SECTION 26 3213

GENERATORS, WEATHER-PROTECTED

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Packaged engine generator set for standby, emergency power application including the following:

1. Liquified-petroleum (LP) gas engine with electronic generator set controls, governor, and voltage regulator.
2. Located in outdoor, weather-protected, sound-attenuated enclosure.
3. Complete with remote annunciator and generator accessories.

1.2 RELATED SECTIONS

A. Gas piping:

1. Liquified-petroleum (LP): Section 23 1126.

B. Grounding and bonding: Section 26 0526.

C. Equipment foundations: Section 26 0528.

D. Transfer switches: Section 26 3600.

1.3 REFERENCES

A. ANSI/NECA/EGSA 404: Standard for Installing Generator Sets.

B. CFR Title 40, Protection of Environment.

C. IEEE 115: Test Procedures for Synchronous Machines.

D. IEEE 446: Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

E. NECA/EGSA 404: Standard for Installing Generator Sets.

F. NEMA MG 1: Motors and Generators.

G. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

H. NFPA 30: Flammable and Combustible Liquids Code.

I. NFPA 37: Installation and Use of Stationary Combustion Engines and Gas Turbines.

J. NFPA 70: National Electrical Code.

K. NFPA 110: Emergency and Standby Power Systems.

L. UL 1236: Battery Chargers for Charging Engine Starter Batteries.

M. UL 2200: Stationary Engine Generator Assemblies.

1.4 DEFINITIONS

A. CFR: Code of Federal Regulations.

B. EPA: Environmental Protection Agency.

C. NIST: National Institute of Standards and Technology

D. NSPS: New Source Performance Standards.

1.5 SUBMITTALS

A. Product data: For each type of packaged generator set indicated. Include rated capacities, operating characteristics, manufacturers' technical data on features and functions, finishes, and furnished accessories. Include product data for each of the following:

1. Engine generator set.

a. Thermal damage curve for generator.
b. Time-current characteristic curves for generator protective device.
c. Documentation proving that generator(s) provided have sufficient starting kVA to start the loads under any load sequence.

2. Generator accessories including batteries and battery charger, silencer, and jacket heater.
3. Remote alarm annunciator panel.
4. Enclosure components and accessories.

B. Bill of materials: Provide detailed list of components.

C. Shop drawings: For each type of generator set and related equipment, detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design calculations: Calculate requirements for designing vibration isolation bases.
3. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring diagrams: Power, signal, and control wiring.
5. Piping schematics for fuel system, lubricating oil, jacket coolant, and cooling water.

D. Source quality-control test reports.

1. Certified summary of performance tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
3. Report of sound generation.
4. Report of exhaust emissions showing compliance with applicable regulations.

a. Factory certification of compliance with EPA emissions regulations.

E. Field quality-control test reports.

F. Operation and maintenance data: For packaged engine generator sets, accessories, and remote annunciator panel to include in operation and maintenance manuals. In addition to items specified in Division 01, include the following:

1. 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.
2. Detailed operating instructions for event conditions.
3. Fuel adjustment procedures and maximum tolerances of wear on bearings and other rubbing surfaces that will require corrective measures.
4. Remote fill station.

G. Warranty: Certificate of special warranty.

H. Air quality permits: Submit air quality construction and operational permits for Owner record.

1.6 QUALITY ASSURANCE

A. Generator accessories, appurtenances, and installation of the same, shall comply with referenced codes and standards listed in Part 1 and applicable federal, state, and local codes and regulations.

B. Emissions: Equipment shall be certified to U.S. EPA Stationary Emission Regulation, 40 CFR, Part 60.

C. Permits: Serve as the Owner's representative during the application process. Collect generator information, prepare and submit required applications for air quality construction and operational permits required by the State of Maryland Department of the Environment in compliance of state environmental regulations. Include payment for applicable permit costs. Approved permits and registration shall be issued to the Owner.

D. Equipment shall bear UL label, and shall be locally tested by an electrical testing specialist, acceptable to local authority having jurisdiction where required.

