Equipment Specifications and Services
RFP 23J-09392 ACQUISITION OF PRIME POWER RECIPROCATING ENGINE GENERATORS FOR THE PORTS AUTHORITY

INTRODUCTION

This section refers to the Equipment Specifications and Services specified in RFP 23J-09392 and dictates the scope of work and requirements for PRIME POWER RECIPROCATING ENGINE GENERATOR(S), including controls, required auxiliaries, fuel conditioning equipment and accessories ("Specification" or "Specifications").

Each engine generator package and required ancillary systems shall include features needed for safe, highly reliable, efficient, long-term operation. Design shall be in accordance with good engineering practice, applicable standards, and shall meet the strict demands typical of industrial power plants for safety and reliability, as well as those imposed by the Owner and all regulatory agencies having jurisdiction in the Commonwealth of Puerto Rico.

1. PRODUCTS

1.1 MANUFACTURER QUALIFICATIONS – ENGINE GENERATORS

A. Only Proponents with demonstrated experience in the manufacturing, testing, and servicing of PRIME POWER RECIPROCATING ENGINE GENERATORS will be considered. If the Proponent is a packager or independent representative, a letter shall be provided from the engine generator original equipment manufacturer authorizing the Proponent to sell and service the proposed engine generator package. Services to be provided with the base proposal shall be limited to that which is necessary to fulfill the installation and warranty requirements as defined herein.

1.2 MANUFACTURER QUALIFICATIONS – MISCELLANEOUS EQUIPMENT

A. Critical system components that may be incorporated into the scope of work should only be sourced from manufacturers with at least five years of experience and a documented record of quality product performance. Critical system components include:
   1. Mechanical Seals
   2. Control Valves and Regulators
   3. Pressure Transmitters (Gage and Differential)
   4. Temperature Transmitters (Sensors, transmitters & thermowells as applicable)
   5. Flowmeters
   6. Pressure Gauges

7. Level/Sight Glasses
8. Instrument Fittings
9. Variable Frequency Drives

B. Provide instruments and control valve actuators with "HART" protocol, where available. Connect HART communication signals as a homerun, not in a multidrop configuration. HART hand-held interface connections shall be fixed to the terminal block on smart transmitters and actuators. HART communications shall include the following device parameters:

1. Digital process variable (primary and secondary)
2. Status and Diagnostic information
3. Device identification
4. Calibration of instruments

1.3 SCOPE OF SUPPLY – ENGINE GENERATOR PACKAGES

Components and systems within the Vendor's engine generator package scope shall be complete, including control valves, piping, equipment, instrumentation, controls, alarms, wiring, insulation, cladding and other items required for a complete, functional, highly reliable and highly-automated installation in accordance with good engineering practices and the rigorous demands of industrial power plant service. To the extent practical, equipment shall be delivered in modular form; pre-piped, pre-wired, pre-terminated and pre-tested.

A. Furnished by Vendor (Engine Generator Package Scope)

1. Freight, FOB Job Site (or FOB Destination).
2. Electric generator.
3. Computer-based engine generator control system as defined herein.
4. Steel base frame with full size, continuous drip pan.
5. Base plates, shims, alignment/leveling hardware, and any other special foundation imbeds required to set and align equipment. Vendor shall provide vibration isolation components as required for sustained operation as defined herein.
6. Compressed Air/Electric starting system or approved alternative.
7. Lube oil systems, pumps and coolers for engine and generator.
8. Fuel system capable of burning syngas specified herein.
9. Interconnecting piping, tubing, and/or flexible hose connections as required between vendor-furnished auxiliary skids and main package. Where equipment location, such as the roof mounted coolers, is by others, the Vendor shall specify materials of construction and identify design requirements.
10. Inlet air filter housing and filter media.
11. One set of clean new combustion air filters for startup and commissioning of the engine generators, and a complete second set of clean new filters upon turnover of the units to Owner.
12. Sound attenuators for combustion air and exhaust systems, as required to meet overall noise limits specified herein.
13. Insulation and cladding for heat retention, noise reduction and personnel protection (140 degrees F maximum surface temperature, or as required by applicable codes and standards).

14. Instruments and equipment required for interface with distribution switchgear such as current transformers and neutral ground resistor.
15. Safety rails as required in accordance with OSHA standards.
16. Borescope inspection ports.
17. Vibration monitoring, condition monitoring, and data management systems.
18. Real-time event recorder with first-out identification and reporting to the operator.
19. Engine performance monitoring system.
20. Painting per Vendor's standard.
21. Safety guards on exposed rotating parts, in accordance with OSHA standards.
22. Required lifting/moving equipment and tools to remove and replace engine, generator (if required), and gear equipment (if required) within 24 hours.
23. Single points of connection for AC and DC emergency power distribution system internal to package for controls, emergency lights and pre/post lube oil pumps (if applicable) for a coast down and cool down period sufficient to prevent equipment damage after a full load trip.
24. On-site support during offloading, setting, startup, commissioning, and performance testing.
25. Operations and maintenance personnel training at the job site, including travel and local living expenses as specified herein.
26. Catalyst for reduction of carbon monoxide and UHCs, catalyst housing, and ducting transitions.

B. Furnished by Others

1. Offloading, storage, erection and installation of the equipment at the job site.
2. Foundations, anchor bolts and grouting.
3. Piping, valves, fittings and supports outside the Vendor's scope of supply.
4. Instrument and service air supply to the unit
5. Duct transitions external to unit between building exterior walls/roof and engine generator package for combustion air connections (note: engine generator vendor shall furnish design criteria for said ductwork – materials of construction, pressure drop limitations, coating & insulation requirements, etc.).
6. DC power for DC emergency power distribution system (to be provided by the Plant DC system).
7. AC Power Supply from station service to package AC power/lighting system.
8. Conducting on-site equipment performance test (Vendor shall provide oversight and support as specified herein).
9. Wiring of Vendor-furnished controls to Plant Control System (PCS).
10. Classroom facilities for on-site training.
11. Required lifting/moving equipment and tools to remove and replace engine, generator.
12. Building permits and environmental permits.

1.4 PERFORMANCE GUARANTEES

The following performance values shall be provided at guarantee base conditions as well as the other conditions indicated in Exhibit A and shall be verified during the on-site Performance Test.

A. Capacity and Fuel Consumption

1. "Guaranteed Power" which is defined as the 100 percent power output of the engine generator, as measured at the generator breaker, expressed in kilowatts, net of package-driven pumps, exciters and other auxiliaries, based on site specific factors, at guarantee ambient conditions and specified fuels.
2. "Guaranteed Fuel Consumption", which is defined as the fuel consumption of the engine generator expressed in BTU/hr, lower heating value basis, at the 100 percent guaranteed power output level and guarantee ambient conditions, based on site specific factors and specified fuel.
3. Part-load performance data shall also be provided for the load conditions indicated in Exhibit A.
4. Performance shall be based on inlet air pressure drop including filters, silencers, and ductwork. Curves to allow correction of engine generator performance for varying inlet pressure drop shall be provided for a range of 0" to 8" water gauge.
5. Performance shall be based on exhaust pressure drops including a stack with height equal to 75 ft above the base of the engine package, vendor supplied silencer, and vendor supplied exhaust catalyst ductwork pressure drops. For bidding purposes, assume stack pressure drop to be 1 in. of water. Curves to allow correction of engine generator Performance for varying back pressure shall be provided for a range of 3" – 10" of water gauge.

