1. GENERAL

1.1 Description of System

.1 The electric power generating system shall consist of two (2) or three (3) generators providing a total site capability of at least 6000 ekW at 0.8 power factor, 4160 V, wye connected, 3 phase, 60 Hz. This power shall be applied for Standby operation. All generators shall be of the same capacity.

.2 Generation system consists of:

.1 Engine.

.2 Engine/alternator common base plate.

.3 Free-standing generator control switchboard.

.4 Engine-driven fan and unit-mounted radiator.

.5 Battery charger and battery.

.6 Fuel system and accessories.

.7 Cooling air ventilation system accessories.

.8 Engine exhaust silencer, flex actions and accessories.

.9 Alternator output circuit breaker in common enclosure, mount with control panel.

.10 Vibration isolators.

.11 Factory testing.

.12 Site delivery.

.13 Installation support and performance verification.

.14 Generator.

.3 Design generator set and automatic transfer switch system for automatic standby power.

.4 In addition to automatic standby operation, the system shall be capable of peak shaving. Peak shaving mode shall be manually initiated. During peak shaving mode the power output shall be automatically adjusted to a maximum of the prime power rating.

.5 The system shall consist of generator sets, which include all controls, protection, wiring, and accessories for automatic start-stop operation.

.6 Generator set to include automatic shutdown and alarm indication for:

.1 Low oil pressure.

.2 High coolant temperature.

.3 Overspeed.

.4 Over-crank.

.5 Emergency stop.

.7 Generator set to include warning systems and indication for:

.1 Low coolant temperature.

.2 Coolant temperature rising

.3 Low daytime tank fuel.

.4 Low battery voltage.

.5 Low coolant level.

.6 Ventilation dampers not open.

.7 Day time leak detection.

.8 Generator output breaker open.

.9 Selector switch “not in automatic” position.

.8 Generator control system shall be connected to the Supervisory Control and Data Acquisition (SCADA) system for remote monitoring and control. All information and control available at the local generator Operator Interface shall be made available to the SCADA system utilizing Modbus/TCP.

1.2 Standards

.1 Canadian electrical code (CEC) and provincial and local amendments.

.2 Manitoba Building Code.

.3 Local building code.

.4 National Electrical Manufacturers Association (NEMA) Motor and Generator Standards.

.5 Canadian Standards Association (CSA) Standard C282 – Emergency Electrical Power Supply in Building.

1.3 System Performance, General

.1 Rating - Engine brake horsepower shall be sufficient to deliver full rated generator set kW/kVA when operated at rated rpm and equipped with all engine-mounted parasitic and external loads such as radiator fans and power generators.

.2 Conditions - The rating shall be based on Organization for International Standardization (ISO) 3046/1 standard conditions of 100 kPa and 27C (29.53 in Hg, 81F); BS 5514, DIN 6271, SAE J1349 and API 7B-11C also apply.

.3 Fuel - Diesel engines shall be able to deliver rated power when operating on:

.1 Diesel fuel, Type A-LS meeting the requirements of National Standard of Canada CAN/CGSB 3.517-2000 - Automotive Low-Sulphur Diesel Fuel, and all Amendments thereto. Further to paragraph 8.1 of said Standard, the fuel shall be Type A-LS or Type A-ULS, and Low-temperature Flow Properties shall be in accordance with paragraph 6.1.1 of said Standard. Commonly referred to as "#1" or "LIGHT"; or

.2 Diesel fuel, Type B-LS meeting the requirements of National Standard of Canada CAN/CGSB 3.517-2000 - Automotive Low-Sulphur Diesel Fuel, and all Amendments thereto. Further to paragraph 8.1 of said Standard, the fuel shall be Type B-LS or Type B-ULS, and Low-Temperature Flow Properties shall be in accordance with paragraph 6.1.1 of said Standard. Commonly referred to as "SEASONAL".

.4 Start Time and Load Acceptance - Engines shall start, achieve rated voltage and frequency, and be capable of accepting load within ten (10) seconds when properly equipped and maintained.

.5 Block Load Acceptance - Transient response shall conform to ISO 8528 requirements.

1.4 Shop Drawings

.1 Submit Shop Drawings in accordance with **Section 01300 – Submittals.**

.2 Shop Drawings to include:

.1 Schematic power and control diagrams showing generator, voltage regulator, metering, battery, battery charger, governor, and all engine/generator protection and controls. Indicate all field connection requirements.