E. Source limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

F. Installer qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.

1. Installer has training in electrical safety as required by NFPA 70E and is qualified as defined in NEMA PB 2.

G. Testing agency qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.

1. Testing agency's field supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

H. Service and maintenance agency qualifications: Manufacturer's authorized service and maintenance representative characteristics shall include the following:

1. Located in the Baltimore/Washington, DC metropolitan area.
2. Staff is factory employed and trained.

3. Service available 24 hours a day, seven days a week, 365 days a year.
4. Maintains an adequate stock of manufacturer's genuine or approved parts to service this equipment.
5. Service and maintenance contracts available.

1.7 COORDINATION

A. Obtain interconnection diagrams, interface hardware, accessory components, and installation manual for generator, and other components of the system. Coordinate installation to provide a complete, integrated, operating generator system.

1. Coordinate installation and interface connections with other emergency power supply system equipment.

B. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate terminations of generator fuel piping outside of generator enclosure.

1.8 PROJECT CONDITIONS

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

1. Ambient temperature: 5 to 40 deg C.
2. Relative humidity: 0 to 95 percent.
3. Altitude: Sea level to minimum 1000 feet (300 m).

1.9 WARRANTY

A. Special warranty: Manufacturer's standard form in which 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:

1. Warranty period: Five years from date of substantial completion.
2. Warranty shall include all parts and labor with no deductible.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every ten of each type and rating, but no less than one of each.
2. Indicator lamps: One for every five of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

B. Provide fuel required for testing, re-testing, and demonstrations.

1.11 MAINTENANCE SERVICE

A. Initial maintenance service: Beginning at Substantial Completion, provide 12 months, full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising 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. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-design product: Subject to compliance with requirements, provide products manufactured by Kohler Co.; Power Systems, or comparable product by one of the following:

1. Caterpillar; Power Generation
2. Cummins Inc.; Power Systems
3. Generac
4. Kohler Co.; Power Systems
5. MTU Onsite Energy; Rolls-Royce Power Systems AG

2.2 GENERATOR SET

A. Generator set characteristics: The generator set system shall comprise a package of equipment including:

1. A liquified-petroleum (LP) gas engine and alternator assembly to provide emergency electric power.
2. Generator-mounted start-stop control system.
3. Mounted accessories as specified.
4. Factory-assembled and -tested, engine-generator set.

B. Generator set ratings:

1. Duty rating shall be based on emergency/standby service.
2. Operate at 1800 rpm and 480/277 volts AC, 3-phase, 4-wire, 60 hertz.
3. The generator set shall be rated at values indicated on the drawings at 0.8 pf based on the project conditions listed in Part 1.

C. Performance characteristics:

1. The engine-generator set shall be able to handle the starting step load effects of the connected equipment. Each automatic transfer switch shall be considered a step unless otherwise indicated.
2. Generator set characteristics shall not exceed the following:

a. Starting voltage dip: 30 percent.
b. Peak voltage dip: 15 percent.
c. Frequency dip: 15 percent.
d. Voltage regulation (no load to full load): Plus or minus 1 percent of rated output voltage.
e. Voltage regulation (random): Plus or minus 0.5 percent of rated output voltage.
f. Frequency regulation (steady-state): Isochronous.
g. Frequency regulation (random): Plus or minus 0.25 percent of rated frequency from no load to full load.

3. AC output waveform: Distortion at no load measured line-to-line or line-to-neutral.

    a. Total harmonic distortion (THD): Less than 5 percent
    b. Singe harmonic: Less than 3 percent.
    c. Telephone influence factor (TIF): Less than 50, as determined by NEMA MG 1.
    d. Telephone harmonic factor (THF): Less than 3, as determined by IEC 60034.

4. 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.
5. Sustained short-circuit current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
6. Start time: Comply with NFPA 110, Type 10, system requirements.
7. Excitation system: Performance shall be unaffected by voltage distortion caused by nonlinear load.