B. Engine Generator Emissions

1. "Guaranteed Exhaust Emissions" from 50-100 percent guaranteed power output for the following pollutants shall be indicated with Vendor's proposal for emissions both upstream and downstream of the catalyst, expressed in 1) g/hp-hr at 15 percent oxygen, and 2) total pounds per hour, for the specified fuel (taken at engine exhaust):

    a. NOx
    b. CO
    c. VOC

2. Each generating unit shall not exceed the following emission limits at maximum capacity as listed below. Additional points may be awarded during the selection process for achieving lower emission rates (during a performance test).

    a. NOx = 1 g/hp-hr (82 ppm @ 15% O2)
    b. CO = 2 g/hp-hr (270 ppm @ 15% O2)
    c. VOC = 0.7 g/hp-hr (60 ppm @ 15% O2)

3. The stationary SI internal combustion engine shall be certified to meet the emission standards and information as required in 40 CFR Parts 1048, 1054, and 1060, as applicable.
4. The manufacturer's recommended operating air/fuel ratio divided by the stoichiometric air/fuel ratio at full load conditions shall be less than or equal to 1.1.
5. Part-load performance data shall also be provided for the load conditions in Exhibit A.

C. Noise Limitations

1. Noise levels for equipment furnished under this scope of work shall be guaranteed not to exceed 85 dBA (maximum) at 3 feet distance and 5 feet above grade under free field conditions over a reflecting plane measured at points spaced six feet apart

around the equipment. Where engine generator noise may not be mitigated without an enclosure, Vendor shall provide noise profiles of the equipment for evaluation by others. Specified noise limits should be applied to the engine exhaust outlet and noise transmitted through the silencer/stack.

2. The specified noise limits shall apply to all normal modes of operation.

D. Seismic & Wind Requirements

1. Seismic & Wind Performance: Engine generator, associated auxiliary equipment, accessories, and components shall withstand the effects of earthquake and wind motions determined according to the seismic load information provided in Attachment E of the RFP 23J-09392.

E. B11 Compliance

1. Comply with B11.19 - Performance Requirements for Risk Reduction Measures: Safeguarding And Other Means Of Reducing Risk.

F. NFPA Compliance

1. Comply with NFPA 37.
2. Comply with NFPA 70.

1.5 DESIGN REQUIREMENTS

The intent of this Specification is to utilize Vendor's standard package design where possible. However, the specific design features discussed herein shall be included as a minimum.

A. Engine Generator Package

1. Engine generator shall be designed for continuous operation including load-following operation between 50 percent and 100 percent load.
2. Combustion emissions control shall be via Lean Burn NOx technology for NOx control and shall utilize an oxidation catalyst for Carbon monoxide and VOC/UHC.
3. Engine performance mapping system shall allow continuous, real-time thermodynamic modeling of engine generator for purposes of optimizing performance. Parameters to be monitored include:

    a. Inlet Dry Bulb and Wet Bulb Temperatures
    b. Turbo Inlet Air Pressure, downstream of the filters
    c. Exhaust Temperature
    d. Fuel Flow & Pressure
    e. Combustion Air Inlet Flow
    f. Exhaust Back Pressure

4. Inlet Air Filters

    a. Heavy-duty air cleaner with replaceable dry-filter element and "blocked filter" indicator.

5. Remote Cooling System

a. Closed loop, liquid cooled, with remote radiator and auxiliary coolant pump, heat exchanger, expansion tank and code required appurtenances.
b. Size of Radiator: Adequate to cool the engine all engine, generator and auxiliary system loads within the scope of the engine generator supplier for all load conditions defined herein.
c. Expansion Tank(s): Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equipped with gage glass and petcock. Expansion tank sized to contain expansion of total system coolant from cold start to 110 percent load condition
d. Fan: Driven by electric motor in compliance with the motor specifications defined herein.
e. Coolant: Solution of ethylene-glycol-based antifreeze and water, with anticorrosion additives as recommended by engine manufacturer. Solution concentration to be determined by Vendor based on site conditions and specified piping and cooler materials of construction.
f. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

6. Muffler/Silencer

a. Silencer to be sized by engine manufacturer coordinated with the general system layout provided in Exhibit B to not exceed engine manufacturer's engine backpressure requirements.

1) Sound level measured at a distance of 3 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

7. Lube Oil System

a. A Lubricating oil system shall be provided for the engine generators. Design of the lube oil system shall be per manufacturer’s standard, but shall include the following features as a minimum:

1) Main oil pump(s).
2) Pumps, filters and strainers shall be fail safe (i.e. pre-installed backups, ready for automatic or manual switchover or gravity fed rundown tanks).
3) A closed loop lube oil cooling system including heat exchanger and a roof-mounted air-cooled radiator. Heat exchangers shall include provisions for cleaning cooling water side
4) Integral lube oil tank.
5) Electric lube oil tank heater (as required).
6) Duplex lube oil filters with transfer valve and ability to shift to the standby filter during normal operation.
7) Demister system suitable for maintaining vent area free from oil collection.
8) Drip pan.
9) Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

10) Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature.

b. Vendor shall furnish lubrication oil, in required types and quantities, sufficient for:

1) Completion of initial lube oil flushing.
2) Additional required for initial operation.

c. Engine shall be equipped with external fresh and used oil connections including isolation valves and flanged connections to be provided by Vendor.
d. Vendor shall furnish necessary materials, containment, controls, and safety procedures (step-by-step) to address specific toxicity characteristics for any synthetic lubricants that are utilized in their systems.

8. Safety ladders, handrails, gratings, steps shall be provided for accessing components of the Vendor's package that require normal maintenance. All structural or support members shall be hot dipped galvanized.

B. Fuel System

1. A fuel system capable of operating on specified syngas fuel as detailed in Exhibit D shall be provided. The fuel system shall include all necessary components (control valves, instrumentation, etc.) to control and monitor fuel flow and pressure to the engine generator package. The unit control system shall automatically control and modulate fuel flow during start-up, shut down, and normal operation. All instrumentation and valves must be accessible and maintainable for maintenance and operation activities.
2. Fuel System shall include the following components, as a minimum:

a. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves.
b. Fuel Filters
c. Manual Fuel Shutoff Valves.
d. Flexible Fuel Connectors

C. Electric Generator

1. The electric generator shall be provided as an integral part of the engine generator set. Vendor is responsible for the delivery, performance, control, and technical field support of the generator.
2. Generator shall be 13,800 volts, 3 Phase, 0.80 power factor, 60 Hz, Totally Enclosed Water-to-Air Cooled (TEWAC), with Vendor-selected capacity based on machine output.
3. The generator shall be capable of operating in standalone, paralleling, synchronous, isochronous and droop mode.
4. The generator shall be rated for continuous (100 percent duty) operation, class F insulation, B-rated temperature rise, and meet the following requirements:

a. TEWAC enclosure rated for outdoor installation
b. Automatic voltage regulation, +/- 0.5 percent

c. Voltage adjustment of +/- 5 percent of rated voltage
d. Load regulation of +/-1 percent
e. Full load efficiency of 97 percent or better
f. Core losses not to exceed 100 KW
g. Sub transient reactance of 0.25 or less
h. Short circuit ratio of 0.43 +/- 5 percent
i. Six RTDs in stator winding for monitoring and protection by the Engine Control Panel. RTDs shall be redundant element type at each location or have redundant RTDs at each location.
j. Bearing RTDs for monitoring and protection by Engine Control Panel.
k. The generator shall be provided with a 2/3 winding pitch.

5. The unit grounding system will be a high resistance system.

   a. System components shall limit line-to-ground fault to 200 amperes at 8000 Volts line-to-ground.
   b. Provide non-corrosive steel grounding pads located at two opposite mounting legs.

6. Furnish a metal cubicle enclosing the generator neutral side terminals, with C400 current transformers with a minimum meter accuracy class of 0.3 at a burden of B-0.9 and a thermal overload rating of 1.5. Phase CT ratios shall be selected based on the generator maximum output current with a minimum rating of 1200:5. Wire the current transformer secondary connections to shorting type terminal blocks in an isolated terminal box on the rotating equipment baseplate. All CT leads shall be brought out to the shorting terminal block. Refer to Exhibit A for the required number of CT's.
7. Owner will supply wye ground-wye ground potential signals to the unit control panel for synchronization and control. Bus PT's and generator line PT's shall be supplied with the switchgear.
8. Furnish a metal cubicle enclosing the generator lineside terminals, lightning arresters and surge capacitors. The cubicle shall have adequate provisions for cable terminations to be furnished and installed by the Owner.
9. Both line and neutral terminations will be cable in conduit. The load side termination cabinet should be adequately sized to accommodate Class 1 terminations (3 x 750 KCMIL conductors per phase minimum).

