SECTION P16620 - PACKAGED ENGINE GENERATOR SYSTEMS (PRE-PURCHASE)

PART 1 - GENERAL

RELATED DOCUMENTS

Include all costs for shipment with F.O.B. to the job site. Provide delivery time from date of approved shop drawings by the Engineer. Provide number of working days for submittal of shop drawings to the Engineer after date of purchase order. Include with the proposal CAD drawings showing the enclosure with side elevations, floor plans and dimensions.

Provide an additive price to the base bid for a 5-year comprehensive, no deductible warranty.

SEISMIC REQUIREMENTS

Submit seismic certification letter from Manufacturer stating equipment and enclosure is designed for Seismic Zone 2.

SUMMARY

This Section includes a packaged diesel engine generator system including engine generator set, cooling system, fuel system, combustion air intake, engine exhaust systems and starting system. Contractor will provide all necessary fuel oil for site testing purposes. As noted herein on page 11 the muffler and necessary accessories shall be factory mounted inside the enclosure.

SYSTEM DESCRIPTION

System Shall Include: Dual rating - prime/standby, automatically started diesel engine coupled to an alternating current generator. Engine and generator shall be factory-mounted and aligned on a structural steel skid. Subsystems and auxiliary components and equipment shall be as indicated.

Functional Description

> When the mode selector switch on the control and monitoring panel is in the "automatic" position, remote control contacts in the automatic transfer control PLC shall initiate the starting of the generator set. The generator shall stop only when the above noted contacts call for engine stop.
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> When the mode selector switch is placed in the "on" position, the generator set shall start manually. The "off" position of the same switch shall initiate cool down and shutdown of the generator set. This shutdown period shall provide for an adjustable cool down period of minimum five to forty-five minutes before the engine actually stops.
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> When the unit is running, specified system or equipment failures or derangements shall automatically shut the unit down without going through a cool down period and initiate alarms. Operation of the unit mounted emergency stop switch shall immediately shut down the unit without going through a cool down period.

Power Output Connections: The power compartment shall be designed for bottom entry of conductors.

SUBMITTALS

General: Submit the following:

To be submitted for Engineer's Approval upon acceptance of bid and prior to equipment order and shipment.

Product data for products specified in this Section. Include data on features, components, ratings, and performance. Data shall include weights, fuel consumption rates, ventilation and combustion air requirements, exhaust flow data, cooling system data and engine and generator data. Include dimensioned outline plan and elevation drawings of engine generator set and other system components.

Shop Drawings: Detail fabrication, piping, wiring, and installation of the field-installed portions of the system. Include general arrangement drawings showing locations of auxiliary components in relation to the engine generator set and duct, piping, and wiring connections between the generator set and the auxiliary equipment. Show connections, mounting, and support provisions and access and working space requirements.

Wiring Diagrams for System: Show power and control connections and distinguish between factory-installed and field-installed wiring. Provide schematic and connection diagrams for all wiring required to day tank and all other control panels. Terminals for field wiring the system controls and between equipment shall be labeled in a consistent point to point manner by the manufacturer.

Certified Summary of Prototype Unit Test Report: Submit certified copies of actual prototype unit test report.

Certified Test Reports of Components and Accessories: Submit for devices that are equivalent, but not identical, to those tested on prototype unit.

Exhaust System Performance Calculations: Provide pressure loss calculations for the complete exhaust system installation. Calculations shall be based upon the actual components, sizes and routings which the contractor intends to install.

Certification of Torsional Vibration Compatibility: Conform to NFPA 110.

To be Submitted After Equipment Order:

Factory Test Reports: Provide for units to be shipped for this Project showing evidence of compliance with specified factory test requirements.

Maintenance data for system and components for inclusion in Operating and Maintenance Manual specified in Division 1. Include the following:

Lists: Tools, test equipment, spare parts, and replacement items. Include part and drawing numbers, current unit prices, and source of supply.

Detailed Operating Instructions: Cover operation under both normal and abnormal conditions.

Field Test Report: Record of tests specified in Part 3.

Provide AutoCAD version 2000 files of all final as-built shop drawing on CD Rom.

Warranty:

The complete electrical power system (generator, engine, controls, enclosure and accessories) shall be warranted by the manufacturer against defects in materials and workmanship for a period of 24 months after arrival to the job site. Coverage shall include parts, travel expenses and labor to remove and install the necessary parts and equipment.

Bid shall include a 24 month (after arrival to job site) preventative maintenance contract during the warranty period.

Compile and assemble the warranties into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

Provide complete warranty information for each item to include product or equipment to include date of beginning warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

QUALITY ASSURANCE

Manufacturer Qualifications: Firms experienced in manufacturing equipment of the types and capacities indicated that have a record of successful in-service performance.

