110% rated load in ambient room temperature of 40°C. Take the following data at the start of load test and every 15 minute interval thereafter:

#### Frequency.

#### Voltage.

#### Current.

#### Kilowatts.

#### Generator winding temperature.

#### Generator frame temperature.

#### Engine coolant temperature.

#### Oil temperature and pressure.

#### Manifold pressure.

#### Ambient room temperature.

#### Generator cooling air outlet temperature.

#### Exciter field current and voltage.

#### Vibration displacement.

#### Ambient air temperature inside panel with all doors closed.

### Miscellaneous: Provide an accurate means for determining fuel and lubricating oil consumption. Provide strip chart recorders for monitoring frequency, voltage and load. The recorder shall have a selection of speeds to allow the accurate measurement of voltage, frequency and time during the tests. Ensure that the recorder is calibrated by the recorder manufacturer (or designated representative) within three months of the factory testing.

### Interpretation of ambient room temperature: Consider ambient room temperature as the lowest temperature registered out of a group of three thermometers when placed in the engine room as follows:

#### One thermometer located on each side of the engine block, approximately two-thirds of the length of the block back from front (radiator) end of block, 900 mm out from block and at a height equal to height of block. A third thermometer located over end of exciter on the unit centre line, approximately 150 mm above the top of the exciter.

#### Take the thermometer showing the lowest temperature to give true ambient air temperature. Adjust the temperature to maintain this thermometer at 40°C during the heat test.

### Voltage and frequency regulation tests: Upon completion of the load tests, take the hot resistance reading of generator windings. Subject the unit to hot voltage and frequency regulation tests for full load to no load, 4/4 load to no load, 3/4 load to no load, 1/2 load to no load, 1/4 load to no load and vice versa.

### Panel performance and functions: Check sequence of operation under service conditions. Make provision for supplying and connecting required levels of voltage for primary circuits. Test overcurrent relays by impressing current in secondary circuits.

### Hi-pot tests: Perform over potential tests on primary and secondary wiring in accordance with CSA Standard *[Consultant to insert applicable CSA standard]*.

### Additional tests: Perform any tests, consistent with the Contract, which the Consultant may require to satisfy himself of the adequacy and satisfactory operation of the unit.

### The Contractor shall ensure that the supplier completes and provides the forms with the requisite information pertaining to make, model and serial numbers prior to the test.

### The Contractor shall ensure that the supplier will record all test data on the appendix forms, recording charts and manufacturers' test forms and be complete with diagrams and description of test results, deficiencies and corrective action. Test data sheets shall be signed by the supplier.

## Site Acceptance Tests (SATs)

### All testing identified in shop testing [Consultant to verify all required tests are cited in the Contract Documents; insert reference for the list of tests required] shall be repeated on Site with the exception of the following:

#### *[Consultant to add the relevant exceptions in this subsection]*

### Perform tests in accordance with Section 01810 – Equipment Testing and Facility Commissioning.

### Notify the Consultant 10 Working Days in advance of the proposed test date.

### Provide fuel for testing and leave full tanks on acceptance by the Consultant.

### Demonstrate:

#### Unit start, transfer to load, re-transfer to normal power, unit shut down, on "Automatic" control.

#### Unit start and shut down on "Manual" control

#### Unit start and transfer on "Test" control.

#### Unit start on "Engine start" control.

#### Operation of [manual] bypass switch.

#### Operation of automatic alarms and shut down devices.

#### Run unit on load for a minimum period of 8 hours to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling.

#### At the end of the test run, check battery voltage to demonstrate that the battery charger has returned the battery to a fully charged state. Leave fuel tanks full on the completion of tests.

## Training

### Arrange and pay for on-Site lectures and demonstrations by the system manufacturer to train designated Region personnel in the use and maintenance of the generator set and transfer switch.

#### Refer to Section 01820 – Demonstration and Training for additional requirements.

## Commissioning

### When the Contractor has completed the installation work and before any equipment is operated, the Contractor shall instruct the supplier to commission the equipment. For all commissioning activities on systems where components of this Specification are integral to functionality and system performance, refer to Section 01810 – Equipment Testing and Facility Commissioning. All inspection and testing activities shall be completed in accordance with the commissioning plan that shall be provided to the Consultant prior to the commencement of commissioning activities.

### The Contractor shall ensure that the supplier will provide the services of a skilled technical representative for a minimum period of two Working Days (16 hours) at Site to carry out, as a minimum, the following work:

#### Check the installation as to its workmanship.

#### Check the operation of the set as required above.

#### Check that the operation of the engine cooling equipment is satisfactory.

#### Check the interconnecting wiring of the engine safety devices.

#### Perform further tests as directed by the Consultant.

#### Instruct the plant personnel in the operation and service of the equipment.

#### This Contractor shall supply all fuel required for commissioning. On completion of the commissioning, the Contractor shall supply a full day tank of #2 Diesel Fuel.

**END OF SECTION**