D. Generator Control and Protection

1. Terminate current transformer leads at shorting type terminal blocks.
2. Provide FT-1 type test blocks for current and voltage inputs to the generator protective devices.
3. Wiring connections for current transformers within panels shall be #12 AWG red SIS type conductors and terminations shall utilize uninsulated ring tongue lugs.
4. Control power terminations should be terminated at pullout type fuse blocks.

E. Miscellaneous Electrical Equipment

1. Motors rated ¾ hp or greater shall be rated 460V, 3-phase, with TEFC enclosure and be non-overloading at the rated condition without using any portion of the service factor.
2. Provide all three phase motors with at least 1.15 service factor at 40 degrees C, continuous duty. Motor hp selection shall be based on a 1.0 service factor.
3. Motors rated ½ hp or less shall be rated 115V, 1-phase, with TEFC enclosure and be non-overloading at the rated condition without using any portion of the service factor.
4. Select motors for low starting current, designed for continuous duty to provide the running torque and pull in torque required to send the load. Maximum kVA starting code letter shall be Code G.
5. Motors shall meet or exceed NEMA Premium™ efficiency ratings.
6. Motors shall have copper windings and Class F or higher insulation but rated based on Class B temperature rise.
7. Motors controlled via variable frequency drives (VFD) shall be inverter duty rated with an insulation system that meets NEMA MG1 Part 31 and are suitable for operation with pulse width modulated variable speed drives.
8. Space heaters: Maintain windings a minimum of 5 to 10 degrees C above dew point during de-energized conditions. Space heaters shall be rated 240V AC and operated at 120V AC.
9. Motors shall be equipped with grease-lubricated, anti-friction ball or roller bearings with InproSeal bearing isolators on fan and drive end shaft extensions for IP56 protection. Bearings shall have an AFBMA L10 life of 100,000 hours or more. All bearings shall be constructed so as to prevent lubricant leakage into the motor under normal or excess lubrication. Permanently-lubricated bearings will not be acceptable. All ball or roller bearings shall be equipped with Alemite or Zerk grease and relief fittings. Grease points shall be readily accessible during normal equipment operation. Lubrication instructions shall be furnished with each motor.
10. Motor frame and end brackets shall be cast iron with non-sparking exterior fan and cast-iron guard. Lifting eyes shall be provided. Include brass drain and breather to ensure drainage from lowest point of motor.
11. Motors shall have cast iron conduit terminal boxes of adequate size to support proper termination of supply conductors selected in accordance with the NEC. Minimum size shall be two sizes larger than required by the National Electrical Code (NFPA 70), latest edition.
12. Direction of rotation shall be permanently marked on motor where motor is suitable for only one direction of rotation.
13. Motors shall have steel sole plates. Maximum allowable no load vibration shall be 0.10 inches per second. Vibration measurement points, capable of routine vibration data collection, shall be identified for all three axes of vibration. If permanent mounted vibration equipment is installed, local vibration monitoring points shall be provided.
14. Select motors for quiet operation. Motor sound power level when measured at a no-load condition shall not exceed 85 dBA when determined in accordance with IEEE Standard 85, latest edition.
15. Equipment (including motors) located within hazardous locations to meet or exceed requirements of NFPA 70 for the class and group of hazards in which the equipment is located.

F. Engine Generator Control System

1. General: The engine generator package shall be equipped with Vendor's standard computer-based control system including meters, gauges, alarms and controls, locally mounted in modular enclosure, suitable for interface with Owner's PCS and Owners Grid Control System (GCS) via hardwired and network connections. The GCS will dispatch the engine generator and the PCS will contain the historian/graphics packages. While the engine generator control system must include all functions required to operate and maintain the engine generator, it must also support integration with the PCS and GCS while minimizing the engineering and support effort to perform the initial integration as well as ongoing maintenance and modifications. Reference Exhibit C for the conceptual network architecture. The engine generator control system and its interface to the PCS/GCS should follow the guidelines below:

    a. Cyber Security: In response to the heightened state of threat awareness surrounding critical infrastructure, given the significant rise of cyber-attacks threatening utilities across the country, Owner seeks to formalize its approach to securing supervisory control systems utilizing reputable standards and frameworks from the National Institute of Standards and Technology (NIST). The NIST Risk Management Framework (RMF), as defined by the Special Publication 800-37 Standard, provides holistic means to quantify the response to risk from a cyber security perspective, and align countermeasures required to effectively reduce, transfer, or remove risk to key systems and critical assets across the industrial control system network (ICS). This extends to associated plant subsystems including the engine generator control system design to support the overall plant cyber security protection;

        1) Control systems shall follow guidelines from NIST 800-82 Rev 2 Controls which defines requirements for control equipment including operator terminals, PLC's and network components.
        2) Alternatively, a cybersecurity design that follows IEC 62443 in lieu of NIST is acceptable.
        3) Remote access to the engine generator controls shall subject to approval of Owner's cybersecurity team. Connectivity for remote monitoring shall be included with the control system, but it will be evaluated for compliance with cyber security requirements.
        4) Software patches or upgrades shall be vetted by an offline computer prior to upload to the engine generator control system.

    b. Interlocks: All safety and equipment protection interlocks are to be interfaced between the engine generator and GCS via individual hardwired I/O signals. All permissive/interlocks between systems shall be implemented with fail-safe design practices such that loss of circuit continuity will remove the permissive and result in the appropriate protective action.
    c. Load Control: Load control to the engine generator shall be via 4-20 mA isolated inputs to the GCS.
    d. Optimization: Various optimization control strategies may require interface between two or more vendor control systems (engine generator, Inlet Air, etc). Non-critical interfaces which support these control strategies shall be implemented utilizing data communication interface. Loss of connection of this interface shall not result in shutdown of the unit but may limit the operating mode of the unit.

e. Visualization: The engine generator control system shall include a data link that sends all signals necessary to remotely view/operate the engine generator control system from the PCS.
f. Alarms: The engine generator control system shall support monitoring of alarm conditions within the engine generator controller(s) by the PCS HMI. Access to engine generator control processors shall not negatively impact the throughput or latency of the engine generator controller communications with its I/O, the engine generator HMI(s) or the PCS controller(s). The vendor shall include a database listing of all engine generator alarm conditions including: Tag/Address, Description, Alarm State.
g. Historian: The engine generator control system shall support collection of data by the PCS historian. Access to engine generator control processors shall not negatively impact the throughput or latency of the engine generator controller communications with its I/O, the engine generator HMI(s) or the PCS controller(s).