Service personnel: Service personnel shall be factory trained and certified in the maintenance of the specified equipment.

Emergency Service: System manufacturer shall maintain a service center capable of providing training, parts, and emergency maintenance and repairs at the Project site with 4 hours maximum response time, 24 hours per day, 365 days per year.

Comply with NFPA 70, "National Electrical Code."

Comply with NFPA 110, "Standard for Emergency and Standby Power Systems," for requirements for a Level 1 emergency power supply system.

Comply with NFPA 37, “Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines”.

Electrical Items and Components shall be listed (or recognized) by Underwriter's Laboratories, Inc.

Non-Electrical Components shall be listed (or recognized) by Underwriter's Laboratories, Inc. or other applicable Nationally Recognized Testing Laboratory.

Engine Exhaust Emissions: Comply with applicable Federal, State, and local government requirements.

Single-Source Responsibility: Unit shall be a representative product built from components that have proven compatibility and reliability and are coordinated to operate as a unit as evidenced by records of prototype testing.

DELIVERY, STORAGE, AND HANDLING

Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is made safe from such hazards.

EXTRA MATERIALS

Furnish extra materials matching products installed, as described below, packaged with protective covering for storage, and identified with labels describing contents. Deliver extra materials to the Program Manager.

Fuses: 1 for every 10 of each type and rating, but not less than 2 of each.
Pilot Lights: 1 for every 3 of each type used, but not less than 2 of each.
Filters: 1 set each of lubricating oil, fuel, and combustion air filters.

PART 2 - PRODUCTS

MANUFACTURERS

Engine Generator Set Manufacturers: Subject to compliance with requirements, provide completely assembled engine-generator units by one of the following engine generator set manufacturers:

Caterpillar, Inc.
Cummins Power Generation
Kohler Company
Detroit Diesel

The above engine-generator set manufacturers shall utilize only the following engines and generators and ancillary equipment:

Engine Manufacturers:

Caterpillar, Inc.
Cummins
Detroit Diesel

Generator Manufacturers:

Newage

Kato
Lima
Magnetek
Marathon
Cummins
Kohler Co.

Radiators:

Modine
Cummins
Young
Inland Engine Accessories, Inc.

Muffler:

Cowl
Hapco
Maxim
Nelson
Silex

Storage Batteries:

Interstate Battery
C&D Charter Power Systems.
Chloride Systems.
Exide Corp.
NIFE, Inc., NIFE, AB.
SAFT America, Inc., Advanced Battery Systems Div.
Sonnenschein Batteries, Inc.
Caterpillar
Johnson

Vibration Isolators:

ACE Mountings
Korfund Dynamics Corp.
California Dynamics Corp.

Battery Chargers:

Exide Corp.
LaMarche Mfg. Co.
Onan Corp.
AED Charles Division
Kohler Co.
SENS

SYSTEM SERVICE CONDITIONS

Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

Ambient Temperature: Minus 20 deg F to Plus 120 deg F.
Relative Humidity: 0 to 95 percent.
Altitude: Sea level to 1000 feet.

ENGINE GENERATOR SYSTEM

General: System shall be a coordinated assembly of compatible components.

Ratings: 600 kW standby. Generator shall be rated at a 0.80 lagging to unity.

System Output Configuration: 480/277 volt, 3-phase, 4wire at 60 HZ.

Safety Standard: Comply with ASME B15.1, "Safety Standard for Mechanical Power Transmission Apparatus."

Nameplates: Each major system component shall be equipped with a conspicuous nameplate of the component manufacturer. Nameplate shall identify manufacturer of origin and address, the model and serial number of the item, and factory order number.

Resistance to Seismic Forces: Internal and external supports for components, supports, and fastenings for batteries, wiring, and piping shall be designed to withstand both static or anticipated seismic forces in any direction. Use minimum force values in accordance with previously noted seismic requirements.

SYSTEM PERFORMANCE

Steady-State Voltage Operational Bandwidth: Shall not exceed 4 percent of nominal rated output voltage from no load to full load. The frequency of cyclical variations shall be less than one hertz.

Transient Voltage Performance: Not more than 13 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 3 seconds.

Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

Steady-State Frequency Stability: When the system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no regular or cyclical hunting or surging of speed.

Transient Frequency Performance: Less than 3 Hz variation for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 3 seconds.

Output Waveform: At no load, the voltage harmonic content measured line-to-line or line-to-neutral shall not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor determined according to NEMA MG1, "Motors and Generators," shall not exceed 50.

Sustained Short-Circuit Current: For a 3-phase bolted short circuit at the system output terminals, the system shall supply a minimum of 250 percent of rated full-load current for 10 seconds.

