

SECTION 26 32 13

STANDBY GENERATOR

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes packaged engine-generator sets for optional standby power supply. This specification is primarily intended for pump station and well site applications for units rated 1000 kW and less. Contact Cape Fear Public Utility Authority (CFPUA) for clarification if project conditions indicate otherwise. Include the following features:
 - 1. Diesel engine.
 - a. Natural gas may be applicable only if directed so in advance by CFPUA.
 - 2. Unit-mounted cooling system.
 - 3. Unit-mounted control and monitoring.
 - 4. Performance requirements for sensitive loads.
 - 5. Fuel system.
 - 6. Outdoor enclosure.
- B. Related Requirements:
 - 1. Section 26 36 23 - Automatic Transfer Switches for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

- A. ATL: Across the Line
- B. ECM: Engine Control Module
- C. FLA: Full Load Amps
- D. HP: Horsepower
- E. kVA: kilo-Volt-Amps
- F. NEMA National Electrical Manufacturers Association
- G. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

- H. Optional Standby Power Supply: NEC 702, optional standby.
- I. RVAT: Reduced Voltage Autotransformer
- J. SSSS3: Solid State Soft Starter @ 300%

1.4 SUBMITTALS

- A. Six sets of submittal data shall be provided, with the exception of Closeout Submittals. Four sets of Closeout Submittals are acceptable.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product, standard accessories, and optional accessories.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include motor starting performance curve(s) indicating voltage drop for motor starting conditions.
 - 3. Include thermal damage curve for generator.
 - 4. Include time-current characteristic curves for generator protective devices.
 - 5. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
 - a. Provide fuel consumption in cubic feet per hour if natural gas unit has been selected by CFPUA. Natural gas may be applicable only if directed so in advance by CFPUA.
 - 6. Include generator efficiency at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
 - 7. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor and rated load. Testing shall be performed per ISO3046 standards. Provide drawings showing requirements and limitations for location of air intake and exhausts.
 - 8. Include generator characteristics, including, but not limited to kw rating, efficiency, reactances, and short-circuit current capability.
- B. Shop Drawings:
 - 1. Include plans and elevations for engine-generator set, subbase fuel tank, enclosure, and other components specified and/or provided. Indicate recommended equipment pad dimensions. Indicate access requirements affected by height of subbase fuel tank.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, center of gravity of full assembly, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Identify fluid drain ports and clearance requirements for proper fluid drain.
 - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
 - 5. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment, automatic transfer switch, and functional relationship between all electrical components.

6. Plans, elevations, and details for maintenance platform.

1.6 INFORMATIONAL SUBMITTALS

A. Specification Compliance Markup: Submit a mark-up copy of this specification with notations and explanations comprehensively showing all deviations and / or exceptions to these Specifications.

B. Voltage Drop Calculations: Submit calculations based on loading criteria indicated below to limit voltage drop to 25% maximum with full recovery of unit to steady state operation.

- 1. Step 1 Loads:
 - a. 5 kW miscellaneous load.
 - b. Motor Nameplate Data:

HP	VOLTS	NEMA Code	FLA	Start Amps	Run kVA	Start kVA	Starter

- 2. Step 2 Load, Motor Nameplate Data:

HP	VOLTS	NEMA Code	FLA	Start Amps	Run kVA	Start kVA	Starter

C. Qualification Data: For supplier / installer.

- 1. Statement from supplier / installer detailing local service capability, factory-trained service personnel, and details of service response required in accordance with this specification. Reference section 1.9B.3 for service response guarantee.

D. Qualification Data: For manufacturer.

- 1. Statement of quality from manufacturer detailing acceptance as an ISO9001 manufacturer.

E. Source quality-control reports, including, but not limited to the following:

- 1. Certified summary of prototype-unit test report.
- 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
- 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria.
- 4. Report of factory test on units for this Project, showing evidence of compliance with specified requirements. Report shall be submitted when units ship.
- 5. Report of exhaust emissions showing compliance with applicable regulations.