D. Engine:

1. Liquified-petroleum gas engine: Four-cycle, with liquified-petroleum (LP) gas backup system with fan and water pump. It shall have the number cylinders and minimum displacement to achieve required brake horsepower rating at 1800 rpm.

    a. Carburetor.
    b. Secondary gas regulators.
    c. Fuel-shutoff solenoid valves.
    d. Flexible fuel connectors.
    e. Liquified-petroleum (LP) gas source pressure shall be 7 to 11 inches H_2O for proper operation.

E. Generator: Three-phase, single bearing, synchronous type built to NEMA MG 1 standards.

1. Alternator: Brushless, 4-pole, 2/3 pitch windings, 125 degrees C standard temperature rise. Class H insulation shall be used on the stator and rotor, and both shall be further protected with 100 percent epoxy impregnation and an overcoat of resilient insulating material on end coils to protect against fungus or abrasion. The alternator shall incorporate a resettable thermal protector for exciter/regulator protection. The alternator shall be twelve lead, wye connected.
2. Regulator: Permanent magnet excitation for power source to voltage regulators, solid-state controlled, exciter/regulator, matching the characteristics of the alternator and engine. Voltage regulation with adjustable electronic isochronous governor. Readily accessible voltage droop, voltage level, and voltage gain controls shall be provided. The solid state regulator module shall be shock mounted and epoxy encapsulated for protection against vibration and atmospheric deterioration.
3. The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

F. Mounting:

1. Unit shall be capable of installation on rail system within enclosure base and include vibration isolation as required.

G. Cooling system: Closed loop, liquid-cooled system with engine mounted radiator and blower type fan, sized to maintain safe operation at 104 degrees F (40 degrees C) maximum ambient temperature. The radiator shall be equipped for a duct adapter flange connected to exterior cabinet with flexible connection.

1. Centrifugal jacket water pump: Built on the engine and driven from the engine crankshaft or camshaft, ample capacity to circulate the required flow of engine jacket water through the radiator to remove the total heat rejected from the engine to the jacket water and lubricating oil at 110 percent rated load in 104 degrees F (40 degrees C) ambient while maintaining the optimum jacket water temperature leaving and entering the engine recommended by the engine manufacturer.
2. Thermostatic control valve: Shall maintain constant water temperature to the engine. Provide modulating type thermostatic valves using self-contained thermostats without external bulbs. Provide valves with one or more interchangeable thermostatic elements. Provide nonadjustable type thermostat with operating temperature factory set at the temperature recommended by the engine manufacturer. Design valve so that in event of thermostatic element failure it will fail safe, permitting water flow through the engine.

H. Fuel system: Liquified-petroleum (LP) gas

1. Fuel system shall consist of the following fuel supply:

a. Uninterrupted Liquified-petroleum (LP) gas fuel supply specified in Section 23 1126.

I. Exhaust system:

1. Provide a silencer, including flexible exhaust fitting, properly sized and installed according to the manufacturer's recommendation. Mounting shall be provided by the installing contractor. The silencer shall be mounted so that its weight is not supported by the engine.

a. Muffler/silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

(1) Minimum sound attenuation of 25 dB at 500 Hz.
(2) Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

2. Exhaust pipe size shall be sufficient to ensure that exhaust backpressure does not exceed the maximum limitations specified by the generator set manufacturer.

J. Automatic starting system:

1. Starting motor: DC electric starting system with positive engagement drive. The motor voltage shall be as recommended by the engine manufacturer.
2. Automatic controls: Fully automatic generator set start-stop controls in the generator control panel. Controls shall provide shutdown for low oil pressure, high water temperature, overspeed, and overcrank; and one auxiliary contact for activating accessory items. Controls shall include a multi-cycle, cranking limit with lockout contacts for starting by switch on remote panel.