Temperature Rise of Generator: Within acceptable limits for insulation systems used, according to NEMA MG1, and as measured by the resistance method, when operating continuously at prime rating in the above specified environmental conditions.

Nonlinear Load Performance: System performance shall not be degraded from that specified in this Article by continuous operation, with the load current having a minimum total harmonic content of 15 percent rms, and minimum single harmonic content of 10 percent rms.

Starting Time: Maximum total time period for a cold start, with ambient temperature at the low end of the specified range, shall be 8 seconds. Time period includes output voltage and frequency settlement within specified steady-state bands.

Block Load: Engine generator shall be capable of accepting a 75 percent block load at 0.80 lagging power factor at the ambient conditions specified above without exceeding a 20 percent voltage dip.

ENGINE GENERATOR SET

Power Output Rating: Nominal ratings as indicated per manufacturer on their drawings, with capacity as required to operate as a unit as evidenced by records of prototype testing.

Skid: Heavy duty steel base to maintain alignment of the mounted components without dependence on a concrete foundation. Skid shall be free from sharp edges and corners. Lifting attachments shall be arranged to facilitate lifting with slings without damaging any components. Skid shall incorporate a battery tray with seismically rated hold-down clamps within the base rails. A separate seismically designed and anchored battery tray may be provided, however it shall not interrupt working clearance to the generator.

Vibration spring isolators for the skid shall be provided as recommended by the engine-generator manufacturer and shall be rated in accordance with previously notes seismic requirements.

ENGINE

Comply with NFPA 37, "Stationary Combustion Engines and Gas Turbines."

Fuel: Diesel fuel oil grade DF-2.

Maximum Engine Speed: Engine - 1800 rpm.

Engine Type: 4-stroke cycle.

Lubrication System: Pressurized by a positive displacement pump driven from the engine crankshaft. The following items shall be mounted on the engine or skid:

Filter and Strainer: Rated to remove 90 percent of particles 3 microns and smaller while passing full flow.

Oil Cooler: Rated to maintain lubricating oil at the manufacturer's recommended optimum temperature throughout continuous operation of the generator set at 100 percent of system power output rating.

Thermostatic Control Valve: Shall control flow in the system to maintain optimum oil temperature. Unit shall be capable of full flow and be designed to be fail-safe.

Crankcase Drain: Arrange for complete gravity drainage to an easily removable container with no disassembly and without the use of pumps or siphons or special tools or appliances.

Engine Fuel System: Comply with NFPA 30, "Flammable and Combustible Liquids." System shall include:

Integral Injection Pumps: Pumps shall be driven by the engine camshaft and be adjustable for timing.

Main Fuel Pump: Shall be mounted on the engine. Pump shall ensure adequate primary fuel flow under starting and load conditions.

Parallel Fuel Oil Filters: Provide two parallel fuel oil filters located ahead of the injection pumps. Changeover valves shall allow independent use of either filter.

Relief/Bypass Valve: Shall automatically regulate pressure in the fuel line and returns excess fuel to the source.

Fuel Oil Return Cooler: Provide fuel oil return cooler to insure adequate cooling of fuel oil.

Jacket Coolant Heaters: Electric immersion type, factory-installed in the jacket coolant system. Units shall be rated and thermostatically controlled to maintain an engine temperature of 25 deg C, 77 deg F at 0 deg F. Heater shall be approximately 6,000 watts at 240 volts, single phase. Supplier shall include all additional costs if units are not at this rating.

Electronic governor: consisting of a magnetic pickup speed sensor, adjustable electronic control, and an electric actuator mounted integrally with the fuel pump, shall provide automatic engine-generator set frequency regulation adjustable from isochronous to 5% droop. Steady-state speed band shall not exceed +/- 0.25 percent over the full rated ambient temperature range.

ENGINE COOLING SYSTEM

Description: Closed-loop, liquid-cooled, with radiator factory-mounted on engine generator set skid and integral engine-driven coolant pumping.

Radiator: Factory piped and rated for specified coolant.

The engine shall be cooled by a unit-mounted closed loop radiator system including belt-driven pusher fan integral engine mounted coolant pump and thermostat temperature control. The cooling system shall be rated for full rated load operation in ambient condition specified above. The cooling capability of the generator set shall be demonstrated by prototype tests on a representative generator set model. **These**

tests shall be conducted by the generator set manufacturer; calculated data from the radiator manufacturer only is not sufficient.

Radiators shall be provided with a duct adaptor flange permitting the attachment of an air discharge duct to direct the radiator air outside according to the manufacturer's instruction. The cooling system shall be filled with 50/50 propylene glycol/water mixture by the equipment supplier.

Radiator Core Tubes: Nonferrous metal construction other than aluminum.