F. Field quality-control reports.

G. Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Initial Manual Submittal for Review: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Owner and/or Engineer will comment on whether scope and content of manual are acceptable.
 - 1. Correct or revise each manual to comply with Owner and/or Engineer comments. Submit copies of each corrected manual as the Final Manual Submittal.

- B. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training.
 - 1. Format: Submit operations and maintenance manuals in the following formats.
 - a. PDF electronic file. Assemble each manual into a composite electronically indexed file. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory. Submit electronic file on both digital disc and USB drive.
 - b. Two paper copies in heavy-duty, three-ring, loose-leaf binders. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.

- C. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. Data shall be provided and identified that is specific to the site where equipment is installed.
 - 1. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
 - 2. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
 - a. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents.
 - b. Product information.
 - c. Maintenance procedures.
 - d. Maintenance and service schedules.
 - e. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
 - f. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
 - g. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
 - h. Warranties: Include copies of warranties and lists of circumstances and conditions that would affect validity of warranties. Include procedures to follow and required notifications for warranty claims.
 - 3. Operation Manuals: Assemble a complete set of operation data indicating operation of each system, subsystem, and piece of equipment not part of a system.
 - a. System, subsystem, and equipment descriptions.
 - b. Operating procedures.
 - c. Wiring diagrams.
 - d. Control diagrams.

- e. Piped system diagrams.
- 4. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- 5. Additionally, include the following:
 - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - b. Operating instructions laminated and mounted adjacent to generator location.
 - c. Training plan.
 - d. Software for unit controller with diagnostic, troubleshooting, and maintenance functionality.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every 10 of each type and rating but no fewer than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
 - 4. Paint: Two spray cans of each color.
 - 5. Keys: Four keys for enclosure access doors.
 - 6. Special Tools: Tools unique to the product for standard maintenance, listed by part number in operations and maintenance manual.

1.9 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer accepted as an ISO9001 manufacturer.
- B. Supplier / Installer Qualifications:
 - 1. Manufacturer and factory authorized representative who is trained and approved by manufacturer.
 - 2. Maintain, within 125 miles or two hours of Wilmington, North Carolina; a factory certified service center capable of providing training, parts, and emergency maintenance repairs.
 - 3. Response for emergency repairs shall be guaranteed to be four hours or less upon receipt of service call notification.
 - 4. Manufacturer's authorized representative shall employ factory-trained and certified service personnel and shall carry single-source responsibility for warranty, parts, and service.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period at no additional cost to the Owner.

1. Warranty Period: 5 year or 2500 hours, whichever occurs first, from date of start-up and Substantial Completion.

1.11 SERVICE CONTRACT

- A. Manufacturer's service representative shall provide a service contract at no additional cost to the Owner for a period of 2 years from date of start-up and Substantial Completion of the generator set installation.
- B. The service contract shall be to semi-annually inspect, and test run the engines and to perform manufacturers recommended preventative maintenance service on the equipment furnished. The service contract shall include operation of the equipment under simulated power failure conditions, adjustment of generator, transfer switch and switch-gear controls as required and certification in the Owner's maintenance log of repairs made and proper functioning of all engines and auxiliary systems.
- C. At the Owner's option, the service agreement shall be renewable on a year-to-year basis, thereafter, with costs being paid by the Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Caterpillar.
 2. Cummins.
 3. MTU.
- B. Manufacturers shall agree to make factory training available for Owner personnel. No costs associated with training are expected to be covered by the manufacturer. The intent of the training is for Owner personnel to be trained and capable of make repairs in the same manner as a manufacturer's factory trained technician after the warranty period has expired.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer. Generator set shall be standard offering from manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance:
 1. Comply with NFPA 30.
 2. Comply with NFPA 37.
 3. Comply with NFPA 54. Natural gas may be applicable only if directed so in advance by CFPUA.
 4. Comply with NFPA 70.
 5. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

- B. UL Compliance: Comply with UL 2200/CSA.
- C. Engine Exhaust Emissions: Comply with current EPA requirements and applicable state and local government requirements.
- D. Noise Emission:
 - 1. At a minimum, sound level measured at a distance of 23 feet from the unit after installation is complete shall be 75 dBA or less.
 - 2. Verify with the Owner and/or Engineer if more restrictive noise emission is required due to a generator unit being located near a property line. New Hanover County, Wilmington, and Wrightsville Beach have noise ordinances that may restrict noise to a level less than what is indicated above.
 - 3. Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- E. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: Minus 15 to plus 50 deg C.
 - 2. Altitude: Sea level to 100 feet.
- F. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:
 - 1. High salt-dust content in the air due to sea-spray evaporation.