.2 Make and model of engine, generator, governor, voltage regulator, battery charger, battery, exhaust silencer, block heater/thermostat, vibration isolators, control devices, and power components, complete with technical and performance data.

.3 Confirmation that the generator set will comply with 100% shop load performance requirements.

.4 Dimensioned Drawings for alternator, engine, control switchboard, and all accessories.

.5 Indication of all anchoring/mounting locations, and all power/control connection locations.

.6 Fuel day tank storage and delivery system, flow rating, flow diagram, and relevant data.

.7 Generator room ventilation system requirements

.8 Confirmation that required engine power at 100% rated load condition, 0.8 PF, does not exceed the engine Manufacturer's recommended standby power rating.

.9 Manufacturer's published stand by power output curves and fuel consumption curves.

.10 Description of set operation including:

.1 Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit pressures rated voltage and frequency.

.2 Automatic shutdown and alarm on.

.1 Over-cranking.

.2 Overspeed.

.3 High engine temperature.

.4 Low lube oil pressure.

.5 Short circuit.

.6 Alternator over voltage.

.7 Lube oil high temperature.

.8 Over temperature on alternator.

.9 Manual remote emergency stop.

.11 Modbus register mapping for connection to the SCADA system.

1.5 Operation and Maintenance Data

.1 Provide operation and maintenance (O&M) data for diesel generator for incorporation into manual specified in **Section 01730 – Operation and Maintenance Manuals**.

.2 Include in O&M manual instructions for particular unit supplied and not general description of units manufactured by supplier, and:

.1 O&M instructions to permit effective operation, maintenance, and repair for engine, alternator, control panel, automatic transfer switch, manual bypass switch, battery

charger, battery, fuel system, generator room, ventilation system, exhaust system, and accessories.

.2 Technical data:

.1 Illustrated parts list with parts catalogue numbers.

.2 Schematic diagram of electrical controls.

.3 Flow diagrams for:

.1 Fuel system.

.2 Lubricating system.

.3 Cooling system.

.4 Certified copy of factory test results.

.5 Maintenance and overhaul instructions and schedules.

.6 Precise details for adjustment and setting of time delay relays or sensing controls which require On-Site adjustment.

.3 Manufacturer's Quality Assurance Procedures Manual.

.4 Certified copy of factory test results.

.5 Copy of guarantee.

.6 Complete set of as-built physical, schematic, and wiring diagrams and complete installation instructions.

1.6 Maintenance Materials

.1 Provide maintenance materials.

.2 Include:

.1 Four (4) fuel filter replacement elements.

.2 Four (4) lube oil filter replacement elements.

.3 Four (4) air cleaner filter elements.

.4 Four (4) Sets of fuses for control panel.

.5 Four (4) of each type of indicating lamps.

.6 Two (2) sets of 'fan' belts.

.7 One (1) set of complete tools for routine servicing.

1.7 Source Quality Control

.1 Factory test generator set including engine, alternator, control panel, and accessories in presence of the Contract Administrator.

.2 Notify the Contract Administrator twenty (20) working days in advance of factory test.

.3 Deleted.

.4 The generator set and accessories are to be tested and manufactured in accordance with the Manufacturer's quality assurance program. The programs to comply with the intent, or CSA CAN3-Z299.3, or ISO 9001. Provide a copy of the Manufacturer's quality assurance procedures manual.

.5 Test procedure:

.1 Prepare blank forms and check sheet with spaces to record data. At top of first sheet record:

.1 Date and location.

.2 Generator set serial number.

.3 Engine make, model, and serial number.

.4 Alternator make, model, and serial number.

.5 Voltage regulator make and model.

.6 Rating of generator set, kW, kVA, volts, amps, RPM, Hz.

.2 Mark check sheet and record data on forms, as test proceeds.

.3 Provide reactive type load bank and related controls to allow testing, including 100% step loads. Provide all necessary instrumentation and recording equipment.

.4 Obtain Contract Administrator's signature on completed forms to indicate concurrence in results of tests.

.5 Indicate name of test operator.

.6 Test

.1 Perform functional and load tests to verify conformance with codes and Specifications.