Coolant: Solution of 50 percent propylene glycol and 50 percent water.

Temperature Control: Self-contained thermostatic control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by the engine manufacturer. Features include:

Thermostatic Elements: Interchangeable and nonadjustable.

Actuator Design: Normally-open valves to return to open position when actuator fails.

Coolant Hose: Flexible assembly with nonporous rubber inside surface and non-aging, ultraviolet, and abrasion-resistant fabric outer covering.

Rating: 50 psi maximum working pressure with 180 deg F coolant, and noncollapsible under vacuum.

End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

FUEL SUPPLY SYSTEM

Fuel Piping: Shall be self contained and provided with generator system.

FUEL BASE TANK

General: A 1000 gallon skid mounted diesel fuel tank shall be provided with the generator and positioned above grade and directly below the engine generator set. It shall be integrated with the engine generator enclosure and it shall have the following features.

Manufacturer Qualifications – Manufacturer shall have a minimum ten years' experience in the design and construction of Underwriters Laboratories (UL) listed sub base tank systems.

Sub Base Tank Construction – Sub base tank shall:

Be Tramont or approved equivalent.

Be constructed in accordance with Underwriters Laboratories Standard UL-142.

Be constructed in accordance with Flammable and Combustible Liquids Code, NFPA 30; The Standard for Installation and use of Stationary Combustible Engine and Gas

Turbines, NFPA 37; and The Standard for Emergency and Standby Power Systems, NFPA 110.

Be rectangular in shape. Include reinforced steel box channel for generator support. Full height gussets shall be provided at gen-set mounting holes.

Be pressure washed with an iron phosphate solution. Interior shall be coated with a solvent-based film rust preventative, providing inter-operational protection.

Sub Base Tank Testing

Primary Tank and Secondary Containment Basin shall be pressurized at 3-5 psi and leak-checked to ensure integrity of sub base weld seams per UL – 142 standards.

Closed Top Dike Primary tank section shall be pressurized at 3-5 psi and leak-checked to ensure integrity of sub base weld seams per UL – 142 standards. Containment basin shall be leak-checked by means of weld penetrant and ultraviolet light.

Sub Base Tank Fittings – The sub base tank shall include the following fittings:

Appropriately sized NPT fuel supply.

2” NPT for normal vent.

NPT for emergency vent, sized as appropriate.

2” NPT for manual fill.

NPT for level gauge, sized as appropriate

3/8” NPT basin drain (tank drain if single wall)

2” NPT for level alarm

NPT fitting for leak detection alarm

Fuel Level Gauge – The sub base tank shall include a direct-reading fuel level gauge.

Fuel Containment Basin – Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.

Leak Detection System – A fuel containment basin leak detector switch shall be provided and factory wired to generator control panel.

Sub Base Tank Venting

Normal Venting: Normal venting shall be sized at 2” NPT through 10,000 gallons in accordance with The American Petroleum Institute Standard No. 2000, for venting

atmospheric and low pressure storage tanks. Tank shall be provided with atmospheric (normal) vent cap with screen.

Emergency venting: The emergency vent NPT fitting shall be sized to accommodate the total capacity of both normal and emergency vents, and is not less than that derived from NFPA 30, Table 2-8, based on wetted surface area of the tank (calculated based on 100% of primary tank). A zinc-plated emergency pressure relief vent cap shall be furnished. The vent shall be spring-pressure operated. Opening pressure shall be .5 psig; full opening pressure shall be 2.5 psig. Limits shall be marked on top of each vent. A second emergency vent fitting shall be provided for the secondary containment portion of the tank if applicable.

ENGINE EXHAUST SYSTEM

Muffler: Critical-type, sized as recommended by the engine manufacturer. Measured sound level according to the "DEMA Test Code for the Measurement of Sound from Heavy-Duty Reciprocating Engines" at a distance of 10 feet from the exhaust discharge, shall be 95 dB or less. Unit and accessories shall be factory installed inside the enclosure.

Muffler shall be complete with drain, flexible pipe connectors, roof (wall) thimble, rain cap and piping as required.

Connections from Engine to Exhaust System: Flexible section of corrugated stainless steel pipe.

COMBUSTION AIR-INTAKE SYSTEM

Air-Intake Silencer: Filter-type providing filtration as recommended by the engine manufacturer.

Mounting: Factory-installed on engine generator set at a location readily accessible for servicing.

STARTING SYSTEM

Description: 24 V electric with negative ground and including the following items:

Components: Sized so they will not be damaged during a full engine-cranking cycle with the ambient temperature at the maximum specified in paragraph "Environmental Conditions."

Cranking Motor: Heavy-duty unit that automatically engages and releases from the engine flywheel without binding.

