

SECTION 16610

ENGINE-GENERATOR, FUEL AND CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. Provide diesel engine-generator sets of the latest commercial type and design, with controls and all accessories necessary for a complete installation.
- B. The quality of the material, method of manufacture, handling and shipping shall insure the finished product has the properties herein as specified.
- C. The finished unit shall comply in all respects with all applicable trade standards and all federal, state, county and municipal ordinances, rules and regulations, including compliance with noise criteria, emissions requirements, and seismic zoning.
- D. Contractor shall be responsible for obtaining and paying for all permits and licenses for operation, including those required by any local pollution control district or commission. The permits and licenses are to cover at least the entire period of construction and the first year of operation.
- E. All equipment shall be new, of current production of a national firm, which manufactures and packages the diesel engine-generator set as a unit. The manufacturer/packager together with its authorized representative shall have full responsibility for the performance of the diesel engine-generator set, control, equipment and its accessories.
- F. The terms "generator," "generator set" or similar terms refer to a packaged assembly consisting of the diesel engine-generator set, controls, instrumentation and all accessories (i.e. radiator, silencer, batteries, charger and fuel sub-base tank) for a complete automatic-start, standby power generator system, exclusive of the generator transfer ATS.

1.2 REFERENCE CODES AND STANDARDS

- A. All Equipment, material, work, and testing supplied shall be in accordance with the latest edition and amendments of all applicable standards, codes, laws and regulations listed below:
 - 1. American National Standards Institute (ANSI)
 - 2. National Electrical Code (NEC)
 - 3. National Fire Protection Association (NFPA)
 - 4. Underwriters Laboratory, Inc. (UL)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. National Electrical Manufacturers Association (NEMA)
 - 7. American Society of Mechanical Engineers (ASME), B-16.5, Steel pipe flanges and Flanged fittings

8. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
9. ASHRAE handbook, HVAC Applications, Chapter 42, "Sound and Vibration Control"
10. American Society of Testing and Materials (ASTM), D975 - Specification for Diesel Fuel
11. Federal, State, and Local codes and Laws

1.3 COMPLIANCE REVIEW

- A. Bidders will provide a Compliance Review of the specifications and addenda. The Compliance Review shall be a paragraph-by-paragraph review of the specifications with the following information; "C", "D", or "E" marked in the margin of the original specification and any subsequent addenda.
 1. "C": COMPLY with no exceptions.
 2. "D": COMPLY with deviations; provide a numbered footnote with reasons for the proposed deviation and how the intent of the specification can be satisfied.
 3. "E": EXCEPTION, do not comply. For every exception, provide a Numbered footnote with reasons and possible alternatives.

1.4 DEFINITIONS

- A. "Manufacturer", "Vendor" or "Supplier": the firm or entity furnishing equipment specified.
- B. "Installing Contractor": the firm or entity under contract to Jackson County who will install the equipment furnished by the Vendor.
- C. "Provide": furnish and install, complete and ready for operation.
- D. "Furnish": supply and deliver to jobsite in new and undamaged condition.
- E. "Install": receive, mount, connect, and test, complete and ready for operation.

1.5 DELIVERY, STORAGE AND HANDLING

- A. The generator set manufacturer shall at all times protect the generator set from adverse environmental conditions during manufacturing, factory testing, storage and shipping. Deliver the Engine-Generator set and system components to their final locations in weatherproof protective wrappings, containers and other protection to prevent damage from construction operations. Generator shall be shipped via direct carrier to the job site.

1.6 BASIS OF DESIGN

- A. The mounting details, coolant and exhaust piping connections, and electrical connections, controls and interlocks shown on the drawings and described in this specification for generator set, and ancillary items are based upon the dimensions and installation details of one acceptable brand of each piece of equipment.

- B. Without additional cost to Jackson County, the Vendor of the generator system equipment shall provide additional mounting hardware, connections, valves, controls and interlocks as required for proper installation and operation of the equipment provided.

1.7 RELATED WORK SPECIFIED ELSEWHERE

- A. Furnished and/or installed under other Divisions or Sections:
 - 1. Setting of generator circuit breaker.
 - 2. AC feeds to the generator breaker.

1.8 OPERATING ENVIRONMENT

- A. The equipment shall be designed and rated for installation at 1000 feet above sea level with a maximum ambient temperature of 122 °F and a minimum of minus 20 °F. Vendors shall provide de-rating curves up to 12,000 MSL (mean sea level).

1.9 QUALITY ASSURANCE

- A. Manufacturer: The complete system(s) shall be engineered, fabricated, tested, delivered, and warranted by one source. Manufacturer of the Engine-Generator set shall be responsible for the entire system.
- B. Vendor Qualifications: The vendor shall be an authorized factory distributor with the engine-generator set manufacturer. The vendor shall have a complete set of parts and service availability with the factory certified technician and mechanics available 24 hours per day, 7 days per week. The vendor shall provide the name, address, and phone numbers of the nearest agency that will provide normal and emergency service.

1.10 RATING

- A. Ratings shall be based on the operating environment conditions specified.
- B. The rating of the standby diesel engine-generator set shall be based on operation of the set when equipped with all operating accessories such as radiator fan, exhaust silencer, air cleaners, lubricating oil pump, fuel pump, jacket water pump, governor, charging generator, etc.
- C. The engine-generator set shall be capable of accepting 100% of rated load at 0.8-power factor, lagging, continuously during power failure conditions. The output voltage shall be 277/480 volts, 3 phase, 4 wire, wye, 60 Hz.
- D. Unless stated otherwise, performance criteria are based on the continuous standby rating.
- E. Provide the necessary controls and accessories to the extent that this equipment, in conjunction with the diesel fueled engine-alternator set, will comprise a complete operating package for installation at 1000 feet above sea level in an ambient temperature of 110°F maximum, minus 10°F minimum. Capacity ratings shall take into account all environmental factors listed above.