.2 Tests are to include:

.1 Automatic shutdown devices and trouble alarms. Tests to include actual out-of-limits operation with protective devices in their installed and in-service condition to prove sensor operation within Manufacturer's recommended limits. Jumper testing of sensors or remote simulation testing to prove shutdowns are not permissible.

.2 Automatic start-up, transfer to load, transfer back to normal power, cool down, and shutdown.

.3 Demonstrate the battery reverts to high rate charge after cranking.

.7 Perform a four (4) hour full load acceptance test, using a 100% rated resistive load bank as follows:

.1 With 100% rated load, operate set for four (4) hours, taking readings at fifteen (15) minute intervals, and record the following:

.1 Time of reading.

.2 Running time.

.3 Ambient temperature in °C.

.4 Lube oil pressure in kPa.

.5 Lube oil temperature in °C.

.6 Engine coolant temperature in °C.

.7 Exhaust stack temperature in °C.

.8 Alternator voltage: phase 1, 2, 3.

.9 Alternator current: phase 1, 2, 3.

.10 Power in kW.

.11 Frequency in Hz.

.12 Power factor.

.13 Battery charger current in A.

.14 Battery voltage.

.15 Alternator cooling air outlet temperature.

.2 After completion of four (4) hour run, demonstrate following shutdown devices and alarms:

.1 Over-cranking.

.2 Overspeed.

.3 High engine temperature.

.4 Low lube oil pressure.

.5 Short circuit.

.6 Alternator over-voltage.

.7 Low battery voltage, or no battery charge.

.8 Manual remote emergency stop.

.9 High alternator temperature.

.8 Next, install continuous strip chart recorders or digital residing devices to record frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments to include:

.1 No load to full load to no load.

.2 No load to 70% load to no load.

.3 No load to 20% load to no load.

.4 20% load to 40% load to no load.

.5 40% load to 60% load to no load.

.6 60% load to 80% load to no load.

1.8 Delivery

.1 Store generator set and accessories in an indoor, dry, heated location until delivered to the Site.

.2 Coordinate Site delivery with the Contract Administrator.

.3 Coordinate lifting, handling, and placing requirements of all items.

2. PRODUCTS

2.1 Diesel Engine

.1 Diesel Engine: to ISO 3046/1.

.1 Engine: standard product of current Manufacturer, from company regularly engaged in production of such equipment.

.2 Turbo charged and after-cooled, synchronous speed 1800 r/min.

.3 Capacity:

.1 Rated continuous power in kW at rated speed, after adjustment for system losses in auxiliary equipment necessary for engine operation, to be calculated as follows:

$$\text{Rated continuous output} = \frac{\text{Generator kW}}{\text{Generator Eff W FL}}$$

.1 Under following site conditions:

.1 Altitude: 300 m.

.2 Ambient temperature: 30°C.

.4 Cooling System:

.1 Liquid cooled: heavy duty industrial radiator mounted on generating set base with engine driven pusher type fan to direct air through radiator from engine side, with ethylene glycol anti-freeze, non-sludging above minus 46°C.

.2 To maintain manufacturer's recommended engine temperature rate at 10% continuous overload in ambient temperature of 40°C.

.3 Block heater: thermostatically controlled lube oil or liquid cooled heater connected to line side of automatic transfer switch to allow engine to start in room ambient 0°C.

.1 Switch and fuse in heater circuit, mounted in engine-alternator control cubicle and fed from line side of automatic transfer switch.

.5 Fuel System: Solid injection, mechanical fuel transfer pump with hand primer, fuel filters and air cleaner, fuel rack solenoid energized when engine running.

.6 Fuel/Water Separator:

.1 A fuel/water separator shall protect the fuel system from water damage.

.7 Fuel Cooler:

.1 Fuel shall be piped from the filter/water separators to the intake of the engine fuel pump, and then to the engine. Excess fuel shall be piped through the fuel cooler and returned to the fuel tank with less than 60 kPa (8.7 psi) restriction. The fuel cooler shall be capable of exchanging heat rejected with the cooling medium under all loading conditions, including 10% reserve to accommodate fouling.

.8 Governor:

.1 Electronic load sharing type, electric actuator, speed droop externally adjustable from isochronous to 5% temperature compensated with steady state speed maintenance capability of plus or minus 0.25%.

.9 Lubrication System:

.1 Pressure lubricated by engine driven pump.

.2 Pre-lube pump c/w motor starter and pump start stop control with operator adjustable on and off timer. Pre-lube pump shall be locked off when engine is running.