2. The engine generator control system shall incorporate an individual panel mount display per engine generator (AB PanelView or equivalent) and a one common desk style computer for locating in the central control room as shown on the conceptual network diagram in Exhibit C.
3. Standard engine generator control screens shall include all normal operator functions, including setpoints, alarms, startup and shutdown control. Engineering interaction with the engine generator control system shall be accomplished through manufacturer's standard interface. GCS interface to the engine generator control system will include standard start-up / shutdown, summary alarm acknowledge, auto-synch permissive, MW / MVAR setpoints, raise / lower commands for speed / voltage, etc. First-out indication shall be included as part of the information provided on the control interface system.
4. Communications link shall be provided via Modbus TCP/IP (Cat 6) to the PCS to allow monitoring and control of equipment at either local control panels/stations or from the primary control room located in the main plant building.
5. The engine generator control system provided in the unit control panel for each of the engine generators shall include the following features as a minimum:

a. The controls system must support control of engine fuel and spark timing through an electronic engine control module to provide isochronous or droop speed control and enhanced performance from variable spark ignition timing and duration. The control module shall provide idle and rated speed settings; adjustable monitoring of vital engine parameters; timing control for load and fuel quality; integrated temperature sensing for cylinder exhaust port, turbocharger inlet/outlet, average for left and right cylinder banks; and adjustable air/fuel ratio control to account for humidity and atmospheric pressure. The control shall include oxygen sensor and detonation sensor.
b. The digital synchronizer and load share control unit internal to the generator control panel of each engine generator must support performing speed and phase matching, synchronizing, paralleling, load sensing, load control, and speed control for the associated generator. The control panel shall provide safe dead bus closure, true RMS power sensing, bumpless transfer, programmable breaker retry, adjustable ramps for loading and unloading, digital power factor control, process import/export control, digital tuning of alternator voltage output, and shall be easily programmable using a hand held programmer.

c. Complete control of engine generator Package, including normal start, automatic synchronization, normal stop, emergency stop, base load, load following and manual load changes. The Control System shall display parameters such as generator voltage, current, power, reactive power, frequency and kWh and status of all key auxiliary devices.
d. Non-resettable hour meter.
e. Automatic, load-following operation between 25 percent and 100 percent of engine generator output.
f. Complete vibration and bearing temperature monitoring.
g. Complete engine performance mapping system, including transducers, wiring, software, monitor and hardware. System shall allow real-time computation of engine generator heat rate, plus trending of compressor efficiency, and other key performance parameters.
h. Automatic synchronizing and closing of the generator circuit breaker control will be provided. Governor and Exciter shall accept raise/lower pulses from remote signals from Owner's GCS and manual controls.
    1) Synchroscope shall be provided in software.
i. KW load control input from load controller as a 4-20 mA signal.
j. KVAR/power factor control input from load controller as a 4-20 mA signal.
k. Electronic Voltage Regulator with Automatic/Manual Control.
l. Generator Metering
m. Integral data Historian capable of archiving and trending real time data from the engine generator for a minimum of 45 days. System shall include complete graphing trending ability. A listing of the data available to be archived shall be provided. Historical data shall also be made available to the PCS via a network connection, separate from the local HMI network, to support a pair of Owner-furnished redundant data servers.
n. In the event of a plant upset or trip, the Control System shall record the sequence in which the alarm signals were received ("first-out" capability), for later analysis and troubleshooting by plant personnel. Time stamps shall be 1msec accuracy minimum.
o. The plant will utilize a GPS based clock system. Engine generator controls and protective devices (as applicable) shall be provided with an IRIG-B clock signal input or a network PTP signal.

6. The engine generator unit control panel shall be designed to permit load control and monitoring by Owner's GCS The unit control panel shall accept the following commands from voltage-free relay contacts (or analog as noted) in the GCS:

    a. Engine Start/stop
    b. Raise/Lower Voltage
    c. Raise/Lower Power Output (4-20 mA from load controller in Auto; dry contacts in manual)
    d. Raise/Lower VAR's (or Power Factor) (4-20 mA from load controller in Auto; dry contacts in Manual)
    e. Emergency Shutdown
    f. Droop/Isochronous

7. The unit control panel shall provide, as a minimum, a Modbus TCP communication link to the PCS via CAT 6 link via access switches which conveys the following functions:

a. Unit Status (shutdown, starting, on-line, etc.)
b. Sensor Values (speeds, temperatures, pressures, vibration, flow, level, etc.)
c. Electrical Values (amps, volts, watts, frequency, VAR's, Power Factor)
d. Generator Circuit Breaker Status (closed/tripped)
e. Alarms and associated set points.
f. Shutdowns
g. Sensor Failures
h. Status of Auxiliaries

8. The unit control panel shall display on its HMI screens, as a minimum, the following parameters (signal source provided in parenthesis):

a. Exciter Amps (Exciter Comm. Link)
b. Exciter Volts (Exciter Comm. Link)
c. Generator MW Output (Engine Control Panel)
d. Generator Amps (Engine Control Panel)
e. Power Factor (Engine Control Panel)
f. Generator and Bus Frequency (Engine Control Panel, 4-20 mA Signal from Owner's Switchgear)
g. Generator Voltage (Engine Control Panel)
h. Bus Voltage (4-20 mA Signal from Owner's Switchgear)

9. The engine generator control system HMI's (Panel mount per engine generator and one common for control room) shall support a multi-level user security system (least privileges basis) per the following user group permissions guidelines:

a. Guest: View only access. Navigation to all process status windows.
b. Operator: Permissions to operate equipment, enter process set points, and acknowledge/reset alarms.
c. Maintenance: Permissions to tune control loops, calibrate instruments, modify process alarms, and modify process constraint parameters.
d. Engineer: Access to all process and machine parameters.
e. Admin: Edit control system, assign user access levels and security configuration.

10. Furnish also a separate overspeed shutdown device which shall, in case of predetermined overspeed condition, instantly stop the associated engine generator.

G. Tagging and Marking

1. Each major piece of equipment shall have a standard nameplate securely affixed showing the tag number; the name and address of the manufacturer; serial and model number; and such other information as the Vendor may consider necessary to complete the identification of the item.
2. Instrument and control valve tag numbering shall be based on ISA format (Unit + System + Function + Number + Train). Owner's engineer will define unit numbers for the equipment.
3. Provide nameplates for each instrument, transformer, light, meter, switch, control, terminal strip, panel mounted component (including fuses), fuse blocks, timers, relays, auxiliary relays, etc., in accordance with a nameplate schedule. Color coding shall be used for equipment and functional identification.

4. Nameplates shall be corrosion resistant metal for items exposed to process or other severe conditions or laminated two-ply plastic (white face to black core) with legend engraved to black core for items such as electrical and control panels which are not exposed to process conditions.
5. Characters shall be uniform block style not smaller than ½ inch (13mm) for switchgear sections, switching devices, and panelboards, and not smaller than ¼ inch (6mm) for instrument transformers, relays, alarms, instruments, and control devices.
6. Nameplates and tags shall be provided for all valves, steam traps and other equipment. Label all piping.
7. All items listed on the Bill of Materials shall be identified by assigned tag numbers and fully described by manufacturer, type and model numbers as applicable.
8. All engine generator parts, components, assemblies and items shall be clearly and permanently match-marked for field assembly and installation. The match-marks shall be marked by letters or numbers and shall be cross referenced to the shipping paper work and erection drawings and instructions.
9. Corrosion resistant metal nameplates shall be attached at easily accessible locations for all equipment and components. The name plates shall be stamped with the information required by the applicable Code and shall also include the Vendor's name, Vendor's serial number, and equipment tag number.

1.6 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Minimum Deflection: 1 inch.

B. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2. EXECUTION

1.1 FACTORY TESTS AND INSPECTIONS

A. Vendor shall provide factory testing of engine generator package(s) and all auxiliaries including certified test reports and witnessing of certain tests by Owner's representatives, as tabulated next page. Column headings are defined as:

1. "Witnessed Test" is a test conducted in manufacturer's factory, witnessed by Engineer or Owner's representative who shall neither participate, nor interfere with test. A certified test report will be provided by manufacturer. Travel costs associated with Engineer or Owner's representative attending the witnessed test will be Owner's responsibility. Vendor's proposal shall include details of all "Witness Tests", including location and duration of test.
2. "Certified non-Witnessed Test" is a test conducted in manufacturer's factory without Owner representative, but with a certified test report provided by manufacturer.

DESCRIPTION	WITNESSED TEST	CERTIFIED NON WITNESSED TEST
Full load string test of power output and fuel consumption	X	
Engine, gearbox and generator vibration/mechanical	X	
Functional test of complete engine-generator and controls package, including demonstration of PCS interface	X	
Generator test, IEEE 115		X
Auxiliary packaged equipment skids		X

B. Provide step-by-step test procedures including conditions required for testing, method of correcting performance to guarantee conditions, instrumentation required, calibration procedures, and acceptance criteria for Owner approval. All procedures shall be accepted by all parties prior to start of tests. Procedures shall be in accordance with ASME PTC 17 – Reciprocating Internal Combustion Engines Performance Test Code.