1.11 SUBMITTAL DOCUMENTS AND SHOP DRAWINGS

- A. Furnish with the submittal data in PDF format.

Engine-Generator, Fuel and Control Equipment

- B. Computer generated dimensioned installation drawings of the generator set being provided, including weight and rigging information, floor plan arrangement showing anchoring details, clearances, accessory locations, elevation views and sections. Indicate the locations of all piping connections, stub-up locations, electrical and control connections, pumps, heaters, valves, gauges, etc.
- C. Piping and Instrumentation Drawings (P&ID's) for the generator assembly. P&ID's shall include instruments for control and indication, all valves, the basic control loops, drains, vents, backflow prevention, fill and sampling system connections, and connections to interconnecting fluid systems for makeup, overflow, recirculation, etc. The P&ID's shall enable one to quickly determine the overall system arrangement, interconnection, and operation of the major items of mechanical equipment.
- D. Literature describing the diesel engine-generator set, indicating its current production status.
- E. Drawings and/or literature describing auxiliary equipment to be furnished.
- F. The following engine-generator data in tabular form:
 - 1. Make of engine.
 - 2. Number of cylinders.
 - 3. BMEP at rated kW output.
 - 4. Make and type of generator.
 - 5. Generator electrical rating, kVA and kW at 0.8 pf lagging.
 - 6. Exciter type.
 - 7. Generator insulation class and temperature rise.
 - 8. Combustion air requirements.
 - 9. Exhaust flow and maximum allowable backpressure.
 - 10. Radiator and alternator ventilation CFM air requirements at maximum rated ambient air temperature static pressure and allowable external static pressure drop.
 - 11. Radiated heat.
 - 12. Maximum break horsepower (BHP) at rated rpm.
 - 13. Generator sub-transient reactance.
 - 14. Generator synchronous reactance.
 - 15. Generator zero-sequence reactance.
 - 16. Engine manufacturer's certified engine BHP curve and certified diesel engine-generator set fuel consumption curve.
 - 17. Lubrication requirements and recommended products.

18. Fuel requirements including fuel line sizes and recommended products.
 19. Shipping and net weight of diesel engine-generator package.
 20. Type of fuel injector system.
 21. Harmonic analysis.
 22. Certified engine horsepower curves.
 23. Type of governor system.
 24. Type of starting system.
 25. Generator Control Panel.
- G. A schematic diagram of control and alarm circuits, including potential and current transformer circuits.
- H. Complete wiring diagrams, including all field-wiring connections between the generator, transfer ATS and other remote devices.
- I. Material and component lists with component manufacturer and catalog number, including types of meters and engine gauges.
- J. Physical dimensions and construction details of the equipment.

1.12 INSTALLATION WIRING DRAWINGS

- A. In addition to the record submittal documents, the generator set manufacturer/supplier shall prepare for the Contractor's use and submit to the Engineer for review, equipment wiring single line drawings showing all control and power conductors required to or between each item of equipment in the generator plant. This drawing shall detail the quantity, type and size of each conductor required for the installation of the generator set, jacket water heater, chargers, pumps and annunciators. Installation wiring drawings shall be submitted along with the record submittal documents.

1.13 CLOSE-OUT DOCUMENTATION

- A. PDF format of the following shall be furnished:
1. "As built" drawings.
 2. Operating manuals and maintenance instructions.
 3. Illustrated parts books covering the diesel engine-generator.
 4. Auxiliary equipment manuals for equipment that will require operating instructions and periodic maintenance.
 5. Final shop drawings of all equipment.
 6. Certification equipment has not been exposed to adverse environmental conditions.
 7. Factory and field-test reports and calibration data.

8. Provide items indicated in close-out documentation in PDF format.

1.14 WARRANTY

- A. The manufacturer/supplier shall guarantee the complete generator set against defects in workmanship and material for two (5) years from date of final acceptance. The warranty shall be comprehensive and cover all components, wiring, and performance of the generator set. Multiple warranties for individual components (e.g., engine, alternator, controls, etc.) are unacceptable. Diminishing component count warranties or warranties that exclude parts or labor after a fraction of the warranting time are not acceptable. Satisfactory warranty documents shall be provided. The manufacturer/supplier shall guarantee consistency in materials, components, assembly, and workmanship.
- B. Warranty begins at successful completion of the on-site live load test.
- C. 1st year Preventive Maintenance Service shall be included.

1.15 TRAINING

- A. The engine-generator supplier shall provide on-site training for the units installed along with all accessory equipment. The training shall include operation and maintenance functions as required for the units installed. Training time shall be separate from start-up and testing time and not be less than 8 hours.

1.16 STARTUP

- A. The engine-generator supplier shall provide complete startup service, including technicians, load banks, cables, instruments and documentation.
- B. Coordinate startup of the generator set with startup and testing of the generator transfer switchgear.
- C. Provide service, exclusive of other start-up duties, for the verification of alarms to Jackson County's remote monitoring system and commissioning.