2.3 ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
- C. EPSS Class: Engine-generator set shall be classified as a Class 72 in accordance with NFPA 110.
- D. Governor: Adjustable isochronous, with speed sensing, capable of maintaining frequency within 0.2 Hertz of normal.
- E. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- F. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated on the drawings at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
2. Output Connections: As indicated on the drawings.
3. Voltage: As indicated on the drawings.
4. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. Nameplate shall be in accordance with NFPA70.

G. Generator-Set Performance:

1. Oversizing alternator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 2 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance:
 - a. Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 3 seconds.
 - b. Not more than 25 percent dip under worst case motor starting conditions. See Informational Submittals, Voltage Drop Calculations for specific step loading criteria.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
8. Block Load Performance: per NFPA110, the unit shall be able to fully recover from a 100% block load.
9. Excitation System: Performance shall be unaffected by 10% total voltage distortion (THD) caused by nonlinear load.
 - a. Provide permanent magnet excitation (PMG) for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.4 ENGINE

- A. Fuel: Diesel Fuel oil, Grade DF-2.
1. Natural gas may be applicable only if directed so in advance by CFPUA.

- B. Engine Rating: Prime mover shall have adequate horsepower to meet the specified kW at the specified site altitude and temperatures. Products that de-rate below specified kW for temperature or altitude shall not be accepted.
- C. Rated Engine Speed: 1800 rpm.
- D. Cylinders: For units 300 kW and larger, cylinders shall be cast iron, sleeved.
- E. Lubrication System: The following items shall be mounted on engine or skid:
 - 1. Positive displacement, full pressure lubrication oil pump.
 - 2. Filter and Strainer: Per manufacturer recommendations.
 - 3. Dipstick to check oil level.
 - 4. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- F. Jacket Coolant Heater:
 - 1. Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity. Heater(s) shall be 3rd party listed.
 - 2. 1500-watts, 120-volt minimum. Provide higher capacity heater as required based on manufacturer requirements for engine size.
 - 3. Thermostatically controlled to maintain engine coolant at not less than 90 deg F in 32 deg F ambient.
 - 4. Shut-off valve to simplify replacement of the heater.
- G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
 - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 - 2. Cooling System Sizing: Sized to adequately cool the generator set, including aftercooler, without de-rate to an ambient temperature of 122 deg F (50 deg C) for diesel. Maximum external restriction shall be no greater than 0.5 inch of water column.
 - 3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 - 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 - 5. Blower fan, water pump, thermostat, and radiator duct flange shall properly cool the engines in 105 deg F ambient with up to 0.5 inches H2O static pressure on the fan. Radiator shall include a duct flange adapter for connection to the discharge air vent.
 - 6. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F (82 deg C), and non-collapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

- H. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- I. Starting System: 12 or 24-V electric, with negative ground.
 - 1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
 - 2. Cranking/Starting Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - a. Speed sensing and a second independent starter motor disengagement systems shall protect against starter engagement with a moving flywheel.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 - a. Cranking cycle with 15 second ON and OFF cranking periods.
 - b. Overcrank protection designed to open the cranking circuit after 75 seconds if the engine fails to start.
 - c. The starting system shall be designed for restarting in the event of a false engine start, by permitting the engine to completely stop and then re-engage the starter.
 - 4. The starting system shall be designed for restarting in the event of a false engine start, by permitting the engine to completely stop and then re-engage the starter.
 - 5. Battery: Lead acid, certified to meet NFPA 110, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
 - 6. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 - 7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
 - 8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and continuous rating adequate for batteries provided, 35-A minimum.
 - 9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with and be listed to UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain +/- 1% constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates. Fuse protection. Reverse polarity and transient protected.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

- f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet with adequate vibration isolation if mounted within the generator set.