.3 Turbo charger to have both pre-run and post-run lubrication systems.

.4 Lube oil filter: replaceable, full flow type, removable without disconnecting piping.

.5 Lube oil cooler.

.6 Engine sump drain valve.

.7 Oil level dip-stick.

.10 Starting System:

.1 Heavy duty dual positive shift, gear engaging starters 24 VDC.

.2 Cranking limiter to provide six (6) cranking periods of ten (10) second durations, each separated by five (5) seconds of rest.

.3 Lead acid, 24 V storage battery with sufficient capacity to crank engine for one (1) minute at 0°C without using more than 25% of ampere hour capacity.

.4 Two (2) CSA approved jacket water heaters with thermostatic control to maintain engine temperature at a sufficient level to maintain normal engine starting temperatures. Jacket water heaters to include a circulating pump and isolation valves. Control voltage shall be 24 VDC and pump rating minimum 35 liters/minute.

.5 Battery Charger: constant voltage, solid state, two stage from trickle charge at standby to boost charge after use. Regulation: plus or minus 2% output for plus or minus 10% input variation. Equipped with DC voltmeter, DC ammeter, and on-off switch. Minimum charger capacity: 7 A.

.11 Vibration Isolation Engine Instrument Panel with:

.1 Lube oil pressure display.

.2 Lube oil temperature display.

.3 Coolant temperature display.

.4 Coolant level display.

.5 Running time meter: non-tamper type.

.12 Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.

.13 Drip tray.

2.2 Alternator

.1 Alternator: to American National Standards Institute/National Electrical Manufacturer's Association (ANSI/NEMA) MG1.

.2 Rating: 3 phase, 4160 V 4 wire, impedance grounded.

.3 Output at 40°C ambient:

.1 100% full load continuously.

.2 110% full load for one (1) hour.

.3 150% full load for one (1) minute.

.4 Revolving field, brushless, single bearing.

.5 Drip-proof.

.6 Amortisseur windings.

.7 Synchronous type.

.8 Dynamically balanced rotor permanently aligned to engine by flexible disc coupling.

.9 Exciter: rotating brushless permanent magnet.

.10 Electrical and Electronic Manufacturer's Association of Canada (EEMAC) class H insulation of windings.

.11 Platinum resistance temperature transducers embedded in stator winding and connected to alternator control circuitry.

.12 Voltage regulator: thyristor controlled rectifiers with phase controlled sensing circuit:

.1 Stability: ± 0.5% maximum voltage variation at any constant load from no load to full load.

.2 Regulation: ± 0.5% maximum voltage deviation between no-load steady state and full load steady state.

.3 Transient: ± 0.5% maximum voltage dip on one-step application of 0.8 PF full load.

.4 Transient: ± 0.5% maximum voltage rise on one-step removal of 0.8 PF full load.

.5 Transient: one (1) second maximum voltage recovery time with application or removal of 0.8 PF full load.

.6 The regulator shall include a reactive droop network to allow paralleling with other alternator. The network shall consist of current transformer, rheostat, and control circuit, which shall provide 8% minimum droop at full load and 0.8 PF.

.13 Alternator: capable of sustaining 300% rated current for period not less than ten (10) second permitting selective tripping of down line protective devices when short circuit occurs.

.14 Space heater rated at 1200 watt, 120/240 V.

.15 Generator bearing RTDs.

2.3 Control Panel

.1 Totally enclosed, free standing mounting base isolated from diesel generator.

.2 Audiovisual Annunciation with National Fire Protection Association (NFPA) 110 Level 1 and CSA C282 capability.

.3 Programmable microprocessor logic and digital display features.

.2 Instruments:

.1 Digital, 100% solid state circuitry, 2% accuracy, rectangular face, and flush panel mounting:

.1 Voltmeter: AC, scale 0 to 5000 V

.2 Ammeter: AC, scale 0 to 500 A

.3 Wattmeter: scale 0 to 2500 kW

.4 Frequency meter: scale 55 to 65 Hz

.5 kVAR meter

.6 kWh meter.

.2 Provide instrument displays via a touch screen graphics display

.3 Instrument Transformers

.1 Potential-dry type for indoor use:

.1 Ratio: 5000 to 120.

.2 Rating: 5000V, 60 Hz, BIL 60 kV.