1.17 OPERATION AND MAINTENANCE MANUALS

- A. The manufacturer/supplier shall provide PDF format of Operating and Maintenance Manuals. Manuals shall be indexed with tabular pages. All manufacturers' printed literature enclosed shall be original or clearly legible copies. Manuals shall include:
 1. System description and drawings (shop drawings where applicable).
 2. Sequence of operation, operating instruction and recommendations, customized to configuration of this project.
 3. Maintenance instructions, including recommendations for oil type, fluid and filter change frequency, oil sampling, or other factory-recommended routine and preventive maintenance.
 4. Parts list.
 5. Descriptive literature.

6. Location and telephone numbers of authorized service agent.
7. Copies of all test reports and certifications required elsewhere in this Specification.
8. Letter of Warranties for all equipment furnished.
9. Provide items indicated for O&M manuals in PDF format.

1.18 CONTENT OF VENDOR'S PROPOSAL

- A. Vendor's proposal shall include all requested pricing, including base bid price, alternate prices where alternates are requested, and any elective alternates proposed by the Vendor.
- B. Technical data and bill of materials shall be submitted with proposal indicating equipment to be furnished.
- C. Data shall include approximate dimensions, performance data including fuel consumption, emissions, and noise data.
- D. Information provided with proposal shall be in sufficient detail to indicate compliance with Specification and Drawings, that equipment will fit in the designated space, and that equipment proposed would properly interface with other components such as ATS or switchgear, emission components, air supply, and other site conditions.
- E. The proposal shall state the delivery date of the equipment at the site.
- F. The proposal shall clearly state any exceptions to the requirements as specified.
- G. Proposal shall include regular time rates and overtime rates for engine technicians and load bank technicians.

PART 2 - PRODUCTS

2.1 MANUFACTURER AND SUPPLIER

- A. The engine-generator shall be manufactured by:
 1. Caterpillar
 2. Cummins-Onan
 3. Kohler.
- B. All equipment furnished shall be the responsibility of the engine-generator manufacturer/supplier.
- C. The manufacturer/supplier shall review the fuel supply piping arrangement and verify fuel flow and pressure will be adequate at the engine to support full load of the engine.

2.2 ENGINE

- A. The engine shall be a compression ignition type, four (4) stroke/cycle, fuel injected engine. The engine may be naturally aspirated or pressure-charge.
- B. Certified engine horsepower curves shall be submitted showing the manufacturer's approval of the engine rating for generator standby power application based on actual testing of a similar package. Special ratings or "maximum" ratings will not be acceptable. Allow for power required to drive radiator fan sized for external pressure drop, as well as other engine-driven accessories.
- C. The engine speed shall not exceed 1800 RPM at normal full load operation. Harmful torsion stresses or vibration shall not occur from 0 to 125% of rated speed.
- D. Fuel Systems
 - 1. The engine shall be capable of satisfactory performance on a commercial grade of distilled petroleum fuel oil such as No. 2 diesel fuel conforming to American Society for Testing and Materials (ASTM) Standard D975.
 - 2. The engine driven fuel pump shall be high-lift type, capable of 6 ft. of lift, and for drawing adequate fuel from sub-base tank, including losses through the fuel filters and valves. Note that that the engine mounted fuel pump is to draw directly from the saddle tank beneath the generator skid base.
 - 3. The engine mounted fuel filters shall include a replaceable element fuel filter conveniently located for servicing and rated for water separation.
 - 4. Wire-reinforced flexible fuel lines shall be furnished for each fuel connection to the engine. The flexible fuel lines shall be AEROQUIP or equal. All flexible fuel lines shall be a maximum 4-feet, 0-inches in length.
- E. Governor:
 - 1. An electronic governor shall govern the engine speed, to maintain governed speed at precise isochronous control for rated frequency operation.
 - 2. Generator shall support and shall be compatible to support existing Jackson County UPS's.
 - 3. The frequency at any constant load, including no load, shall remain within a steady state bandwidth of +/-0.25% of rated frequency.
 - 4. Transient: 8% maximum frequency dip on block loading of 100% unit rating with a maximum 6-second recovery time.
 - 5. Governor shall be provided with the generator set.
 - 6. Overspeed shutdown; the engine shall be equipped with overspeed shutdown and shall positively operate when the engine exceeds 2200 RPM.
- F. Lubrication:
 - 1. The engine shall have a gear-type lubrication oil pump for supplying oil under pressure to the main bearings, turbocharger (if required), crankpin bearings,

pistons, piston pins, timing gears, camshaft bearings, and valve rocker mechanism.

2. Threaded, spin-on type, replaceable full flow lubricating oil filters, conveniently located for servicing shall be provided. Filters shall be equipped with a spring loaded, pressure calibrated bypass valve to insure oil circulation if filters are clogged.
3. Crankcase lubrication oil pan capacity shall be sufficient to permit at least 150 hours of operation on one filling, after the break-in period, under normal operating conditions.
4. Provide a valved oil pan drain extended to a threaded connection located outside the engine rails for easy servicing.
5. The flexible oil lines shall be AEROQUIP or equal. All flexible oil lines shall be as short as practicable

G. Cooling System:

1. Cooling system shall be a liquid cooled closed loop consisting of unit mounted radiator and fan.
2. Provide flange for sheet metal duct connection to radiator.
3. Provide immersion jacket water heaters 208V, 1-Phase, each with a thermostat, and of adequate capacity to insure starting under low ambient conditions. Provide 1/4-turn ball valves on the supply and discharge connections to the jacket water heater and lines for servicing. Jacket water heater shall automatically disconnect during engine operation.
4. Critical low coolant level, low coolant temperature, high temperature alarms for remote indication shall be furnished.
5. Provide a valved radiator drain with pipe extension to a threaded connection located outside the engine rails for easy servicing.
6. Coolant hoses shall be reinforced silicone rubber.
7. Engine shall be shipped with factory-recommended antifreeze coolant, distilled water and inhibitor solution.
8. Cooling system shall be adequate for any excess pressure drop in intake air and exhaust air acoustical treatment provided in a generator enclosure, as well as pressure drop through the radiator

H. Exhaust System:

1. Suitable silencers of carbon steel construction with aluminized finish of the hospital grade shall be furnished with the engine. The exhaust system shall be sized to prevent excessive backpressure.
2. The silencer shall be the chambered type, with condensate drains with pipe flange connections.