C. Vendor shall provide factory calibration records for all Vendor-furnished instruments prior to final acceptance tests as noted below:

1. Calibration (5 points, up and down scale for analog transmitters; for switches verify action 2 times for increasing and decreasing inputs) of all instrumentation required for both linearity and accuracy in accordance with standard industry practices or manufacturer's recommendations.
2. Test equipment accuracy shall be calibrated in accordance with the NIST, National Institute of Standards and Technology.
3. Field mounted instruments shall be bench calibrated and panel mounted instruments shall be calibrated in the panel.
4. Calibration and installation records shall be documented digitally and submitted with the final records with the following information provided:

    a. Equipment tag number
    b. Data component received
    c. Purchase order number and/or contract number
    d. Serial number
    e. Calibration data
    f. Date of calibration
    g. Person responsible for calibration
    h. Date component installed

1.2 PREPARATION FOR SHIPMENT

A. Vendor shall submit step-by-step procedures for the cleaning, preservation, packaging, handling, lifting, shipping, and storage of the material and equipment provided under this order.

B. If extended layup of equipment is required due to the Vendor's production schedule, Vendor shall provide a detailed procedure for preservation, along with a list of utility requirements.

C. Equipment and piping must be cleaned of all foreign material, dirt, scale, grease, oil, and chemical residues, etc., in accordance with the approved cleaning methods. Items will be inspected for compliance with approved cleaning step-by-step procedures. Items which are not immediately packaged or shipped must be protected from contamination until preservation or packing is complete.

D. Vendor shall provide all special tools for unloading, installation and maintenance of Vendor-furnished equipment. Special tools and handling equipment shall be packed separately and identified as included in the shipment. Spare gaskets shall not be bolted in place but shall be packed separately and identified. Loose clips and similar small structural items shall be packed separately, marked, tagged, and attached to larger pieces.

E. All exposed machinery surfaces (threads, flange faces, gasket sealing surfaces, etc.) shall be coated with an easily removable protective coating. All weld bevels of carbon or ferritic alloy steel piping or equipment components that are to be welded by others shall be coated on the inside and outside surfaces for a distance of three inches from the end of the component.

F. All flange openings shall be protected and made waterproof with bolted full size metal covers and gaskets. Flanges shall be furnished with one bolt for every other hole (minimum of four bolts). Threaded openings shall be plugged with threaded plugs of the same material as the connected part and sealed with PTFE tape thread sealant. Beveled and plain edge openings shall be suitably closed with solid metal wedge type connectors. Where required, based on the Vendor's production schedule, piping shall be filled with inert gas to prevent corrosion.

G. Piping shall not be designated as attachment points for lifting equipment.

H. All tagged items need to be identified with permanent stenciled metal tags or a material not subject to deterioration from outdoor storage.

1.3 INSTALLATION SUPERVISION

A. Proponents shall furnish a list of site assistance hours needed for each of the required milestones. Proponents shall include the site assistance hours as a line by line detailed list for each task.

B. Provide full time (10 hrs/day) field erection supervision for the duration of the tasks listed below by manufacturer's personnel. This erection shall include but not limited to:

1. Installation of Engine, Generator and other items shipped loose.
2. Alignment of generator and engine.
3. Installation of air filter module and inlet transition ducting.
4. Installation of engine/generator foundations and anchors.
5. Installation of lube oil and other auxiliary skids.
6. Installation of wiring and interconnects.
7. Cleaning, connecting, and sealing all parts of the engine generator package.
8. Electrical control and utility mechanical and fire system functional check-outs.

9. Installation of engine generator exhaust expansion joint and exhaust system ductwork.
10. Receiving, unloading and moving all major components into place on foundations.
11. Any items that affect the warranty of the unit.

C. Balancing of rotating equipment shall be accomplished prior to shipment. Field balancing shall only be performed with the written approval of the Owner and the Engineer.

1.4 COMMISSIONING AND STARTUP SUPERVISION

Vendor shall provide qualified field representative(s) in required disciplines to supervise the commissioning checks and initial startup of the engine generator package, including setting up and demonstration of controls, monitoring systems, performance/trending systems and auxiliaries in Vendor's supply, and interfaces with Owner's PCS. Proponents shall furnish a list of site assistance hours needed for each Commissioning and Startup activity.

1.5 FIELD TESTS AND ENGINEERING SUPPORT

A. The following Acceptance and Performance tests shall be performed in the field upon completion of the installation:

1. Functional test(s) for purposes of demonstrating that the equipment and systems function as designed, operate safely, reliably, and as part of an integrated plant system in accordance with good engineering practice. These tests shall include normal operations, such as startup, shutdown and load changes, as well as emergency operations, such as generator trip/overspeed and emergency coast down. Fully automatic start sequences shall be made repetitively (3 minimum) without manual control override, or failed start attempt.
2. Functional test shall also include one hour of operation each at 25 percent, 50 percent, 75 percent, and four hours at 100 percent load.
3. Performance test to demonstrate ability to maintain Guaranteed power and guaranteed fuel consumption. Guaranteed power and Guaranteed fuel consumption tests shall be conducted simultaneously.
4. Reliability test to demonstrate ability to continuously run for five days without alarm or trip events. No alarm or trip devices may be bypassed during this test without Owner's approval. The performance assessment may be conducted during the reliability test.
5. Performance tests shall be in accordance with the ASME Performance Test Code PTC17.
6. Tests shall be performed with permanently installed plant instrumentation unless such instrumentation is non-existent. Where special temporary instrumentation is required, Vendor shall furnish said instrumentation which shall be calibrated within one week before the tests, and the calibration sheets shall become part of the test documentation. No safety device (alarm or trip) shall be bypassed during or following the reliability tests.

B. At least 60 days prior to scheduled acceptance testing, the Vendor shall submit, for Owner's and Engineer's review, a complete acceptance test step-by-step procedure that defines

details such as protocol, type of tests, measurements to be taken, sample calculations and correction formulas, and responsible parties.

C. Provide all step-by-step procedures and supervision required for the acceptance tests. During testing, the plant shall be operated and maintained by Owner's operating personnel, the Owner's consultant or a third-party vendor.

D. An emissions test will be performed by Owner's consultant with Vendor's assistance. The emissions test will be designed to demonstrate and document satisfactory levels of air emissions in accordance with Vendor's guarantee and air permit limits at engine exhaust, before downstream emissions control equipment. Demonstrate and document satisfactory levels of air emissions in accordance with Vendor's guarantee and air permit limits at engine exhaust, before and after stack emissions control equipment.

E. Vendor shall provide engineering support of and coordination with the Owner and Owner's engineers for all tests.

1.6 TRAINING

A. Vendor shall provide training, at the Owner's facility, for the personnel listed herein so that the Owner can operate, maintain, change system configuration, and repair the complete system.

B. Training for operators shall be conducted to accommodate a multiple shift schedule.

C. Separate training sessions will be held for each of the following groups:

1. Engineers.
2. Plant Operators (Minimum of 4 sessions over three weeks).
3. Mechanical Maintenance Technicians (Minimum of 2 sessions).
4. Electrical/ Instrumentation Maintenance Technicians (Minimum of 2 sessions)

D. Prior to project closeout and field acceptance testing, provide training plan and schedule including the following information:

1. List of all classes/courses.
2. Description of course.
3. Duration of course.
4. Sequence of courses.

E. Provide competent, factory authorized personnel to provide instruction to O&M personnel. Include sufficient hours of training to provide complete training for operation and maintenance of the equipment and system.

F. Provide the name and resume of proposed instructor; instructor must have at least 5 years' experience teaching the designated course. Instructor's primary language must be English.

G. Provide training manual that includes, as a minimum, the following:

1. Course objective.
2. Course outline.
3. Theory of operation.
4. Case studies that demonstrate application, operation (including casualty control), troubleshooting, repair and maintenance of equipment.
5. Notes that supplement and enhance information provided in the manufacturer's operation and maintenance manuals.
6. Thorough review of applicable drawings, photos, tables, diagrams and schematics.