K. System accessories:

1. Jacket water heater: Unit mounted thermal circulation type water heater incorporating a thermostatic switch, capable of maintaining engine jacket water to 90 degrees F in ambient temperature of minus 10 degrees F. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
2. Starting and station batteries: Lead-acid storage battery set of the heavy duty starting type. 24Vdc battery voltage shall be compatible with the starting system. The battery set shall be of sufficient capacity to provide for 1 1/2 minutes total cranking time without recharging. Include a battery rack and necessary cables and clamps.
3. Battery charger: UL 1236 listed. Engine starting, current limiting battery charger to automatically recharge batteries. The charger shall have adjustable float and equalize voltage. DC amperage output shall be no less than 10 amperes. Output voltage shall be compatible with starting system. AC input voltage shall be 120V. Charger shall include fused overload protection; circuit breaker overcurrent protection; solid-state, silicon diode full wave rectifiers; voltage surge suppressors; DC voltmeter and AC ammeter; temperature voltage regulator; relays indicating AC power failure, low-, and high-battery voltage.

L. Generator control panel:

1. Type: Generator mounted NEMA 250 Type 1, vibration isolated, dead front, made of sheet metal gauge steel, with lockable hinged door.
2. Panel shall contain, but not be limited to, the following equipment:

    a. Voltmeter, 2 percent accuracy.
    b. Ammeter, 2 percent accuracy.
    c. Ammeter voltmeter, phase selector switch.
    d. Frequency meter, dial type (45-65 Hz).
    e. Automatic starting controls.
    f. Voltage level adjustment rheostat.
    g. Dry contacts for remote alarms wired to terminal strips.
    h. Fault indicators for low oil pressure, high water temperature, overspeed, and overcrank.
    i. Three position selector switch with the following functions: auto, manual, off/reset.
    j. Emergency stop switch.
    k. Panel light.
    l. Running time meter.
    m. Oil pressure and water temperature gauges.

3. Remote outputs for monitoring.

M. Generator output circuit breaker(s):

1. Type: Molded-case circuit breaker serving standby loads, Molded-case electronic trip type serving life safety loads, size as indicated on drawings. Circuit breaker shall conform to standards established by UL 489, and NFPA 70. Circuit breaker trip elements shall have inverse time delay for overload conditions and instantaneous magnetic tripping for short-circuit protection.
2. The circuit breaker trip curve shall be coordinated with alternator thermal damage curve as required by generator manufacturer data.

    a. Generator/exciter field circuit breakers do not meet the specified electrical standards and are unacceptable for line protection.

3. Shunt trip device: The shunt trip shall open the generator circuit breaker in the event of an engine shutdown signal, and shall operate from the cranking battery voltage.
4. Circuit breakers shall be lockable in the open position.

2.3 GENERATOR ENCLOSURE

A. Manufacturer's standard enclosure: Prefabricated weather-resistant, sound attenuated enclosure sized to house the generator, sub-base fuel tank, battery charger, batteries, and required accessories. Enclosure shall be factory-assembled by the generator manufacturer.

B. Sheet metal steel enclosure primed with corrosion protection and painted with electrostatically-applied powder coat finish of manufacturer's standard color. Enclosure shall include roof, side walls, and end walls. Hardware shall be stainless steel.

1. Lifting provisions: Capacity to support total assembly weight during rigging.
2. Access doors: Provide sufficient access for maintenance and operation from outside the enclosure.

    a. Handles key lockable, all doors keyed alike.

3. Air intake and sound attenuation louver openings shall be screened to limit entry of rodents.
4. Roof shall be designed to prevent collection of rainwater.
5. Provide factory-mounted exhaust silencer inside the enclosure. Exhaust shall exit the enclosure through a rain collar and terminate at a rain cap. Exhaust connections to the generator set shall be made with seamless flexible connections.

C. Sound attenuation: Enclosure shall be constructed to mitigate noise level to 85 dBA maximum at 23 feet (7 m) from enclosure at rated generator output.

D. Accessories:

1. Enclosure manufacturer shall provide the hardware required to mount the exhaust silencers while maintaining the enclosure's weather resistance.