3. All piping, flanges and gaskets in the exhaust system shall be rated for 1200 °F. All hardware, (i.e., bolts, washers, nuts, lock washers, etc.) shall be casehardened stainless steel rated at 1200 °F and furnished with the generator set.
 4. To provide vibration isolation, a flexible stainless steel, interlocking bellows type section shall be provided for the engine exhaust outlet. The pipe outlet connections shall be compatible with standard ANSI-125 lb. pipe flange.
 5. The exhaust system manifold at the engine shall be jacketed or blanketed to prevent personnel burns. All guards shall be easily removed with standard tools.
 6. Valved extensions through insulation shall be provided for condensate drains on silencers and piping.
 7. Provide a fitting on the engine exhaust manifold to allow measurement of backpressure.
 8. The exhausted gas emission shall comply with all Federal, State, and Local Emission Codes in force at the project location. Information on the content and capacity of exhaust gases emitted by the proposed engine at 1/4, 1/2, 3/4 and full load shall be included in the submittal package.
- I. Hose Connections
1. Flexible connections for fuel, lube oil, and instrumentation shall be constructed of neoprene with internal braided stainless steel reinforced flexible hose rated for the application. Fittings shall utilize compression connection to hose with threaded male or female adapter as required for application. Hose and fittings shall be as manufactured by AEROQUIP or equal.
 2. Hose clamp connections shall not be used except for coolant hose connections where glycol solution is not compatible with AEROQUIP hose. Radiator connections, if using worm gear or similar hose clamps, shall be equipped with double clamps on each end.
 3. Provide flexible hose connections to fuel oil supply and return piping.
- J. Starting Equipment
1. Provide dual cranking motors and contactors with either capable of starting the engine.
 2. Battery cables supplied shall be welding type cable using compression connectors.
 3. Provide a 24-Volt DC start system utilizing lead calcium type battery, with battery rack, containment tray suitable for acid containment and sized to hold the liquid content of one battery and insulated battery terminal link protectors.
 4. Batteries shall have sufficient capacity for cranking the engine for a total of 60 seconds at 32 °F at firing speed. Terminal voltage shall be no less than 18 VDC at the end of the cranking cycle, in the minimum ambient temperatures specified.
 5. Vent caps shall be explosion resistant.

6. Provide protective covers for battery terminals and intercell connectors.
 7. A suitable dual rate, temperature compensated, solid-state automatic battery charger (single-phase, 10-Amp capacity minimum) shall be provided to maintain the batteries at full capacity. The charger shall restore the batteries to full capacity within 8 hours after discharge. Provide Accessory alarm to provide high/low DC voltage alarms and charger fail alarm, form "C" output alarm contacts. Provide delay not to alarm on power loss, until generator starts.
 8. Battery charger alarm contacts shall be routed to the engine control panel and connected to a customer alarm point for a remote monitoring system.
 9. Battery racks shall be adequate for Seismic Zone of the site.
 10. Battery shall be installed outside the area of the generator skid and secured to the battery rack.
- K. Miscellaneous
1. A dry type air cleaner assembly equipped with a service (air restriction) indicator shall be supplied with replaceable element filter.
 2. Provide crankcase ventilation filters.
 3. All valves and drains shall be located in an accessible location, or shall be otherwise made operable from an accessible location.

2.3 GENERATOR

- A. The AC generator shall be synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees C.
- B. The AC generator shall be connected for 120/208 volt solid-grounded wye operation. The leads shall be permanently identified to provide proper phase connections. The neutral shall be insulated from ground at the generator.
- C. The generator shall be capable of producing its rated output at any power factor from - 0.80 to 1.00, at +/- 5% of rated voltage at 60 Hz, in the environmental conditions specified elsewhere.
- D. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating supplied to a single phase or three-phase fault at approximately 300% pf rated current for not more than 10 seconds.
- E. The windings shall be copper, designed for good wave shape and low noise level. Amortisseur windings shall be integral with the rotor-coil support. The rotor shaft bearing shall be shielded type with provisions for easy servicing. The bearings shall be designed for a minimum L-10 service life of 40,000 hours.
- F. Output shall not deviate from a standard sine wave form more than +/- 5%. Total Harmonic Distortion (THD) shall be less than 5% aggregate and less than 3% for any