Cranking Cycle: As required by NFPA 110 for system level specified.

Battery complies with SAE J537, "Storage Batteries," and has adequate capacity within the ambient temperature range specified in paragraph "Environmental Conditions" to provide the specified cranking cycle series at least twice without recharging. Battery cells shall be of lead calcium type and be of vented, flooded cell construction. Provide minimum of 4-type 8D high capacity batteries.

Battery Cable: Size as recommended by the generator set manufacturer to provide proper starting current and voltage for the cable length required and range of ambient conditions specified. Include required interconnecting conductors and connection accessories.

Battery Compartment: Factory-fabricated of metal with acid-resistant finish and thermal insulation. Include accessories required to support and fasten batteries in place. In lieu of a compartment on the floor, provide skid mounted batteries with hold down clamps and seismic springs. Rack support shall be seismically designed and installed for Seismic Zone 2.

Battery-Charging Alternator: Factory-mounted on engine with solid-state voltage-regulation current adequate to supply all connected loads while recharging a fully discharged battery to no less than 20 percent of the ampere-hour rating of the battery within a one hour period.

Battery Charger: Current limiting, automatic equalizing and float charging-type designed for operation from a 120 V 60 Hz supply source. Unit shall comply with UL 508, "Electrical Industrial Control Equipment," and include the following features:

Operation: Equalizing charging rate of 20 amperes minimum shall be initiated automatically after the battery has lost charge until an adjustable equalizing voltage is achieved at the battery terminals. The unit shall then automatically switch to a lower float-charging mode, and continue operating in that mode until the battery is discharged again.

Automatic Temperature Compensation: Adjusts the float and equalizes voltages for variations in the ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

Automatic Voltage Regulation: Shall maintain output voltage constant regardless of input voltage variations up to plus or minus 10 percent.

Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing "low battery voltage" indication on control and monitoring panel. Also include sensing of high battery voltage and loss of a.c. input or d.c. output of battery charger. Either of these conditions closes contacts that provide "battery charger malfunction" indication at system control and monitoring panel and an additional set of command alarm dry contacts (120 Volt @ 1 Amp) shall be provided for field connection by Contractor.

Enclosure and Mounting: NEMA Class 1 wall-mounted cabinet.

Battery Heating Pads: Provide battery heating pads with thermostat control.

CONTROL AND MONITORING

Configuration: Operating and safety indications, protective devices, engine gages, basic system controls, instrument transformers and other indicated components shall be panel-mounted on the generator set as noted below. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Electronic microprocessor based panel shall combine engine status and AC metering into one

unit with digital graphics. Panel shall be equal to a Caterpillar EMCP 3.3 model. The control panel shall be provided auxiliary power from the engine starting batteries, if the generator fails.

Note that the generator control panel shall incorporate all functions of engine governor/speed control, voltage regulation, engine-generator safety shutdown control, and automatic synchronizing, including monitoring of stator and bearing RTD's (if provided).

Generator Circuit Breaker: Molded case type with solid state trip. Breaker shall be U.L. listed for 100% continuous current operation.Breaker shall include long time delay, short time pickup and delay (I^2t in and out), instantaneous pickup, ground fault pickup and delay (I^2t in and out). Breaker instantaneous rating shall be adjustable up to 13x continuous trip rating. Unless otherwise indicated, set instantaneous trip at 13x. Mount in enclosure on generator set. Do not secure the breaker using the cover plate. Provide two 800 ampere frame output circuit breakers factory connected on the line side to the generator.

Indicating Devices, Protective Devices and Controls Including those required by NFPA 110 for a Level 1 system plus the following:

A.C. Voltmeter (Ø – Ø and Ø – N)	Adjustable Cool down Timer
A.C. Ammeter (Ø – Ø and Ø – N)	Overspeed Shutdown Indication
A.C. Frequency Meter	Battery Voltage - High
D.C. Voltmeter (Alternator Battery Charging)	Battery Voltage - Low
Running Time Meter	Control Switch Not In Auto
Fuel Tank Common Alarm	Battery Charger A/C Failure
Fuel Pressure Gauge	Low Oil Pressure Warning
Fuel Filter Differential Gauge	Low Oil Pressure Shutdown
Fuel Tank Common Alarm	High Coolant Temperature Warning
Generator Voltage	Overspeed
Emergency Stop Pushbutton (Mushroom Red)	Overcrank
Low Engine Coolant Temperature Warning	Stator and Bearing RTD Temperatures
Intake Manifold Temperature Gauge	Water Temperature Gauge
Lube Oil Pressure Gauge	Oil Filter Differential Gauge
Lube Oil Temperature Gauge	Air Cleaner Restriction Gauges
Exhaust System Pyrometer	High Coolant Temperature Shutdown
Engine Tachometer	

Auxiliary Contacts (Generator Panel): Separate terminal blocks factory wired to separate form C dry contacts. Contacts shall be for field connection. A separate pair of contacts shall be provided for starting of motorized dampers, stopping ventilation fans and stopping unit heater fans. Contacts shall activate upon generator start signal. Provide two Form a and two Form b contacts, each rated no less than l0 amperes at 120 volts ac and no less than 5 amperes at 24 volts dc. Necessary spare contacts shall also be provided for all the interconnecting wiring to the medium voltage switchgear.