.2 Current-dry type for indoor use:

.1 Ratio: 600 to 5.

.2 Rating: 600 V, 60 Hz, BIL 10 kV.

.3 Positive action automatic short-circuiting device in secondary terminals.

.3 Controls:

.1 Engine start button.

.2 Selector switch: Off-Auto-Manual – [Test full load test no load].

.3 Engine emergency stop button and provision for remote emergency stop button.

.4 Voltage control setting in control panel.

.5 Operating lights, panel mounted:

.1 “Normal power” pilot light.

.2 “Emergency power” pilot light.

.3 Green pilot lights for breaker on and red pilot lights for breaker off.

.6 Solid state indicator lights for alarm with two (2) sets manually reset NO/NC contacts wired to terminal block for remote annunciation on:

.1 Low daytime tank fuel level.

.2 Low battery voltage.

.3 Ventilation failure.

.4 Low coolant temperature.

.5 Coolant temperature rising

.6 Low daytime tank fuel.

.7 Low coolant level.

.8 Day time leak detection.

.9 Generator output breaker open.

.10 Selector switch “not in automatic” position.

.7 Solid state controller and indicator lights for automatic shutdown and alarms with two (2) sets manual reset NO/NC contacts wired to terminal block for remote annunciation on:

.1 Engine over-crank.

.2 Engine overspeed.

.3 Engine high temperature.

.4 Engine low lube oil pressure.

.5 Short circuit.

.6 AC over-voltage.

.7 Emergency stop.

.8 Lamp test button.

.9 Synchronization and load sharing.

.10 Provision for remote monitoring.

.11 Programmable logic controller (PLC) – Refer to **Division 17** for Specifications

.12 Operator Interface – Refer to **Division 17** for Specifications

2.4 Automatic Transfer Switchboard

.1 See **Section 16627 – Automatic Load Transfer Equipment**.

2.5 Steel Mounting Base

.1 Complete generating set mounted on structural steel base of sufficient strength and rigidity to protect assembly from stress or strain during transportation, installation, and under operating conditions on suitable level surface.

.2 Assembly fitted with vibration isolators.

.1 Spring-type isolators with adjustable side snubbers and adjustable for levelling.

.3 Sound insulation pads for installation between isolators and concrete base.

.4 Fasten steel base to floor, to withstand seismic forces

2.6 Exhaust System

.1 Heavy duty, critical, horizontally mounted exhaust silencer with condensate drain, valve, and flanged couplings.

.2 Heavy duty flexible exhaust pipe with flanged couplings as required.

.3 Fittings and accessories as required.

.4 Expansion joints: stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion.

2.7 Fuel Tank System

.1 Fuel storage tanks: to ANSI/API 650, Underwriter's Laboratories of Canada (ULC) labelled.

.1 Tank: to ULC S601 and CSA B139.

.2 Day Tank:

.1 Double wall sub-base fuel tank. Sized for four (4) hours operation at 100% load

.2 Manual fill inlet with overfill prevention.

.3 Fuel supply from remote tank.

.4 Overflow return to main tank.

.5 Vent fitting.

.6 Engine fuel transfer pump.

.7 Fuel transfer control level switches: pump start, pump stop, high alarm, low alarm.

.3 Fuel Transfer System

.1 Supply fuel transfer system complete with control system. Fuel transfer system shall comply with the requirements of **Division 15** and **Division 17**.

.2 Fuel transfer system shall continuously monitor fuel levels in the sub-base fuel tanks and the two (2) 50,000 L storage tanks. The fuel levels shall be available to the plant SCADA system through Modbus TCP/IP.

.4 Outdoor Storage Tank

.1 Specified in **Division 15**.

2.8 Finishes

.1 Alternator control cubicle: paint inside, exterior to match engine and alternator.

.2 Exhaust and inlet air hoods:

.3 Other ducts and racks: grey.

.4 Supply 0.25 L of grey touch-up enamel.

2.9 Equipment Identification

.1 Provide equipment identification in accordance with **Section 16010 – Electrical General Requirements**.

.2 Control Panel:

.1 Nameplates for controls such as alternator breakers and program selector switch.

.2 Nameplates for meters, alarms, indicating lights, and minor controls.

2.10 Fabrication

.1 Shop assemble generating unit including:

.1 Base.

.2 Engine and radiator.