- single harmonic. Telephone Influence Factor (TIF) shall be less than 40, based on the 1961-weighting curve.
- G. The generator shall carry 60% fully automatic SCR load without damaging or overheating of the generator or voltage regulator. Total harmonic distortion (THD) shall be less than 5%. TIF shall be less than 40. Total voltage waveform distortion with open circuit shall be 3% between phases or between phases and neutral. Total distortion for a three-phase balance, harmonic-free load shall be 3% or better.
- H. The insulation system shall be Class H, minimum, 100% epoxy resin vacuum and pressure impregnated into the windings to give specific temperature and environmental performance.
- I. The generator winding shall be two-thirds pitch. Submit harmonic analysis for 3rd, 5th and 7th harmonics to Jackson County and Jackson County's Design Build representative for approval.
- J. Damper windings shall provide for unbalanced loading conditions and shall be integral with rotor coil support.
- K. The basic impulse level (BIL) of the insulation shall be minimum of 7.5 kV.
- L. Provide alternator cabinet heater with thermostat to prevent condensation on the generator windings.
- M. Generator Terminal Box:
1. Generator phase and neutral leads shall be brought into the terminal box and terminated at copper bus bar extensions, where external connections can be made to generator feeder disconnect. Bus pads shall be arranged for long-barrel two-hole compression connector with NEMA drilling.
 2. Provide a copper ground bar in the box, bonded to the box, for termination of grounding conductors. Ground bar should be copper (98% conductivity) and configured for 2-hole compression connections, NEMA spacing with 9/16-inch holes.
 3. An oversize terminal box shall be provided to accommodate the main line disconnect switch, incoming conduit, cables and lugs.
 4. Arrange terminal box for entry as determined by the final feeder arrangement. Provide an insulated neutral bus.
- N. Generator Main Disconnect
1. Provide a generator main disconnect. Disconnect shall be rated for continuous output of the generator set (100% rated breaker, size as indicated on the dwgs) and shall include high instantaneous trip function. Switch shall be stationary mounted, manually operated; normally closed.
 2. Breaker shall be insulated case power breaker, ABB, Square D or General Electric.
- O. Rating & Miscellaneous Items

Generator kW Rating	Breaker Frame Size	Breaker FLA
Size as indicated on the dwgs)	Size as indicated on the dwgs)	Size as indicated on the dwgs)

1. Provide 24-volt DC shunt trip coil and additional 2 sets of spare A/B contacts for future use by Jackson County. Wire all breaker auxiliaries to an accessible terminal strip in the control panel enclosure.
2. Install breaker in a dead-front, NEMA-2 enclosure, factory wired to alternator terminal bus. Set-mounted enclosure is preferred; however, it is acceptable for enclosure to be floor-mounted if NEC clearances are maintained.
3. Enclosure shall be sized and constructed to comply with the breaker manufacturer's requirements for ventilation, temperature rise and wire bending space.
4. Provide suitable protection for cables between the alternator and breaker.
5. Breaker opened / tripped shall be alarmed as scheduled.

2.4 VOLTAGE REGULATOR

- A. The voltage regulator shall be of solid-state construction type, and powered from the PMG exciter to maintain voltage within limits as specified below. It shall have Volts per Hertz capability and three-phase sensing.
- B. The regulator shall control the generator exciter field as required to maintain a constant and stable generator output voltage within +/- 1.0% of nominal for all steady state loads from no load to full load, including a 5% variation in frequency and the effects of field heating. Over excitation shutdown and regulator current limit protection shall be provided. The regulator shall have three-phase sensing, with loss of sensing protection to shut off the regulator and reset when sensing is restored.
- C. There shall be no more than a 20% (maximum) voltage dip on a one-step application of 0.8 power factor 100% load with a recovery time of less than 4 seconds.
- D. Upon load removal, (0.8 power factor, full load) there shall be a maximum of 2.5 seconds voltage recovery time.
- E. The voltage regulator shall be mounted in the generator control panel.
- F. Engine-Generator Set Mounting
- G. A skid base shall be furnished from heavy steel channel utilizing welded construction. The base shall be of sufficient size and mass to prevent damaging torsional vibration for the entire speed range from 0-125% of rated speed. Mounting holes shall be provided to fasten the skid base to spring isolators.
- H. Seismic Rated Spring Isolators rated for the geographic location.

1. Color-coded springs assembled into telescoping upper and lower housings separated by extruded rubber comer cushions.
2. Neoprene noise isolation pad: Mounting holes in base plate.
3. The isolators shall provide one-inch static deflection with a minimum of 50% additional travel with the weight of the generator set applied. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load.
4. Isolation efficiency shall be 90% nominal.

2.5 ENGINE GENERATOR SET- CONTROLS

- A. The generator set shall be provided with a microprocessor-based control system to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set and remote monitoring of the generator set.
- B. The controls shall be mounted on the generator set. The controls shall be vibration isolated and tested to verify the durability of all components in the system under the vibration conditions encountered.
- C. All switches, lamps and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control panel (with the door open) that operate in excess of 50 volts.
- D. Remote start configuration.
- E. The generator set mounted control shall include:
 1. RUN/OFF/AUTO control. In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 2. Red "mushroom-head" push-button EMERGENCY STOP-EPO switch. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting. Include 2nd EPO switch in a lockable enclosure on the exterior side of the enclosure.
 3. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has been shut down for any fault condition.
 4. PANEL LAMP. Activating the panel lamp control shall cause the entire panel to be lighted with DC control power. The panel lamp shall have automatic and manual deactivation control.
 5. Digital Metering: Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output kW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.
 6. Alarm and Status Indicators (Local): The generator set shall be provided with alarm and status indicating lamps to indicate generator status, existing alarms,

and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The indicator lamps shall illuminate alarms and status as listed in Table 1 (provide 2-10 dry contacts modules – to be programmed per county requirements).