2.5 DIESEL FUEL-OIL SYSTEM

- A. Comply with NFPA 30.
- B. Flexible fuel lines rated 300 deg F and 100 psi ending in pipe thread.
- C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions. Engine-driven or electric fuel transfer pump capable of lifting fuel 4.7 feet minimum.
- D. Fuel Filtering: Primary fuel filter to remove water and contaminants larger than 10 micron. Secondary filter to remove contaminants larger than 2 micron.
- E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:
 - 1. Fuel-Tank Capacity: Fuel for 72 hours' continuous operation at 100 percent rated power output (200 gallons minimum). Tanks larger than the minimum capacity specified are acceptable
 - 2. Tank level indicator gauge.
 - 3. Low Fuel Sensing Switch: shall be provided, in accordance with NFPA110, to indicate when less than the minimum fuel necessary for full load running, as required by the specified EPSS class.
 - 4. Leak detection in interstitial space.
 - 5. Vandal-resistant fill cap.
 - 6. Spill containment box for filling location.
 - 7. Normal vent shall extend to 12' above grade. Adequately brace extended vent so that attachment of the vent to the tank is not the sole means of support.
 - 8. Containment Provisions: Comply with requirements of authorities having jurisdiction.
 - 9. Tank shall be production tested to 2 psi.
 - 10. Tank shall be equipped with overfill protection, fuel line check valve, fuel level gauge, low fuel level alarm contact, low fuel level shutdown contact, and fittings for fuel supply, return, fill and vent.
 - 11. Top of tank shall be a minimum of 30" above slab and/or grade to aid in preventing flood damage to engine.
 - 12. The tank shall feature all welded construction and have the structural integrity to support the genset, accessories, and the weather-protective enclosure.

2.6 GASEOUS FUEL SYSTEM

- A. As noted previously, natural gas is to be used only if directed so in advance by CFPUA.
- B. Natural-Gas Piping: Comply with requirements of NFPA 37 and 54.

1. Gas piping and first stage gas regulator shall be the responsibility of the installing contractor.
 2. Gas piping shall be sized to provide adequate fuel to the engine while allowing for no greater than 1-inch water column pressure drop from no load to full load.
 3. Gas piping shall supply pressure to the generator set inlet per manufacturer's recommendations, nominally 11 to 14 inches of water column.
 4. Gas regulator shall be sized to provide 125 percent of full-load generator set capacity.
- C. Gas Train: Comply with NFPA 37.
- D. Engine Fuel System:
1. Natural-Gas, Vapor-Withdrawal System:
 - a. Carburetor.
 - b. Secondary Gas Regulator.
 - c. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
 - d. Fuel Filters: One for each fuel type.
 - e. Manual Fuel Shutoff Valves: One for each fuel type.
 - f. Flexible Fuel Connectors: Minimum one for each fuel connection.

2.7 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown with a programmed 5-minute cooldown period. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Activation of a remote emergency-stop switch also shuts down generator set. When mode-selector switch is in the OFF position, the engine shall not start even though the remote start contacts close. This position shall also provide for immediate shutdown in case of an emergency. Reset of any fault shall also be accomplished by putting the switch to the OFF position.
- B. Provide minimum run time control set for 15 minutes with override only by switching the model-selector switch to Off or by operation of a remote emergency-stop switch. Provide engine cooldown timer, factory set at 5 minutes, to permit unloaded running of the standby set after transfer of the load to normal.
- C. Comply with UL 508A.
- D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration. Panel shall be powered from the engine-generator set battery.
1. Engine and generator control wiring shall be multi-stranded annealed copper conductors encased by cross-linked polyethylene insulation resistant to heat, abrasion, oil, water, diesel fuel, and antifreeze. Wiring shall be suitable for continuous

use at 250 deg F (121 deg C) with insulation not brittle at minus 60 deg F (minus 51 deg C). Cables shall be enclosed in nylon flexible conduit, which is slotted to allow easy access and moisture to escape.