7. List of references for further independent study.

H. Owner reserves the right to require Vendor to repeat training classes if the objectives of such training are not met at the satisfaction of Owner. The costs of such required additional training sessions shall be borne by Vendor.

I. Owner reserves the right to video record the training sessions.

J. Overview training for all groups:

1. Course shall cover, as a minimum, the following topics for 15 to 20 persons:

    a. Thorough description of the engine generator equipment, interconnections, functions and capabilities.
    b. Review system terminology, abbreviations and acronyms.

K. Operator Training:

1. Operator-training course shall be conducted at times that accommodate a multiple shift schedule. A minimum of four eight-hour, on-site training sessions are required.
2. The course shall be an in-depth instruction on the engine generator and Package equipment.
3. The course shall enable the Owner's operators to be proficient in the following topics, as a minimum:

    a. Start-up, Normal Operation and shutdown of equipment.
    b. Response actions to equipment failures.
    c. Response to system alarms.
    d. Modifying and locating setpoints.
    e. Review interface to process control system.

L. Mechanical Maintenance Training:

1. Mechanical maintenance shall be conducted in two separate and identical sessions in order to train half of the workforce at one time.
2. The course shall be an in-depth instruction on the engine generator and Package equipment.
3. The course shall enable the Owner’s mechanical maintenance personnel to be proficient in the following topics, as a minimum:
    a. Response actions to mechanical equipment failures.
    b. Response to system alarms.
    c. Normal mechanical maintenance requirements and procedures for engine generator equipment.

M. Electrical/Instrumentation Maintenance Training

1. Electrical/Instrumentation maintenance shall be conducted in two separate and identical sessions in order to train half of the workforce at one time.
2. The course shall be an in-depth instruction on the engine generator and package equipment.
3. The course shall enable the Owner's electrical/instrumentation maintenance personnel to be proficient in the following topics, as a minimum:

    a. Start-up, normal operation and shutdown of control equipment.
    b. Response actions to hardware and software failures including restoration/reloading software on a new machine after equipment failure.
    c. Response to control system equipment alarms.
    d. Modifying and locating setpoints.
    e. Review interface to process control system.
    f. Control loop tuning concepts, strategies, and methods.
    g. Normal electrical/instrumentation maintenance requirements and procedures for engine generator equipment.

N. Provide certification in writing that this Training has been accomplished.

3. CODES AND STANDARDS

1.7 REFERENCED CODES AND STANDARDS

A. The equipment, materials and services furnished under this Specification shall meet or exceed the requirements of all applicable federal, state and local codes; standards and regulations; and the applicable codes, standards, and specifications of the following organizations:

1. AISC - American Institute of Steel Construction
2. AISI - American Iron and Steel Institute
3. ANSI - American National Standards Institute
4. ASME - American Society of Mechanical Engineers
5. ASTM - American Society for Testing and Materials
6. AWS - American Welding Society
7. EPA - Environmental Protection Agency
8. FM – Factory Mutual
9. FEMA – Federal Emergency Management Agency
10. IEC – International Electrotechnical Commission
11. IEEE – Institute of Electrical and Electronic Engineers
12. IRI – Industrial Risk Insurers
13. ISA – International Society of Automation
14. ISO – International Standards Organization
15. NEMA - National Electrical Manufacturers Association.
16. NETA – International Electrical Testing Association
17. NFPA - National Fire Protection Association
18. NIST - National Institute of Standards Technology
19. OSHA - Occupational Safety and Health Administration.

20. SAMA - Scientific Apparatus Makers Association
21. UL - Underwriters' Laboratories

B. The following documents shall form part of this Specification:

1. ANSI B16.5 - Pipe Flanges and Flanged Fittings
2. ASME B31.1 - Power Piping
3. ASME PTC 17 - Performance Test Code on Reciprocating Internal Combustion Engines
4. AWS D1.1 - Structural Welding Code
5. ISO 8528 – Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets (inclusive of all applicable sections/parts)
6. NESC – National Electric Safety Code
7. NFPA-70 - The National Electric Code (NEC)
8. NFPA 37 – Standard for the Installation and Use of Stationary Combustion Engines

C. While a number of applicable sections of the aforementioned codes and standards have been identified in sections of this Specification, the Vendor has the ultimate responsibility for the complete identification and execution of all applicable sections of the aforementioned codes and standards.

D. Unless otherwise stated, these codes, standards or material Specifications shall be the latest revisions, including all effective publications, supplements, addenda and editions, in effect at the issuance date of this document.

E. These codes and standards set forth the minimum requirements. These may be exceeded by the Vendor if, in its judgment and with Owner's acceptance, superior or more economical designs or materials are available.

F. The most severe requirements shall prevail in the event of conflict between requirements, Specifications and applicable and governing codes. All conflicts among the Codes, Specifications and/or purchase order and/or the contract shall be brought to the Owner's and Engineer's attention for written resolution prior to release for fabrication.

G. It is the Vendor's responsibility that all equipment and materials furnished and installed be in strict conformity with all current, applicable codes and regulations of the Commonwealth of Puerto Rico. Violations resulting from stipulations in the existing codes shall be corrected by the Vendor at its own expense.

H. The Vendor shall be responsible for obtaining copies and paying all costs of all applicable codes and regulations.

4. PROJECT APPLICATION

A. Puerto Rico Ports Authority (PRPA) is constructing a new power generating facility to furnish electrical power to the Luis Muñoz Marin International Airport (LMM) and other facilities on the PRPA property in San Juan, Puerto Rico. The engine generators will be installed in a new power generating facility to be constructed on the PRPA property. The engine generator stack will be routed through the building roof and terminate above the roof line.

B. The engine generators in this Specification will be part of a power generating facility power block which will include the engine generators, an energy storage device (battery or otherwise supplied by Owner) and a black start diesel generator (supplied by Owner). The engine generators will supply base power and the energy storage device will be used to address fluctuations in the power demand in island mode operation. There will be a GCS

(i.e. microgrid controller; supplied by Owner) which will control the generators within the power plant and a PCS (supplied by Owner) which will control miscellaneous balance of plant equipment and archive engine generators' alarm as specified herein. The engine generators shall have the capability of interfacing with the GCS. The GCS will provide a demand signal to the engine generators to modulate load to accommodate variations in electric demand. Due to the unpredictable nature of island operation, it is expected that the engines may operate at loads of 25 to 100 percent for limited durations as loads are brought online.

C. The power block as described above shall be capable of operating in an island mode to satisfy PRPA electric loads without dependency on the utility grid. The unit governor response time shall be compatible with this operation. Controls and operation of the engine generators working in synch with the GCS shall be suitable for normal operation in parallel with the Puerto Rico electric grid operated by PREPA/LUMA.

D. The engine generators will be mounted indoors. Combustion and ventilation air will be drawn through the building's exterior walls through wall louvers (by others). Combustion air will be ducted to the interface of the engine generator's filtration system. Engine and lube oil cooling to be provided by Vendor furnished radiators mounted on the roof of the engine room. Roof mounted cooler, heat exchangers, pumps, control valves, and associated instrumentation to be provided by Vendor. Interconnecting piping for cooling system to be provided by others based on material specifications and design details provided by the Vendor. Refer to Exhibit B for general arrangement of engine generators and associated equipment.

E. Based upon the anticipated power demand profiles for the facility, the targeted peak electrical production is 12,000 kW. The design intent of the plant is to install syngas-fueled engines meeting the required capacity of 12,000 kW, with one engine generator installed as backup. One 2,000 kW additional diesel fuel-powered engine generator will be included in the facility for black start and grid stability during island operation.

The engine generators shall be capable of sustained operation with fuel consisting of a propane-air mixture known herein as "SYNGAS". Vendor shall specify required gas pressure and quality to the engine generator package. Copies of existing fuel analyses are included as Exhibit D.