Table 1: Status and Alarm Indicators (LED)	
DESCRIPTOR	LED COLOR
Engine Running	Green
Engine Off Normal (not in auto)	Red
Low Coolant Temperature	Yellow
Weak/Low Battery Voltage	Yellow
Low Coolant Level	Yellow
Fault (Shutdown summary alarm)	Red
Circuit Breaker open / tripped	Red
Battery Charger Malfunction	Red
High Coolant Temperature	Red
Under Voltage	Red
Over Voltage	Red
Low Fuel	Red
Interstitial fuel leak detection	Red
Pre-alarm (Warning Summary alarm)	Yellow

- F. The following information shall be available from a digital status panel on the generator set control:
1. Engine oil pressure (psi or kPA)
 2. Engine coolant temperature (degrees F or C) Both left and right bank temperature shall be indicated on V-block engines.
 3. Engine oil temperature (degrees F or C)
 4. Engine speed (rpm)
 5. Number of hours of operation (hours)
 6. Number of starts attempts
 7. Battery voltage (DC volts)
 8. All Gen-set alarms and shutdown conditions.
 9. The control system shall also incorporate a data logging and display provision to allow logging of warning or shutdown indications on the generator set, as well as

total time of operation at various loads as a percent of the standby rating of the generator set.

- G. Alarm and Status Indicators. The generator set shall be provided with a remote alarm module/RANN complete with status indicating lamps, lamp test switch, horn and silence switch. The lamps shall be high-intensity LED. The lamp condition shall be clearly apparent under bright room lighting conditions. The indicator lamps shall illuminate alarms and status as listed in Table 2. The remote annunciator shall be provided with the necessary interfaces and enclosures, for remote mounting in the building within line of site of ATS controls, as directed by Owner.

Table 2: Status and Alarm Indicators (Remote Annunciation)	
DESCRIPTOR	LED COLOR
Engine Running	Green
Engine Off Normal (not in auto)	Red
Low Coolant Temperature	Yellow
Weak/Low Battery Voltage	Yellow
Low Coolant Level	Yellow
Fault (Shutdown summary alarm)	Red
Pre-alarm (Warning Summary alarm)	Yellow
Under Voltage	Red
Circuit Breaker Open / Tripped	Red
Generator on Load	Green
High Coolant Temperature	Yellow
Low Fuel	Red
Battery Charger Malfunction	Red
Overcrank	Red
Low Oil Pressure	Yellow
Interstitial fuel leak detection	Red

- H. Communication points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features for remote communications.
1. Modbus module/protocol which can be easily integrated into Jackson County monitoring system.
 2. SNMP / IP protocol module that provides complete engine and generator data in the SNMP format Data Map which can be easily integrated into Jackson County monitoring system.
 3. Provide register list defining all inputs and outputs for monitoring and control.

4. Provide Form "C" dry common alarm contact set rated 2A (provide 2-10 dry contacts modules – to be programmed per COUNTY requirements) to indicate existence of alarms indicated below / required to interface to existing Building Alarm Panel:

Table 3: Status and Alarm / Dry Contacts—to be interfaced to Building Alarm Panel	
DESCRIPTOR	
Generator Start & Run	
Generator Failure	
Low Fuel	
Fuel Tank Leak	
Weak/Low Battery Voltage & Battery Charger Malfunction	
Circuit Breaker Open / Tripped	
Fault (Shutdown summary alarm)	
Pre-alarm (Warning Summary alarm)	
EPO Activated	
Engine Off Normal (not in auto)	

5. Electrical contractor shall provide required wiring for RANN inside the bldg + to the network switch.
- I. Control Functions:
1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time and number of cycles. Initial settings shall be for 4 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
 2. The control run system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
 3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
 4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-30 minutes) functions.
 5. The control system shall include sensor failure monitoring logic for speed sensing, oil pressure, and engine temperature, which is capable of discriminating between, failed sensor or wiring components, an actual failure conditions.
- J. Alternator Control Functions:

1. The generator set shall include an automatic voltage regulation system, which is matched, and tested with the governing system provided. It shall be immune from disoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control build-up of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.
2. Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.
3. Controls shall be provided to monitor the kW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.
4. An AC over/under voltage monitoring system, which responds only to true RMS voltage conditions, shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.
5. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 18 VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.
6. The control system shall include a ground fault-monitoring relay. The relay shall be for indication only and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set and provide relay.

2.6 GENERATOR SET AUXILIARY EQUIPMENT AND ACCESSORIES

A. Coolant heater

1. Engine mounted, thermostatically controlled, coolant heater(s). Heater voltage shall be as shown on the project drawings.
2. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed to allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

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3. The coolant heater shall be provided with a 24 VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
 4. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104 °F (40 °C) in a 40 °F ambient.
- B. Vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.
 - C. Batteries shall have sufficient capacity for cranking the engine for a total of 60 seconds at 32 °F at firing speed. Terminal voltage shall be no less than 18 VDC at the end of the cranking cycle, in the minimum ambient temperatures specified.
 - D. Exhaust muffler(s) shall be provided for each engine, size and type as recommended by the generator set manufacturer. The mufflers shall be hospital grade. Exhaust system shall be installed according to the generator set manufacturer recommendations and applicable codes and standards.
 - E. Air intake silencer shall be provided. The silencer shall be installed according to the generator set manufacturers recommendations and in accordance with applicable codes and standards.
 - F. Air exhaust silencer shall be provided. The silencer shall be installed according to the generator set manufacturers recommendations and in compliance with applicable codes and standards.