- a. Engines that are equipped with an electronic engine control module (ECM) shall monitor and engine functionality and seamlessly integrate with the generator set controller through digital communications. ECM monitored parameters shall be integrated into the genset controllers NFPA 110 alarm and warning requirements.
 2. Construction: All circuitry within the control panel shall be individually environmentally sealed to prevent corrosion. Encapsulated circuit boards with surface mounted components and sealed, automotive-style connectors for sensors and circuit board connectors.
- E. Indicating Devices: As required by NFPA 110 for Level 1 system. All ECM fault codes shall be displayed at the generator set controller in standard language; fault code numbers are not acceptable. Utilizing a digital display, including the following:
1. AC voltage: True three-phase sensing.
 2. AC current.
 3. Frequency.
 4. EPS supplying load indicator.
 5. DC voltage (alternator battery charging).
 6. Engine-coolant temperature.
 7. Engine lubricating-oil pressure.
 8. Running-time meter.
 9. Current and Potential Transformers: Instrument accuracy class.
- F. Protective Devices and Controls in Local Control Panel: Shutdown devices and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:
1. Start-stop switch.
 2. Overcrank shutdown device.
 3. Overspeed shutdown device.
 4. Coolant high-temperature shutdown device.
 5. Coolant low-level shutdown device.
 6. Low lube oil pressure shutdown device.
 7. Overcrank alarm.
 8. Overspeed alarm.
 9. Coolant high-temperature alarm.
 10. Coolant low-temperature alarm.
 11. Coolant low-level alarm.
 12. Low lube oil pressure alarm.
 13. Lamp test.
 14. Contacts for local and remote common alarm.
 15. Coolant high temperature prealarm.
 16. Generator-voltage; digitally adjustable via controller, password protected.
 17. Fuel tank low-level alarm.
 18. Run-Off-Auto switch.
 19. Control switch not in automatic position alarm.
 20. Low cranking voltage alarm.
 21. Battery-charger malfunction alarm.

- 22. Battery low-voltage alarm.
 - 23. Battery high-voltage alarm.
- G. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
 - H. Data Connection: Provide an RS-485 ModBus port.
 - I. The control system shall provide pre-wired customer use dry contact outputs (4 minimum). Customer I/O shall be software configurable providing full access to all alarm, event, data logging, and shutdown functionality. For the initial installation, configure:
 - 1. One relay output shall be configured for a summary indication of pre-alarm/alarm/shutdown conditions.
 - 2. One relay output shall be configured for RUN indication of the generator.
 - J. Programmable Cycle Timer: To start and run the generator for a predetermined time. The timer shall use 14 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:
 - 1. Day of the week.
 - 2. Time of the day start.
 - 3. Duration of cycle.
 - 4. Option to exercise at reduced speed for quiet test mode.

2.8 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
 - 1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.
- B. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with UL 489.
 - 1. Tripping Characteristic: Designed specifically for generator protection.
 - 2. Trip Rating: Matched to generator output rating.
 - 3. Trip Settings:
 - a. Selected to coordinate with generator thermal damage curve.
 - b. Selected to coordinate with magnetic only, motor circuit protector breaker at a fire pump controller, as applicable.
 - c. The instantaneous trip setting shall not exceed the calculated short circuit fault current available from the generator.
 - 4. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 - 5. Mounting: Each circuit breaker installed in separate box in accordance with NEC700 separation of circuits.

2.9 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1 and UL2200, sized for 248 deg F (120 deg C) temperature rise above ambient at rated load.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H, vacuum impregnated with epoxy varnish in accordance with MILSPEC 1-24092 for improved fungus and salt spray resistance.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide twelve lead alternator.
- E. Range: Provide broad range of output voltage by adjusting the excitation level.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rated speed, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Drip-proof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type on a sealed circuit board, separate from exciter, providing performance as specified and as required by NFPA 110. Must be 3-phase sensing.
 - 1. Voltage Adjustment on Control and Monitoring Panel: Provide plus or minus 10 percent adjustment of output-voltage operating band.
 - 2. Provide anti-hunt provision to stabilize voltage.
 - 3. Isolated to prevent tracking when connected to SCR loads.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Subtransient Reactance: 12 percent, maximum for sites with motor load supplied from VFDs or solid-state soft starters.
- L. Excitation: Permanent magnet (PMG) type providing 300 percent current output for up to 10 seconds to a downstream breaker for selective coordination and improved motor starting.