2.4 EXTERNAL VIBRATION ISOLATION DEVICES

A. Elastomeric isolator pads: Oil- and water-resistant elastomer, arranged in single or multiple layers, molded with a non-slip 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.

1. Material: Double layer, standard neoprene.

2.5 REMOTE ALARM ANNUNCIATOR PANEL

A. Surface-mounted panel, complying with the requirements of NFPA 110, Level 1 equipment, providing visible and audible alarm signals powered by the storage battery of the generator. Unit enclosure: Fabricated of sheet steel, with removable front panel. The front panel shall contain LED type indicating lamps (visible signals) as listed below. The enclosure shall contain the required printed circuits, internal wiring, terminal block and battery voltage sensors. Provide knockouts for external wiring through bottom of box.

B. Provide on face of panel the following switches:

1. Lamp test pushbutton.
2. Audible alarm: Silence switch.

LAMP LEGEND	GENERATING SET CONDITION INDICATED	DERANGEMENT SIGNALS Audible	Visible
EXERCISING	Generator exercising	No	Yes
GENERATING	Generating Power to Load	Yes	Yes
OVERCRANK	Failed to Start	Yes	Yes
LOW ENG TEMP	Low Lube Oil Pressure	Yes	Yes
HI ENG TEMP PRE	Excessive Engine Temperature Pre-Alarm	Yes	Yes
HI ENG TEMP	Excessive Engine Temperature	Yes	Yes
LOW OIL PRESS PRE	Low Lube Oil Pressure Pre-Alarm	Yes	Yes
LOW OIL PRESS	Low Lube Oil Pressure	Yes	Yes
OVERSPEED	Engine Overspeed	Yes	Yes
LOW FUEL	Low Fuel Supply	Yes	Yes
LOW COOLANT	Low Engine Coolant Level	Yes	Yes
AUTO SWITCH	Control Switch Not in Automatic Position	Yes	Yes
LOW CRANK VOLT	Low Engine Cranking Voltage	Yes	Yes
LOW BATT VOLT	Low Battery Voltage	Yes	Yes
HI BATT VOLT	High Battery Voltage	Yes	Yes
ALARM CONTACT	Contacts for Common Alarm	Yes	Yes

2.6 MONITORING SYSTEM

A. Monitoring system: Provide contacts from generator for monitoring by the power monitoring system for the following functions:

1. Generator off.
2. Generator running.
3. Generator exercising.
4. Generator alarms: Overcrank, low oil pressure, high or low engine temperature, overspeed, batteries.

B. Provide control interface for monitoring the generator status through the building fire alarm system.

2.7 SYSTEM OPERATION

A. Loss of normal power:

1. System is given signal to start by one of the automatic transfer switches or a remote device. Loss of power can occur at any automatic transfer switch, which can cause the generator to start. On receipt of this signal, generator shall automatically start, accelerate to rated frequency and build up to rated voltage.
2. Priority shall be set to actuate the automatic transfer switch designated in the following order:

   a. ATS-1: Emergency / Life safety
   b. ATS-2: Standby Equipment

3. After the first transfer switch closes to the bus, subsequent transfer switches shall close to the bus after pre-determined time delays.

B. Failure of generator to start:

1. If a unit fails to start, after the overcrank time delay (in the generator set control) has expired, the unit will be shut down, and an alarm will sound.

C. Return of normal power:

1. When normal power has been restored to the normal power system bus and sensed at each transfer switch, the loads shall be transferred back to normal source.
2. The generator shall operate until all transfer switches have returned to normal power switch position and operate at no load for a cool-down period. When the cool-down period has been completed, the generator shall shut down.
3. If a system start signal is received during the cool-down period, generator shall remain online and operate as described in “Loss of Normal Power” above.

2.8 SOURCE QUALITY CONTROL

A. Prototype testing: Perform factory performance tests using prototype generator of same engine model and alternative configuration, and assembled with like components and accessories. Provide three certified copies of the successful test reports.