.3 Alternator.

.4 Control panel.

.5 Battery and charger.

.6 Automatic transfer equipment.

2.11 Acceptable Manufacturers

.1 Caterpillar, Cummins.

3. EXECUTION

3.1 Installation

.1 Installation by others.

.2 Provide installation assistance in accordance with **Section 01650 – Equipment Installation**.

3.2 Field Quality Control and Testing

.1 Provide performance tests in accordance with **Division 1**.

.2 Provide fuel required for all testing plus an additional 20%. Coordinate fuel delivery with the Installation Contractor.

.3 Operation of all components to be demonstrated – battery charger, alarm devices, transfer switch, block heaters, controls, and all other components making up the overall system.

.4 Using a resistive load bank, 100% of alternator rating, perform a running test of all equipment and record the following:

.1 Engine oil pressure.

.2 Water temperature.

.3 Cranking time to start.

.4 Time to achieve standby power operation.

.5 Time delay on start.

.6 Time delay on retransfer to normal.

.7 Voltage current, every fifteen (15) minutes, for one (1) hour.

.5 Perform an eight (8) hour full load running test, using a 100% rated resistive load bank or rated Plant load, as follows:

.1 With 100% rated load, operate set for eight (8) hours, taking readings at fifteen (15) minute intervals, and record the following:

.1 Time of reading.

.2 Running time.

.3 Ambient temperature in °C.

.4 Lube oil pressure in kPa.

.5 Lube oil temperature in °C.

.6 Engine coolant temperature in °C.

.7 Exhaust stack temperature in °C.

.8 Alternator voltage: phase 1, 2, 3.

.9 Alternator current: phase 1, 2, 3.

.10 Power in kW.

.11 Frequency in Hz.

.12 Power factor.

.13 Battery charger current in A.

.14 Battery voltage.

.15 Alternator cooling air outlet temperature.

.2 After completion of eight (8) hour run, demonstrate following shutdown devices and alarms:

.1 Over-cranking.

.2 Overspeed.

.3 High engine temperature.

.4 Low lube oil pressure.

.5 Short circuit.

.6 Alternator over-voltage.

.7 Low battery voltage, or no battery charge.

.8 Manual remote emergency stop.

.9 High alternator temperature.

.6 Next, install continuous strip chart recorders or digital residing devices to record frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments to include:

.1 No load to full load to no load.

.2 No load to 70% load to no load.

.3 No load to 20% load to no load.

.4 20% load to 40% load to no load.

.5 40% load to 60% load to no load.

.6 60% load to 80% load to no load.

.7 Demonstrate:

.1 Automatic starting of set and automatic transfer of load on failure of normal power.

.2 Operation of manual bypass switch.

.3 Automatic shutdown of engine on resumption of normal power.

.4 That battery charge reverts to high rate charge after cranking.

.5 Peak shaving

.6 Soft loading and unloading.

.8 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.

3.3 Vibration Analysis

.1 Perform an On-Site vibration analysis of the new diesel engine generator package units under no load and full load conditions as further specified herein.

.2 Submit a complete vibration analysis report to the consultant. Report shall include a sketch of the engine generator sets showing the points at which the analysis took place, copies of the vibration signature at each point and a summary sheet.

.3 Vibration analysis shall be conducted at each of the following points:

.1 Front (fan end) of engine.

.2 Rear (drive end) of engine.

.3 Front (driven end) generator.

.4 Rear (exciter end) of generator.

.5 Front of base (at vibration isolators).

.6 Midpoint of base (between isolators).

.7 Rear of base (at vibration isolators).

Exact locations of analysis points shall be as directed On-Site. Each point shall be permanently marked and numbered with a lamaciod nameplate on each unit to ensure that future readings are conducted in the same location.

.4 Vibration analysis shall include horizontal, vertical, and axial readings at each analysis point exact that axial readings may be omitted for points in the middle of the generating set and on the base of the unit.

.5 Vibration analysis shall be conducted using a vibration analyser in conjunction with a chart recorder to produce a continuous vibration signature at each analysis point in each direction of vibration. (total of thirty two (32) signatures required). Each vibration signature shall show both vibration amplitude in mils and velocity in inches/second as a function from 200 cycles per minute to 200,000 cycles per minute.

3.4 Training

.1 Provide demonstration and training in accordance with **Division 1**.

END OF SECTION