2.10 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, sound-attenuating, weatherproof housing, wind resistant up to 130 mph. Roof shall be peaked or sloped for water runoff. Access doors shall be positioned to provide adequate access to components requiring maintenance. Instruments and controls shall be mounted within enclosure.
 - 1. Structural Design and Anchorage: Comply with North Carolina Building Code for wind loads up to 150 mph. Enclosure shall be mounted to the subbase fuel tank.
 - 2. Aluminum alloy, 0.063" thick minimum (14-gauge equivalent).
 - 3. Enclosure exterior shall be primed and finish coated with machinery gray, powder baked manufacturer standard paint.

4. Hinged Doors:
 - a. Provide a minimum of two doors per side for operator and service access. A rear door or removable access panel shall provide access to generator end of unit.
 - b. Door Panels: With integral stiffeners, and capable of being removed by one person without tools. In lieu of being removed, hardware that retains doors in fully open position are acceptable.
 - c. Slip-pin hinges and latches stainless steel with nylon spacers.
 - d. Gasketed for weather and rodent protection.
 - e. Handles to have padlocking provisions.
 - f. Door locks, hardware, and fasteners shall be stainless steel. Locks shall be keyed alike to match the existing Owner standard, manufacturer A.L. Hansen, Key #1250.
 5. Silencer:
 - a. Located within enclosure.
 - b. Super critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. At a minimum, sound level measured at a distance of 23 feet from exhaust discharge after installation is complete shall be 75 dBA or less. Reference section 2.2D for coordination required to determine if more restrictive noise emissions are necessary.
 - c. Coated to be temperature and rust resistant.
 - d. Integral condensate drain.
 - e. Gas proof, stainless steel, flexible exhaust bellows with threaded NPT or flanged connections.
 - f. All exhaust piping shall be wrapped for personnel protection and to eliminate excessive heat build-up during generator operation.
 6. Assembly Hardware (Nuts and Bolts): Use stainless steel hardware and nylon washers to prevent paint deterioration.
- B. Sound Attenuation: Factory or third-party enclosure, designed to meet the following design criteria:
1. Sound attenuated enclosure designed to match the criteria for the silencer. Reference section A.5.b. Enclosure shall have intake and discharge hoods, as needed to reduce the mechanical and exhaust noise to an acceptable level.
 2. Sound attenuation materials shall be securely supported, attached, and mechanically held in place; preferably with aluminum perforated metal sheeting.
- C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow. Screened openings to prevent rodent entry.
- D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.11 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel

baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2.12 MAINTENANCE PLATFORM

- A. A prefabricated maintenance platform shall be provided around three sides of the generator. The radiator discharge end of the unit does not require a platform.
- B. Materials: Aluminum.
- C. Grating: Extend 48 inches around the perimeter of the genset enclosure on three sides.
- D. Access steps.
- E. Safety handrails shall extend around the platform perimeter and up both sides of the steps.
- F. Platform height shall match the top of the sub-base fuel tank.
- G. A variance for the maintenance platform may be granted upon written request for small generators where the control panel is less than 60 inches above the generator slab.

2.13 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
 - 2. Additionally, test and document the following:
 - a. Maximum power (kW).
 - b. Maximum motor starting (kVA) at 35% instantaneous voltage dip.
 - c. Alternator temperature rise by embedded thermocouple and by resistance method per NEMA MG1 -22.40.
 - d. Governor speed regulation under steady-state and transient conditions.
 - e. Voltage regulation and generator transient response.
 - f. Fuel consumption at 1/4, 1/2, 3/4, and full load.
 - g. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
 - h. Three-phase short circuit tests.
 - i. Alternator cooling air flow.
 - j. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.
 - k. Endurance testing.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Test generator, exciter, and voltage regulator as a unit.