If applicable, engine generator Vendor shall provide a proposal alternate price for an oversized generator which would allow the engine to be modified at a later date to operate on natural gas, with full output capability.

F. Asbestos, polychlorinated biphenyls (PCBs) and lead-based paint shall not be used anywhere in the equipment supplied by Vendor, including sub-vendors. Use of ceramic fiber shall be noted where used. Vendor shall comply with all Federal and local environmental regulations regarding the use of materials. Vendors are encouraged to use sustainable materials and reduce maintenance materials where possible.

G. Instrument Air will be available from the owner at 125 psig Maximum; 80 psig Minimum pressure.

H. The engine generator shall be started via compressed air, battery power, or an approved alternative. Engine starting equipment to be supplied by the vendor.

I. Site ambient conditions and other design criteria are shown in Attachment E of the **RFP 23J-09392.**

5. WARRANTY

Equipment to be warranted for two (2) year warranty from date of initial start-up of the system. Warranty shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Submittals received without written warranties as specified will be rejected in their entirety.

6. SEQUENCING AND SCHEDULING

A. Prerequisite Activities and Lead Times: Do not start following key project activities until prerequisite activities and lead times listed below have been completed and satisfied.

B. Shop Drawing Reviews by Engineer:
   1. Prerequisite: Engineer acceptance of schedule of values and progress schedule.
   2. PLC and HMI Software Development Prerequisite: PLC and HMI coordination meetings (Minimum of 2) with the Owner, Vendor, and Engineer.

C. Factory Test Prerequisite:
   1. Associated test procedures submittals completed.
   2. PLC and HMI Software Meeting 1 completed.
   3. PLC and HMI Application (Draft) Software Shop Drawings approved.
   4. PLC and HMI Software Meeting 2 is completed.

D. Training Prerequisite: Associated Training Plan Submittal is completed and approved.

E. PLC and HMI Configuration Training Session 1 Prerequisite:
   1. PLC and HMI Software shop drawings approved.
   2. Factory Demonstration Test (FDT) is completed.

F. New Control Panel Shipped to the Site: General Prerequisites:
   1. Approval of Vendor shop drawings and preliminary operation and maintenance data.
   2. FDT completed.

G. PLC and HMI Applications Software Installation Prerequisite:
   1. PLC an HMI software shop drawings approved.
   2. FDT completed.

H. Performance Test Prerequisite:
   1. FDT completed.
   2. Control panel shipped to and installed at site.
   3. PLC and HMI applications software installation complete.
   4. FDT completed and facility started up.

7. VENDOR COORDINATION MEETINGS

1. Vendor Schedule Coordination Meeting:
   a. Timing: Following Engineer review of Vendor schedule. Schedule includes submittals, factory testing, shipment of equipment, field testing & start-up, and training.

b. Purpose: Discuss Owner's and Engineer's comments and resolve scheduling issues.

2. Startup and Training Coordination Meeting:
   a. Timing: Following Owner and Engineer review of preliminary testing and training plan submittals.
   b. Purpose:
      1) Startup and test planning.
      2) Resolve required changes to proposed training plan.
      3) Identify specific Owner personnel to attend training.
3. PLC and HMI Software Design (Programming) Meetings:
   a. Two meetings minimum are required. Specific meeting dates will be established in the progress schedule.
   b. Attended By: Engineer, Owner, and Vendor
      Purpose:
      1) PLC and HMI Software Design Meeting 1: Review and discuss the Applications Software (programming) Draft submittal which includes the Control Panel preliminary OIU graphics, PLC control narratives, and HMI graphics.
      2) PLC and HMI Software Design Meeting 2: Review and discuss the Applications Software (programming) submittal prior to the FDT.

8. DOCUMENTATION

A. Submittal Drawings and Catalog Data:
   1. Refer to Exhibit E for a tabulation of the required submittals for this scope of work.
   2. Failure to comply with the submittal requirements defined herein, shall not be justification for schedule delays or change orders.
   3. Submittals will be submitted only by Vendor. Indicate by signed stamp that Documents have been checked, that the work shown in the submittals is in accordance with Purchase Order and/or Contract requirements, and that dimensions and relationship with work of other trades have been checked. Submittals submitted for review that have not been checked and signed by Vendor will be returned for checking before being considered by the Engineer.
   4. All documents, drawings, and data submitted shall be in the English language, with all dimensions in USCS (United States Customary System) units.
   5. Include indication, via highlighting or other means, any information relevant to the particular equipment or materials to be furnished where product data published by the manufacturer is part of submittal.
   6. Provide documentation of compliance with manufacturer's published literature or drawings or letter signed by an officer of manufacturer in cases where compliance with UL, FM, IRI, or other similar organization standards are required.
   7. Furnish submittal schedule with proposal.
   8. Include identifying symbols, tag names, and equipment numbers a defined in the Tagging and Marking requirements within to allow for full integration with the installation design documents for all equipment and material submitted.
   9. Submit requested submittals complete by types of equipment labeled with applicable specification section(s) included. Each submittal will be handled separately. Should any item not be acceptable, the entire submittal will be returned to Vendor for correction and resubmittal. Partial submittals will not be acceptable. The intent of this requirement is that all approved bound sets of data will be identical and will contain only acceptable information.

10. Submit a compliance sheet for each submittal indicating the submittal is in full compliance with the drawings and Specifications. Indicate by drawing number or specification section number and paragraph numbers all exceptions taken and include an explanation.
11. The review of submittals does not relieve or modify Vendor's responsibility for compliance with design documents or dimensions or errors contained in the submittal or quantity count. It is clearly understood that noting of some discrepancies but not identifying others does not grant Vendor permission to proceed in error. Regardless of any information contained in the submittals, design documents govern the work and are neither waived nor suspended in any way by the review of the submittals.
12. A minimum review period of two weeks, exclusive of transmittal time, will be required in the Engineer's office for each submittal. Take this time period into consideration when scheduling work.
13. Include in submittals sufficient plans, elevations, sections, performance data, dimensions, bolt locations, ratings, sound data, weights and schematics to clearly describe the equipment and to show compliance with these Specifications. Provide a cover or title sheet for the submittal containing the following:

    a. Name of Vendor originating the submittal.
    b. Name of project for which the submittal is made.
    c. An index of all items submitted including:
        1) Mark of equipment on drawings.
        2) Manufacturer.
        3) Catalog number.
        4) Specific section number.
        5) Date of submittal and date of each revision.
        6) Vendor’s certification of review.
        7) Vender’s certification of compliance.

14. Drawings and data which do not comply with specified requirements will be returned for resubmittal. One copy will be returned to Vendor marked FURNISH AS SUBMITTED, FURNISH AS CORRECTED, REVISE AND RESUBMIT or REJECTED. If it is marked FURNISH AS SUBMITTED or FURNISH AS CORRECTED, no additional submittal is required. If it is marked REVISE AND RESUBMIT or REJECTED, repeat the submittal in accordance with this section. It is intended that Vendor submit complete and accurate shop drawings and product data at the first submittal.
15. If the drawing or product data marked FURNISH AS SUBMITTED or FURNISH AS CORRECTED is altered for any reason after it has been stamped, the REVIEWED stamp shall automatically be voided.
16. Provide all work in accordance with the submittals stamped FURNISH AS SUBMITTED or FURNISH AS CORRECTED in as much as they are in agreement with design documents. Where differences occur between the submittals and design documents, design documents shall govern the work.
17. The following additional submittal requirements shall be met:

    a. Each submitted drawing and document shall include the following Owner project identification:
        CLIENT NAME/PROJECT NAME/NUMBER
    b. The data, documents, drawings, SAMA logic diagrams, and manuals shall be submitted in digital form for each review cycle, except for the final

approved/certified drawings which shall be submitted in hard copy form as part of the O&M documentation as specified below.

c. The digital form shall be in software compatible with industry standards (Excel, Word, AutoCAD, 3D AutoCAD, CADWORKS, etc.). If proprietary software is utilized, necessary viewing software shall be furnished by the Vendor.

d. Minimum size for hard copy drawings is 11" x 17" and must be clear and fully reproducible. Larger sizes are acceptable but must be folded to 8-1/2" x 11" for binding in the O&M manuals. Cut sheets, product data, specifications, and narratives may be 8-1/2" x 11".

e. All "Certified Final" reference data/drawings submitted after the order shall be provided on hard drives, USB, or other approved media, in addition to the stated hard copies. Files may be delivered via cloud-based host with secure access.

f. Include Vendor's certificate that products meet or exceed specified requirements.