2.7 WEATHERPROOF, NON-WALK-IN, SOUND-ATTENUATED METAL ENCLOSURE

- A. Provide a no walk-in, aluminum outdoor enclosure and its accessories including sub-base tank. Access doors shall be provided.
- B. Design Criteria and Description
 1. Access to either side to engine from exterior via doors.
 2. The enclosure shall be anchored to the saddle tank and provided with a suitable heavy rubber gasket between tank and enclosure. The enclosure is not required to cover the entire length of the saddle tank. Coordinate with tank manufacturer and provide suitable anchor points.
 3. The enclosure shall consist of a roof, underframe, two (2) side walls, and (2) end walls. The interior of the enclosure shall be designed to permit normal maintenance of the set without enclosure removal. Large opening doors on the sides and rear of the module shall be provided with retainers and locks to allow easy access for maintenance. For extraordinary maintenance, the enclosure shall be designed with lifting rings and anchor fittings to permit lift off removal of the enclosure. Control panel shall be fully accessible through one large door.
 4. Rigidity wind test equal to a minimum of 125 mph.
 5. Roof load equal to 50 lbs. per square foot.
 6. Rain test equal to 4 inches per hour.

7. Acoustical abatement to meet noise requirements as directed by Jackson County - sound attenuated enclosure, level 1.
 8. Air intake shall be via a fixed louver system of sufficient size to allow proper cooling and combustion air flow as specified by the manufacturer. Air exhaust from radiator shall be via a gravity operated louver. Provide 10 gage 1/2" X 1/2" bird screen on the interior of fixed intake louvers.
 9. Stainless steel muffler support, rain shields, and exhaust flange.
 10. Six-point lift rings (minimum).
 11. GFCI receptacle.
 12. Silencer/muffler shall be installed inside enclosure – pancake style.
 13. AC lighting system to provide sufficient light to allow engine servicing under normal conditions. The switch shall be located next to the primary access door.
 14. At least two prime and two finish coats of automotive type paint.
 15. Stainless steel rain shields / flapper.
- C. Enclosure color – pending owner approval.
- D. Ltg fixtures / one on each side + 1 switch, etc to be wired by generator vendor).
- E. Provide exterior / enclosure mounted EPO in lockable enclosure.
- F. Provide exterior fire extinguisher.

2.8 FUEL STORAGE TANK

- A. The fuel tank system is scheduled as a saddle tank type, double wall tank, suitable for mounting and support of the generator module on top of the tank. Tanks shall be constructed and listed in accordance with Underwriters Laboratories, Inc., Standard 142, for Secondary Containment Aboveground Tanks containing Diesel Combustible Liquids. The tank shall have the capacity for 24 hours @ full load, installed as recommended by the manufacturer, and in accordance with the codes and regulations indicated above. All fuel reserve times shall be calculated with the supply at 85% tank capacity.
- B. The tank shall come equipped with an emergency vent (primary tank and interstitial space) from the manufacturer. The tank shall be clearly labeled as to product contained, and gross capacity of the tank. A spill container (with lockable lid) or integral spill box shall be provided.
- C. Fuel port preferred by local bldg engineer inside enclosure.
- D. Spill kit shall be the PIG brand (www.newpig.com) Model KIT241 or equal.
- E. Comply with latest US EPA emissions regulations. Provide compliance report.

- F. Comply with the latest clean air policies of the state of Georgia. Provide compliance report.
- G. The fuel tank shall meet all requirements of the most current Environmental Protection Agency Publications and local and State requirements. Shall be installed in accordance with the manufacturer's recommendations and NFPA 30, NFPA 30A, NFPA 37, and local requirements.
- H. Tanks shall be vented to the outside air and shall be designed for operation at atmospheric pressure.
- I. The tank shall be constructed as a UL listed secondary containment tank, utilizing steel inner and outer tanks.
- J. The port openings in the top of the secondary tank shall be constructed with full welds to prevent moisture from seeping between the fire proofing material and secondary and primary tanks.
- K. An electronic fuel tank monitoring system shall be provided that provides a minimum of; interstitial leak detection, high level alarm, and low level alarm (40%). The monitor shall transmit low level alarm interstitial and leak detection to the generator remote annunciation panel.
- L. The tank shall include a warranty for 20 years.
- M. The tank manufacturer shall provide proof of a minimum of 5 years of manufacturing vault tanks.
- N. The primary tank shall be pressure tested to UL 142 Standard (minimum 3 to 5 psi) at the factory, and shall be field-tested by the contractor.
- O. Aboveground storage tanks shall be a minimum of 5 feet from the building exterior wall.
- P. After construction is complete, the contractor shall complete the State Storage Tank Notification form, signed by the installing Contractor where appropriate. Return form to the Project/Construction Manager along with installation documentation.
- Q. The State, County, and/or local authorities may require notification 30 days prior to installation. The Contractor is responsible for providing required notification.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation is not in the scope of work of the Gen Vendor / installation under the scope of installing Contractor. Certain work related to installation is within the scope of work of the Vendor where specifically required, such as work related to testing, startup, documentation and coordination of the work with the installing Contractor.
- B. Generator set shall be handled only by using lifting eyes or slings as recommended by the manufacturer.

- C. Place the generator set level and square on concrete pad. Anchor in place at all prescribed locations using either cast-in-place anchor bolts or drilled, epoxy-set anchors. Impact and/or expansion anchors are not permitted.
- D. Concrete pad shall be checked and accurately leveled so that generator set is level. Contractor shall coordinate pad layout with manufacturer approved shop drawings.
- E. Accurately coordinate all power and control conduits stub-up locations with shop drawings for entry into equipment.
- F. One five-pound CO2 (dry chemical is not acceptable) fire extinguisher mounted on the exterior of the generator enclosure or building wall/near the generator.