3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Report factory test results within 5 days of completion of test.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DELIVERY

- A. Generator equipment shall be shipped to the site as a “single-source” item for which responsibility for overall installation, maintenance, spare parts, and service is through the local factory representative.
- B. Delivery of the generator shall include off-loading and setting the generator in place on a concrete slab. Installation shall include mounting of all accessories specified elsewhere in this specification along with external power and control connections of the unit.

3.3 PREPARATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify Owner no fewer than two weeks in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Engineer / Owner’s written permission and without the presence of an Owner representative on site.

3.4 INSTALLATION

- A. Comply with packaged engine-generator manufacturers’ written installation and alignment instructions and with NFPA 110.

- B. Equipment Mounting:
 - 1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified and/or as detailed in the drawings.
 - 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases.
- C. Install packaged engine-generator to provide access, without removing connections or accessories, for periodic maintenance.
- D. Install engine-generator in enclosure with elastomeric isolator pads on concrete base. Secure set as required by the manufacturer.
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- F. Provide fuel as required for startup, testing, and demonstration.

3.5 CONNECTIONS

- A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine-generator to allow service and maintenance.
- B. Connect engine exhaust pipe to engine with flexible connector.
- C. Where natural gas unit has been designated in advance by CFPUA, connect fuel piping to engines with a gate valve, regulator, union, and flexible connector. Install manual shutoff valve in a remote location to isolate natural-gas supply to the generator enclosure. If corrosion resistant piping is not installed, paint piping to prevent corrosion.
- D. Ground equipment according to Section "Grounding."
- E. Connect wiring according to Section "Wire and Cable." Provide a minimum of one 90-degree bend in flexible conduit routed to the generator set from a stationary element.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs as specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage, alignment, and grounding.

- 4) Verify the unit is clean.
 - 5) Provide fluids and check levels of fuel, lubricating oil, and antifreeze for conformity to the manufacturer's recommendations, under the environmental conditions present and expected.
 - 6) Accessories that normally function while each set is standing by shall be checked prior to cranking the engines. These shall include block heaters, battery chargers, etc.
- b. Electrical and Mechanical Tests
- 1) Test protective relay devices per manufacturer recommendations.
 - 2) Verify phase rotation, phasing, and synchronized operation as required by the application.
 - 3) Start-up test mode to check for exhaust leaks, path of exhaust gases outside buildings, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage, and phase rotation.
 - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
 - 5) Conduct performance test in accordance with NFPA 110.
 - 6) Verify correct functioning of the governor and regulator.
 - 7) Seven hour load bank test with an external load bank as follows: 1 hour @ 50% load, 1 hour @ 75% load, 4 hours @ 100% load and 1 hour @ 50% load, monitor and record the following data in 15 minute intervals: engine coolant temperature, oil pressure, battery charge level, generator output voltage, amperes, and frequency.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks. Repair leaks and retest until no leaks exist.
 6. Voltage and Frequency Transient Stability Tests:
 - a. Use data capture from manufacturer control panel and software for measurements.
 - b. Measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.
 - c. Measure voltage and frequency transients for actual site loads, similar to the steps indicated for voltage drop calculation requirements.

7. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge.
 - a. Make measurements at four locations, 90 degrees apart and 23 feet from the exhaust discharge.
 - b. Make measurements at 4 locations on the property line, nearest to the generator unit.
 - c. Compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently. Perform automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown.
- D. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Remove and replace malfunctioning units and retest as specified.
- G. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- H. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.7 MAINTENANCE SERVICE

- A. After the seven-hour load bank test has been completed:
 1. Change the lubrication oil, lubrication oil filters, and fuel filters.
 2. Fill fuel tank.
- B. Under the service contract, provide full service and maintenance by certified employees of manufacturer's designated service organization.
 1. Quarterly: Include inspection, testing, exercising, and adjustments to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation.
 2. Yearly: Along with quarterly activities, include a load bank test for a minimum of 3 hours at 100% load.
 3. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
 4. Include certification in the Owner's maintenance log of repairs made and proper functioning of all engine and auxiliary systems.

3.8 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation, maintenance, and repair of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner. Time permitting, training will be tentatively scheduled after start-up.

END OF SECTION