18. Final Submittal: In addition to the number of copies of shop drawings and product data required to review submittals, maintain separate file of final reviewed copies of such material. Deliver approved submittals in hardback binder for Owner's use. Incorporate changes and revisions made throughout construction period.

B. Operation and Maintenance Manuals

1. Vendor shall provide six (6) hard copy sets of operations and maintenance manuals for all equipment and auxiliaries provided and an electronic pdf copy on two (2) hard drives or USB. Cloud based documentation hosted by the engine generator manufacturer is encouraged when live updates to the manuals are anticipated.

2. Organize binders to contain similar equipment such as piping, valves, transmitters, terminal boxes, sight glasses, relief valves, etc., in separate divisions. Provide a complete double index for each binder to include:

   a. An alphabetized list of the products by name.

   b. An alphabetized list of manufacturers whose products have been incorporated in the work, together with their addresses and the name, addresses and telephone numbers of the local sales representative or Vendor.

3. For each section of product, equipment or system, organize the data as follows:

   a. Furnish a general description of the equipment or system listing the major components, intended service and other general data.

   b. Furnish technical data including nameplate data (on a separate excel file), design parameters, normal operating bands, ratings, capacity, performance data, operating curves, etc. Clearly distinguish between information which does and does not apply.

   c. List warnings and cautions to be observed during both installation and operations.

   d. Provide fully detailed installation and operation instructions including special tools required, alignment instructions, start up and shut down sequences, emergency and casualty step-by-step procedures, and extended lay-up step-by-step procedures.

e. Furnish maintenance, service and repair instructions including maintenance and service schedules, materials, and methods for performing routine and annual service.
f. Furnish a cause and effects matrix where the 'Cause' is in a row which reflects a process change, the 'Effect' is in the column that reflects a process action, and the 'Intersection' is marked to show the cause/effect relation.
g. Furnish a troubleshooting guide and check list indicating common failures, test methods and procedures for determining component fault or failure.
h. Furnish a spare parts list indicating part and order number with name, address, and telephone number of Vendor. Include current prices of replacement parts and supplies.
i. Furnish diagrams including controls, wiring, installation and operation of the equipment or system.
j. HMI Graphics screens (complete - listing and color screen shots)
k. Furnish cyber security controls procedure/methodology as to how the system is protected from cyber-attacks during production and how software upgrades are implemented post installation for future upgrades.
l. Furnish list of all set points, interlocks, alarms and trip points in MS EXCEL file format.
m. Furnish copies of all final approved submittal drawings and documents.
n. Furnish all warranties and guarantees.

C. Routine Maintenance Schedule, Parts & Service

1. Provide a complete schedule of normally required inspection, preventative maintenance, predictive maintenance, and overhaul tasks and the outage hours required for all the equipment supplied under the purchase order and/or contract, plus replacement parts associated with each task. Provide inspection and maintenance plan required to support the minimum on-line availability specified herein. List requirements by year with a list of recommended spare parts for each through one entire cycle. Spare parts list shall consist of total/in-service quantity, recommended spare quantities, lead times and criticality factor.
2. Submit a line item pricing (proposal alternate) for recommended spare parts for 2 years of normal operation, including expendables, beyond first year of operation.
3. Submit an itemized list and pricing (proposal alternate) for all required tools including any special lifting fixtures to support on-site maintenance of engine generator Package(s).
4. Submit itemized pricing (proposal alternate) for Long Term Service Agreement (LTSA). Service agreement term to be 5 years or to first major overhaul, whichever is greater.
5. For each inspection, preventative maintenance and overhaul task, list the following:

    a. Tools required
    b. Materials required
    c. Associated warnings and cautions
    d. Initial system conditions required
    e. Procedure (step-by-step)

D. Software

1. Provide a minimum of 3 licenses/copies of all proprietary software required for installation, testing, tuning, and operation of the equipment, instrumentation, and/or protective devices.
2. For any instrument or component which must be connected to a computer for testing, tuning, or programming and utilizes a proprietary cable, provide a minimum of two cables to the Owner.
3. Provide software patches and revisions (versions) during the LTSA term.

9. QUALITY ASSURANCE

A. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified.

B. The Vendor shall have in place a complete and functioning comprehensive Quality Assurance program covering the design, procurement, fabrication, packaging and delivery of the specified equipment and materials. This program shall ensure that the equipment and materials furnished by the Vendor meet the requirements of this Specification as well as the Vendor's own procedures (step-by-step) and processes.

C. It shall be the Vendor's responsibility to ensure that the Vendors, and Sub-vendors meet the intent of this requirement and are able to demonstrate their compliance.

D. Owner or its representative shall be given opportunity to witness all testing.

E. The Owner reserves the right to reject equipment and or components which require major modification or alteration to meet Specifications.

F. Non-conformances to this Specification and major equipment or component repairs that occur shall be documented and approved by the Owner in writing prior to testing and shipment.

G. Software Quality Assurance (SQA):

1. Establish an SQA plan that addresses software tests normally performed by programmers and tests performed to verify system operation.
2. Perform software tests to benchmark functional evaluations, including the following:

    a. Conformance to specification.
    b. Language deviation.
    c. Error handling.
    d. Operational speed.
    e. Maintain a software error log to record occurrence, solution, and corrected resolution.
    f. Provide software programming as required to perform functions as specified. Provide annotations in the programming describing functions and changes such that the Owner and others in the future can understand the logic so that changes can be readily made.
    g. Provide software licensed to the Owner in perpetuity.

EXHIBITS

Exhibit A: Performance Tables

Proponents shall furnish the performance data and utility requirements summarized in the following tables. In addition, Vendor shall provide a set of performance correction curves illustrating the impacts on engine generator net power output and net heat rate of the following parameters as a minimum:

- Ambient temperature
- Ambient relative humidity
- Intake pressure drop
- Exhaust backpressure
- Any other relevant parameters specific to Vendor's equipment

Proponents shall also furnish voltage and frequency versus time curves as summarized in the following tables. Curves shall be provided for both a single islanded engine generator at normal operating temperatures as well as two engine generators operating in parallel

As an alternative, Vendor may furnish performance software (or access to Vendor's online software) which allows for calculation of unit performance corrections for parameters noted above.

Note: Proponents **shall submit completed performance data sheets for the proposed engine generator.**

Exhibit B: CEP Plant General Arrangement Drawings

Exhibit C: Conceptual Network Architecture Diagram

Exhibit D: Fuel Sample Analysis

NAME	METHOD	UNIT	RESULT
Natural gas analysis	GPA 2261		
Hydrogen		mol %	<0.01
Oxygen		mol %	11.94
Nitrogen		mol %	38.94
Carbon Dioxide		mol %	0.09
Methane		mol %	0.92
Ethane		mol %	0.40
Propane		mol %	46.99
Isobutane		mol %	0.34
N-Butane		mol %	0.25
Isopentane		mol %	0.01
N-Pentane		mol %	0.01
Hexanes Plus		mol %	0.11
Hydrogen Sulfide		mol %	<0.10
Total		mol %	100.00
Relative Density		-	1.25689
Compressibility Factor		-	0.99443
Gross Heating Value (Real)		Btu/CF	1224.3
Net Heating Value (Real)		Btu/CF	1126.3
Pressure Base		psi	14.696
Molecular Weight		#/#-mol	36.2

Exhibit E: Submittal Requirements