1. Tests: Comply with NFPA 110, Level 1, energy converters in Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2.
2. Alternator tests: Comply with IEEE 115.
3. Equivalent components and accessories: Submit evidence that items furnished with the unit, but that are not identical to those on the prototype, are reliable and compatible with the application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in requirements for connecting piping and wiring for generator and verify conditions. Verify actual sizes and locations of connections are correct before packaged engine-generator installation.

3.2 PREPARATION

A. Battery equalization: Equalize charging of battery cells according to manufacturer’s written instructions.

3.3 INSTALLATION - GENERATORS

A. Install generators, complete with controls, accessories, and enclosure, as indicated on the drawings and in accordance with manufacturer’s recommendations.

B. Comply with generator manufacturer’s written installation and alignment instructions and with NFPA 37 and 110.

C. Install the remote alarm annunciator panel where indicated on drawings.

D. Set generators plumb and level on concrete base with vibration isolators. Secure to anchor bolts installed in the concrete base.

E. Install generators so as to provide access for maintenance and service, including removal of drivers and accessories.

F. Install piping, wiring, accessories, and appurtenances in accordance with the applicable specifications and manufacturers’ recommendations. Ground equipment.

G. Comply with applicable portions of NECA 404.

H. Generator and enclosure accessories shall be connected to the building electrical distribution system via branch circuits and feeders as indicated on drawings.

I. Verify proper fuel pressure for natural gas engines.

3.4 IDENTIFICATION

A. Materials: Refer to Section 26 0553 for requirements on identification of electrical systems. Identify units, devices, fuse blocks, relays, controls, and wiring. Identify equipment ratings.

B. Nameplates: Refer to Section 26 0553 for requirements on identification of electrical systems. Provide nameplate for each unit and associated components located on front of assembly.

C. Control components mounted within the assembly shall be identified with tags and other identification materials, and correspond to designations on manufacturer's drawings.

D. Operating instructions: Provide fabricated frame on side of unit to house operating instruction manuals.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's field service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections; and to assist the Contractor in testing.

B. Tests and inspections:

1. Perform tests recommended by manufacturer. Perform electrical tests and visual and mechanical inspection for "AC Generators and or Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
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: 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. Retain subparagraph below for long, restricted exhaust systems.
6. Voltage and frequency transient stability tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
7. Harmonic-content tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

8. Noise level tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations, and compare measured levels with required values.

C. Coordinate generator testing with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units; retest and reinspect as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. The unit shall operate without undue noise or vibration, or excessive heating. Correct defects and retest until unit is operating satisfactorily.

K. Demonstrate satisfactory operation of each feature required of the generator set and accessories.

L. Test emergency power system: After completion and acceptance of the generator tests, perform an operational test of the emergency power system. Perform a power failure test on the emergency electrical system. This shall be performed by interrupting the normal power source and verifying proper generator start and transfer switch operation.

M. Report results of tests and inspections in writing. Record adjustable device 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.

3.6 ACCEPTANCE TESTING

A. In addition to the factory and field tests required in Part 2, perform a scheduled on-site test and demonstration of the completely installed generator before making final electrical connections.

B. Test shall be witnessed by the Owner's representative, and manufacturer's representative. Manufacturer's representative shall conduct demonstrations.

C. Provide and utilize load bank for testing. Load banks shall be capable of providing full load at 1.0 power factor.

D. Test procedures: Test the generator in accordance with NFPA 110 and as follows:

1. Test the generator for at least two hours under full load, starting and stopping at least five times.

   a. The unit shall operate without undue noise or vibration, or excessive heating. Correct defects and retest until unit is operating satisfactorily.

b. Demonstrate satisfactory operation of each feature required of the generator set and accessories.

3.7 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by the manufacturer.

3.8 OPERATING INSTRUCTIONS

A. As specified in Section 26 0500, provide operating instructions.

B. Provide at least one session of four consecutive hours of additional instruction time for each system specified in this section.

END OF SECTION