Terminal Box: Provide a factory mounted terminal box with copper bus bars factory connected to the generator windings, or generator circuit breaker, as applicable, to allow for field connection to the generator output. Arrange the terminal box and bussing for top or bottom entry, as required for the particular installation. Size the terminal box and arrange the bus bars to provide adequate conductor training and termination space for the size and number of power conductors and current transformers used in this application. Bus bars shall be drilled for standard NEMA terminal lug hole pattern.

Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items in engine generator control panel unless otherwise indicated. Also see data connection requirements.

Common Remote Audible Alarms: Conform to NFPA 110 requirements for Level 1 systems. Include necessary Form C contacts and terminals in control and monitoring panel. Locate audible device and silencing means where indicated. Also see data connection requirements.

Stator Temperature Detectors: Not required for this project.

Bearing Temperature Detectors: Not required for this project.

Space heaters: Not required for this project.

Connection Box: Not required for this project.

Remote Emergency Stop Switch: Flush wall-mounted red 2¼ inch jumbo mushroom head pushbutton type similar to Allen-Bradley Bulletin 800H with 800T-N247R head), with prominent label. Pushbutton shall protect from accidental operation.

Provide all conversion equipment and software required so that communications between the Generator Panel and the switchgear PLC (NOT IN CONTRACT) is via vendor designated cable and protocol. Data shall be capable of being communicated from the generator control panel and engine to the automatic transfer switchgear via Modbus or Ethernet. Switchgear vendor will provide programming on the switchgear's PLC.

GENERATOR, EXCITER, AND VOLTAGE REGULATOR

Comply with NEMA MG 1, "Motors and Generators," and specified performance requirements.

Electrical Insulation: All windings shall be Class H or F insulation applied under a vacuum pressure impregnation (VPI) cycle.

Windings: All windings shall be random or form wound construction

Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 100 percent of rated capacity.

Enclosure: Drip-proof.

The AC generator shall be; synchronous, four pole, revolving field, drop-off construction, with single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc(s) with two prelubricated sealed bearings, air cooled by a direct drive centrifugal blower fan, and close-coupled to the engine. The stator shall have skewed laminations of insulated electrical grade steel. The rotor shall have amortisseur (damper) windings. The rotor shall be dynamically balanced. The exciter shall be brushless, three phase, with full wave silicon diodes mounted on the rotating shaft and a surge suppressor connected in parallel with the field wiring.

All insulation system components shall meet NEMA MG1 standard temperature limits for the specified insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade, above a 40^{o} Centigrade Ambient.

A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum motor starting and to sustain short circuit current as described above under "System Performance."

The automatic voltage regulator shall be temperature compensated, solid-state design. The voltage regulator shall be equipped with three-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. Overvoltage protection shall sense the AC generator output voltage and in the event of regulator failure or loss of reference, shut down regulator

output on a sustained overvoltage of one (1) second duration. Overexcitation protection shall sense regulator output and shut down regulator output if overloads exceed ten (10) seconds duration. Both overvoltage and overexcitation protection shutdowns shall be latched, requiring the AC generator to be stopped for reset.

The regulator shall include an under frequency rolloff torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58-59 HZ. The torque-matching characteristic shall include differential rate of frequency change compensation to use maximum available engine torque and provide optimal transient load response. Regulators which use a fixed volt per hertz characteristic are not acceptable. The automatic voltage regulator shall be furnished with var/power factor control.

A voltage control adjustment device compatible with the voltage regulator shall be provided.

GEN SET ENCLOSURE

General: A weatherproof walk-in acoustic enclosure shall be provided that is self-contained with a engine-generator set and a base mounted fuel tank ready for delivery to the site. It will be installed on a concrete pad by the Owner's Contractor. Enclosure shall be as manufactured by Tramount (Level 2) or equal as noted below.

It shall have the following features:

90° vertical air inlet and outlet hoods: Redirects air to reduce noise. All air inlet and outlet hoods lined with acoustic insulation.

Sound-attenuated: 75 dBA @ 23 feet away with acoustic insulation (mechanically restrained); listed to UL-94 HF1 for flammability.