3.2 FACTORY TESTING

- A. Before the equipment is being shipped, a factory load test and log of the diesel engine-generator set showing a minimum of 4 hours testing at 100% of its maximum standby-rated load shall be submitted to Jackson County and the Design Engineer. Factory test data and recording sheets are to be available for comparisons during the on-site acceptance test.
- B. The factory load test shall be performed with the generator set completely assembled including silencer, radiator and accessories + provide report.
- C. Normal preliminary diesel engine and generator tests shall have been performed at the place of manufacture before unit assembly.
- D. All engine safety features shall be tested for operation and calibrated before the load test.
- E. All control and relay functions shall be tested for proper operations.
- F. A high potential test of the generator shall be performed.
- G. Load Testing:
 - 1. If any load tests required by this Specification exceed the capabilities or recommendations of the generator set manufacturer, those limitations shall be clearly stated in the Vendor's Proposal.
 - 2. Provide recording of total 3-phase kW, Voltage and Frequency for each series of tests, operating at an appropriate and acceptable chart speed. Clearly label each test performed. Test shall be capable of both load steps and transient tests as well as 4-hour run.
- H. Initial Step Load Test
 - 1. The generator set shall accept full rated load from a cold start. The engine temperature shall be stable at a temperature maintained by the jacket water heaters only. The engine shall not have been run for at least 24 hours.
 - 2. The engine shall be started and full load shall be applied and accepted by the generator set within 10 seconds.
 - 3. Transient performance shall be recorded.

4. Full Load Test of 4 hours: Load test shall be a continuation of the initial cold start. If for any reason the 4-hour load is terminated the entire 4-hour test shall be restarted until satisfactory results are obtained.
 5. Record generator output continuously during test.
 6. The following engine run data shall be recorded at 20 minute intervals:
 - a. Time
 - b. kW output
 - c. Output voltages
 - d. Output currents
 - e. RPM
 - f. Input water temperature
 - g. Output water temperature
 - h. Oil temperature
 - i. Fuel pressure
 - j. Oil Pressure
 - k. Ambient Temperature
 - l. The engine shall be checked for oil, coolant or fuel leakage at the same intervals.
- I. Transient Tests:
1. During the 4-hour load test, at least one set of transient tests shall be performed. Tests shall be as follows:
 - a. No-load to 1/4 load to no-load
 - b. No-load to 1/2 load to no-load
 - c. No-load to 3/4 load to no-load
 - d. No-load to 100% load to no-load
 - e. 1/4 load to 1/2 load
 - f. 1/2 load to 3/4 load
 - g. 3/4 load to 1/4 load
 - h. Allow machine to stabilize briefly after each load change.
- J. Furnish copies of all test sheets to Jackson County at the completion of the test. Normal preliminary diesel engine and generator tests shall have been performed before unit assembly.

3.3 DUMMY LOAD BANK FOR START-UP AND TESTING

- A. Outdoor, air-cooled dummy load banks shall be provided, with a rated capacity of – generator capacity.
- B. Provide load bank cables of sufficient length to reach the load bank location from the generator.
- C. The generator set Vendor shall provide load bank. Load bank shall be on-site for a period of time required by generator set Vendor to complete startup of the generator sets, exclusive of switchgear testing.
- D. Generator Vendor shall state in his proposal, the daily cost of load bank rental including cables, etc.

3.4 SITE TESTING

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- A. Before acceptance of the standby AC plant installation, an entire system test shall be performed. If for any reason the 4-hour load bank test is terminated, the entire 4-hour test shall be restarted until satisfactory results are obtained. If satisfactory results are not obtained because of installation errors, the installing contractor will be responsible for all retesting charges including labor, materials and transportation.
- B. The engine-generator Vendor shall provide qualified personnel, load banks, test equipment, cable, etc., for system test.
- C. Before site testing, the Vendor shall provide certification equipment has not been exposed to adverse environmental conditions.
- D. Site Integration Test - provide site integration test with existing ATS and provide written report to the owner.
 - 1. Simulate utility loss opening building main disconnect breaker, generator shall start and ATS transfer building load to generator in less than 10 seconds.
 - 2. After 5 minutes restore utility, ATS shall transfer building load to utility in approx 5 minutes, generator shall run in cool down mode and shut-down after approx 5 minutes (verify existing ATS settings).
- E. Prior to the load test, all functions and safeties shall be tested:
 - 1. Verification of the proper operation of safety shutdowns.
 - 2. Verification of all alarms (local and remote).
 - 3. Verification of all control functions (automatic and manual).
 - 4. Verification of proper interfaces and control with the transfer switchgear, including proper engine starting controls and safeties.
- F. Load Tests:
 - 1. Unless otherwise noted, all load tests specified to be performed at the factory shall be repeated in the site test, including cold-start step-load test and transient tests. Provide 4-hour field load bank test.
 - 2. Tests shall be performed as specified above for factory testing.

3.5 FUEL AND CONSUMABLES

- A. The engine-generator Vendor shall provide all lubricating oil, coolant, lubricants and filters and other incidental consumables required for generator set testing and for ATS testing.
- B. The Contractor shall provide fuel for testing including top off, after all testing.
- C. After the completion of testing, all lubricating and cooling fluid levels shall be topped off.
- D. Oil and filters shall be changed in the event of abnormally long testing.
- E. Spare parts - provide (2) oil filters, (2) fuel filters, (2) air filters.

END OF SECTION 16210