Interchangeable modular panel construction: Allows design flexibility without compromising building standards.

Bolted panels: Facilitate service, future modification, upgrades or field replacement.

Radiator ducted to enclosure air outlet: Prevents air recirculation within the enclosure.

Pitched (16;1) enclosure roof: Prevents water accumulation.

Heavy-gauge steel construction. Minimum14 gage sheet metal for side panels and 12 gauge sheet metal for top panels. Provide a durable, dent resistant structure.

Powder-baked paint: Creates a tough, scratch resistant finish (color to be determined)

Lift off door hinges and radiator fill panel: Enable easy service access.

Hinged doors on opposite sides with cylinder type locks keyed alike.

Stainless steel hinges and latches.

Recessed and lockable door handles.

Rubber sealed access doors to prevent water infiltration and minimize noise

Minimum 24" working clearance on sides of engine gen. set and 42" minimum clearance in front of control panel and circuit breaker.

Options and Accessories shall be provided as follows:

Internal release door latches.
Gravity air outlet louver.
Motorized air intake louver.
120 VAC interior lighting with on/off switch

Provide four 2 lamp, 32 watt vapor tight fluorescent light fixtures above engine and one above control panel.

AC load center 120/240 single phase, provide a dry transformer 480 Volt single phase primary , 120/240 Volt single phase, 3 wire secondary. Transformer and load center sized by manufacturer to serve loads furnished.

All the AC equipment associated with enclosure, including but not limited to jacket water heaters, battery heating pads, unit heaters, engine generator, battery charger, battery heating pads, receptacle, light fixtures and fuel tank shall be factory wired in conduit to this common load center.

DC light package (Emergency battery pack)
Exterior 120 volt photocell controlled 70 watt high pressure sodium light fixtures (two total).
Plexiglas panel viewing window
Sub base and cross member for generator set.
Enclosure heater

Unit heater shall be interlocked to turn off when generator is operating.

Door holders
Duplex GFI 20 amp-120 volt wp receptacle

SOURCE QUALITY CONTROL

Factory Tests: Include prototype testing and Project-specific (factory witness testing) equipment tests (equipment manufactured specifically for this Project).

PROTOTYPE TESTING

Performed on a separate engine generator set at 80 percent lagging power factor using the same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories. Submit with shop drawings.

Tests: Conform to those required for Level 1 energy converters in paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2 of NFPA 110.

Additional Tests: Provide the Following Test Results:

- Torsiograph Analysis and Test
- Temperature Rise
- Short Circuit
- Endurance Run
- Maximum Power
- Linear Vibration
- Cooling System
- Maximum Motor Starting kVA
- Transient Response
- Exhaust Emission

FACTORY WITNESS TESTING

Manufacturer shall provide one day of factory witness testing and inspection by the Owner's Representatives. Manufacturer shall have present factory personnel responsible for fabrication, engineering and testing of the engine generator system. Testing may be performed at an authorized distributor provided they have a satisfactory history of testing and trained personnel for all recording instruments.

Project-Specific Equipment Tests: Test engine generator set and other system components and accessories prior to shipment. Test items individually and assembled and connected as a complete system at the factory as specified herein. Record and report test data. Provide written report of each individual test and their results.

Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype shall have been acceptably tested to demonstrate compatibility and reliability.

Test Equipment: Use instruments calibrated within the previous 12 months and with accuracy directly traceable to the National Institute of Standards and Technology (NIST).

Harmonic Content Tests: Measure harmonic content of output current under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

Hydrostatic Test: Perform on radiator, heat exchanger, and engine water jacket.

Insulation Tests: Test generator windings using direct current voltage values and requirements per NETA standards.

Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify measurements are within manufacturer's specifications.

Battery Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

Simulation of malfunctions to verify proper operation of local and remote protective, alarm, and monitoring devices.

Exhaust System Back-Pressure Test: Use a manometer with a scale exceeding 40 inches of water. Connect to the exhaust line close to the engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's published allowable limits for the engine.

Voltage and Frequency Transient Stability Tests: Provide chart recorder to measure voltage, current and frequency transients for 50-percent and 75-percent step-load increases and decreases to verify that performance is as specified.

Generator Tests: Conform to IEEE 115, "Test Procedures for Synchronous Machines."

Complete System Continuous Operation Test at Standby Rating: Includes nonstop operation for a minimum of 8 hours, including at least 1 hour each at 1/2, and 3/4, load, and 2 hours at 100 percent of full load. Variable resistive and reactive load bank shall be capable of simulating kW, kVA, and power factor for which unit is rated. Perform the 100 percent load run at 80 percent power factor. If unit stops during the 8-hour test, repeat the complete test. Record the following minimum data at the start and end of each load run and at 15-minute intervals between those times.

- Fuel consumption.
- Exhaust temperature.
- Jacket water temperature.
- Lubricating oil temperature and pressure.
- Generator load current and voltage, each phase.
- Generator system gross and net output kW.
- Generator power factor.

Complete System Performance Tests: Include the following to demonstrate conformance to specified performance requirements:

- Step-load pickup.
- Transient and steady-state governing.
- Transient and steady-state voltage performance.
- Safety shutdown devices.

The following continuous and simultaneous straight-line recordings versus time, shall be made at a chart speed of no less than fifty millimeters per second. The recorder shall run from at least ten seconds before the test event and until at least ten seconds after the test event.

Phase A rms current.	Phase A to N rms voltage.
Phase B rms current.	Phase B to N rms voltage.
Phase C rms current.	Phase C to N rms voltage.
Frequency of one selected phase.	

The following simultaneous actual wave shape recordings versus time, shall be made at a chart speed of no lees than 200 millimeters per second. The chart recorder shall run from at least five seconds before the test event to at least five seconds after the test event. These recordings do not have to be run at the same time as the above recordings.

Phase A to neutral voltage.	Phase A current.
Phase B to neutral voltage.	Phase B current.
Phase C to neutral voltage.	Phase C current.

Analyzers which indicate only the maximum and minimum values of frequency, current and voltage are not acceptable. In addition to the above recordings, analyzer shall also have digital readout of each input channel, 3.5 inch disk drive and battery back-up. Unit shall have 0.1% accuracy or better. Suggested analyzer is ASTRO-MED Dash 10M Thermal Array Recorder with frequency deviation conditioner, true rms current conditioners and rms voltage conditioners for the straight line recordings and DC high voltage conditioner for wave shape recording. Provide all necessary current transformers, amplifier racks, and other accessories for complete testing. Current transformer primary shall be as close to the generator full load current as possible, without causing saturation of the current transformer or saturation or overload of the analyzer or signal conditioning circuits. This unit and all accessories may be rented from Continental Resources at 1-800-937-4688 or General Electric at 1-800-GE-RENTS.

In lieu of the above, a Dranetz – BMI Model #PX5 power analyzer is acceptable. Include 128m FLASH CARD AND “Enterprise” Version software to provide hard copy printouts of measured values. An alternative rental agency is TRS-REN (1-800-621-6354). The technical representative for the PX5 is Ed Russo at 1-800-372-6832.)

Observation of Test: Provide 2-week advance notice of tests and opportunity for observation of test by Owner’s representatives.

Submit test results to Engineer within 10 days of completion of test. Data shall be recorded in accordance with the requirements noted herein. Correct deficiencies identified by tests and observations. Retest until specified requirements are met. Submit written verification unit that complies with NFPA 110.

PART 3 - EXECUTION

INSTALLATION

Manufacturer's Field Services: Include in the proposal the services of a factory-authorized service representative to supervise the installing, connecting, testing, and adjusting of the unit.

DEMONSTRATION

Training: Include in the bid costs the services of a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of the system and to train Owner's personnel.

Conduct a minimum of 8 hours of training.

Schedule training with at least 21-day advance notice.

DOCUMENTATION REQUIREMENTS

Within four weeks of the completion of the site testing, a complete set of "Operations and Maintenance Manuals" shall be furnished for the generator system, including the following:

Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions, regulation, control, stopping, shut-down and emergency instructions; and summer and winter operating instructions.

Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair and reassembly; aligning and adjusting instructions.

Servicing instructions and lubrications charts and schedules.

Equipment outline, showing front and side plan views, electrical power one line diagram, conduit entrances, and equipment ratings.

Schematic drawings.

Wiring diagrams.

Interconnection wiring diagram, showing all field interconnections among generator sets, circuit breakers and relays, and other remote devices, battery charger and all fuel tanks.

Material list, cross-referenced to schematics for component identification.

Narrative sequence of operation description, detailing all possible operating modes.

Ladder diagram and program listing for programmable controller with each logic rungs purpose clearly defined, including identification of inputs and outputs.

Test Data per Factory and Field Testing.

All equipment drawings shall specifically show the interface between the generator, control and monitoring equipment, and remote devices. Standard or typical drawings are not acceptable.

Provide three sets each of complete documents to the Engineer in three-ring binders.

WITNESS TESTING:

The engine-generator supplier shall include in his bid all costs associated for a factory witness test by two Owner representatives. Cost shall include transportation and overnight lodging, if necessary. The factory witness test shall include simulated automatic transfer and load bank testing as previously described under “Factory Witness Testing”. The load data shall be recorded in accordance with the requirements noted previously under “Part 3-Execution".

END OF SECTION P16620