

**DIVISION 26 - ELECTRICAL**  
**SECTION 263214 - ENGINE GENERATORS**

**1.1 PART 1 GENERAL**

**A. RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**B. SUMMARY**

1. Section includes packaged engine-generator sets for Emergency Standby power supply with the following features:
  - a. Diesel engine.
  - b. Unit-mounted cooling system.
  - c. Unit-mounted control and monitoring.
  - d. Performance requirements for sensitive loads.
  - e. Fuel system.
  - f. Parallel generator sets.
  - g. Load banks.
  - h. Outdoor enclosure.

**C. DEFINITIONS**

1. **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.

D. ACTION SUBMITTALS

1. Product Data: For each type of product.
  - a. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - b. Include thermal damage curve for generator.
  - c. Include time-current characteristic curves for generator protective device.
  - d. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
  - e. Include generator efficiency at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
  - f. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95, 80, 70, and 50 deg F. Provide drawings showing requirements and limitations for location of air intake and exhausts.
  - g. Include generator characteristics, including, but not limited to kw rating, efficiency, reactances, and short-circuit current capability.
2. Shop Drawings:
  - a. Include plans and elevations for engine-generator set and other components specified. Indicate access requirements affected by height of subbase fuel tank.
  - b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and

location and size of each field connection.

- c. Identify fluid drain ports and clearance requirements for proper fluid drain.
- d. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

E. INFORMATIONAL SUBMITTALS

- 1. Source quality-control reports, including, but not limited to the following:
  - a. Certified summary of prototype-unit test report.
  - b. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
  - c. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
  - d. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
  - e. Report of sound generation.
  - f. Report of exhaust emissions showing compliance with applicable regulations.
  - g. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
  - h. Field quality-control reports.
  - i. Standard Warranty: Terms for factory standard warranty that must include parts, labor, and travel coverage for the full term of the

warranty.

F. CLOSEOUT SUBMITTALS

1. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.
  - a. In addition to items specified in division 1 "Operation and Maintenance Data," 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) Operating instructions laminated and mounted adjacent to generator location.
    - 3) Training plan.

G. QUALITY ASSURANCE

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved by manufacturer.

H. WARRANTY

1. 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.
  - a. Warranty Period: Two (2) years from date of Substantial Completion.

**PART 1 PRODUCTS**

2.1 **MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar; Engine Div. (Basis-of-Design), Carter Machinery Co. Inc. - Jason Crews 757-995-7546. No alternates will be accepted.
  2. Basis-of-Design: Catapilar model #3516CHD with alternator arrangement #3111156
  3. Source Limitations: Obtain packaged generator sets and auxiliary components through local Caterpillar dealer assigned to the building site territory that would normally provide service and product support.

## 2.2 **PERFORMANCE REQUIREMENTS**

- A. ASME Compliance: Comply with ASME B15.1.
- B. Comply with EPA emission standards for reciprocating internal combustion engines (RICE).
- C. NFPA Compliance:
1. Comply with NFPA 37.
  2. Comply with NFPA 70.
  3. Comply with NFPA 110 requirements for Level 1 emergency power supply system.[If applicable]
- D. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.

- E. Noise Emission: 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. Not to exceed 52 db over a 4 hour period of time at the property line.
- F. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: -25 to 40 deg C
  2. Relative Humidity: Zero to 95 percent.
  3. Altitude: Sea level to 3000 feet.

### 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 24 in accordance with NFPA 110.
- D. Induction Method: Turbocharged.
- E. Governor: Adjustable isochronous, with speed sensing.
- F. Emissions: Comply with EPA Tier 2 requirements.
- G. 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.
  - 2. Capacities and Characteristics:
    - a. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
    - b. Output Connections: Three-phase, four wire.
    - c. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

H. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: 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 three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
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. 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 five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
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 generator system components.

8. Start Time: Comply with NFPA 110, Type 10, system requirements.

## 2.4 **ENGINE**

- A. Fuel: Fuel oil, Grade DF-2 ULS type.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.
- D. Lubrication System: The following items are mounted on engine or skid:
  - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
  - 3. 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.
- E. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- F. 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. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 100 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
  - a. Rating: 50-psi maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
  - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
6. Fan: Driven by multiple belts from engine shaft
7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

- G. 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 15dBA attenuation for industrial grade muffler
  - 2. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 75 dBA or less and complies with local sound level restrictions
- H. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- I. Starting System: 24Vdc 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 Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  - 3. Cranking Cycle: As required by NFPA 110 for system level 1.
  - 4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. 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.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
  - a. Operation: Equalizing-charging rate of 20 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 F to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
  - c. Automatic Voltage Regulation: Maintain 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.

- 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.

## 2.5 **DIESEL FUEL-OIL SYSTEM**

- A. Comply with NFPA 30.
- B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanizing shall not be used in the fuel-oil system.
- C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.
- D. Fuel Filtering: Remove water and contaminants larger than 1 micron. Raycor bypass dual filter arrangement.
- E. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:
  - 1. Tank level indicator.

2. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills, plus fuel for the hours of continuous operation per section G.2 above.
3. Leak detection in interstitial space.
4. Vandal-resistant fill cap.
5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

## 2.6 **PART 1**

- A. CONTROL AND MONITORING
- B. Automatic Starting System Sequence of Operation: When generator mode, on the Engine Mounted Control Panel (EMCP) is set to Auto, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When EMCP mode is set to Run, generator set starts. Setting the control mode to Stop initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
- C. Provide minimum run time control set for 30 minutes with override only by operation of a remote emergency-stop switch.
- D. Comply with UL 508A.

- E. Configuration: Operating and safety indications, protective devices, basic system controls, and engine indications 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.
- F. Indicating Devices : As required by NFPA 110 for Level 1 system, including the following:
1. AC voltmeter.
  2. AC ammeter.
  3. AC frequency meter.
  4. EPS supplying load indicator.
  5. Ammeter and voltmeter phase-selector switches.
  6. DC voltmeter (alternator battery charging).
  7. Engine-coolant temperature gage.
  8. Engine lubricating-oil pressure gage.
  9. Running-time meter.
  10. Current and Potential Transformers: Instrument accuracy class.
- G. 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 / warning
16. Generator-voltage adjustment
17. Main fuel tank low-level alarm.
  - a. Low fuel level alarm shall be initiated when the level falls below that required for operation for the duration required in "Fuel Tank Capacity" Paragraph in "Diesel Fuel-Oil System" Article.



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.
- H. 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.
- I. Generator Run and Common Alarm: Generator Control system must include a generator run relay and common alarm relay.
- J. Connection to Datalink: Provide connections for datalink transmission of indications to remote data terminals via CAN data link. Provide RS-485 Annunciator data link (Modbus RTU / RS485 Half Duplex).
- K. Engine Mounted Control Panel with Integrated Audible Alarm: Comply that meet NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Panel shall be powered from the engine-generator set battery.
1. Capable of storing a minimum of 40 events for recall by operator.

2. Include 6 programmable digital inputs and 6 form A dry contacts
- L. Local Alarm Annunciator: Local indication of generator alarms and warnings for ease operation and maintenance
- M. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface-mounting type to suit mounting conditions indicated.
1. Overcrank alarm.
  2. Coolant low-temperature alarm.
  3. High engine temperature prealarm.
  4. High engine temperature alarm.
  5. Low lube oil pressure alarm.
  6. Overspeed alarm.
  7. Low fuel main tank alarm.
  8. Low coolant level alarm.
  9. Low cranking voltage alarm.

10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Low cranking voltage alarm.

- N. Remote Emergency-Stop Switch: Wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

## 2.7 **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, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
  2. Trip Settings: Selected to coordinate with generator thermal damage curve.

3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
  4. Auxiliary Contact: Included for indication and control functions
  5. Mounting: Adjacent to or integrated with control and monitoring panel.
- C. Integrate Generator Protection: Engine Mounted Control Panel shall have integrated generator protection to include generator phase sequence, over/under voltage, over/under frequency, reverse power (kW), reverse power (KVA<sub>r</sub>), Overcurrent, and Thermal Damage Curve.
- D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.
1. Indicate ground fault with other generator-set alarm indications.
- E. If output circuit breaker(s) and/or generator controls are located more than 6'-6" above the finished grade and/or are not readily accessible and with clearances as required by the NEC, provide all necessary work and materials including but not limited to ramps, stairs, and platforms required to achieve compliance with the conditions above. All provisions shall conform to OSHA, state and local safety requirements including but not limited to handrails, markings, signage, and access barriers.

## 2.8 **GENERATOR, EXCITER, AND VOLTAGE REGULATOR**

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H
- D. Generator Winding Temperature Rise: 105°C over 40°C ambient
- E. Range: Provide limited 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 rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Dripproof.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
  - 1. Adjusting Controls on Engine Mounted Control Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
  - 2. Maintain voltage within 30 percent on one step, full load.
  - 3. Provide anti-hunt provision to stabilize voltage.
  - 4. Maintain frequency within 30 percent and stabilize at rated frequency within 5 seconds.

5. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
6. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
7. Subtransient Reactance: 12 percent, maximum.

## 2.9 **OUTDOOR GENERATOR-SET ENCLOSURE**

- A. Description: Sound-attenuating, weatherproof steel housing, wind resistant up to 150 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance.
1. Structural Design and Anchorage: Comply with IBC for wind loads up to 150 mph.
  2. Hinged Doors: With padlocking provisions.
  3. Space Heater: Thermostatically controlled and sized to prevent condensation.
  4. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
  5. LED Lighting: Interior LED lighting capable of AC or DC operation
  6. Control Panel Viewing Window: Integrated into enclosure door
  7. Muffler Location: Mounted Inside Enclosure. No rooftop mounted muffler
- B. 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.
  2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating. [if required by ambient conditions]
  3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running. [if required by ambient conditions]
- C. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.
- D. Sound Attenuation: With four generators operating at 100% the sound shall not exceed the local requirement having jurisdiction and/or not to exceed 52 db over a 4 hour period of time at the property line.

## 2.10 **MOTORS**

- A. Description: NEMA MG 1, Design B, medium induction random-wound, squirrel cage motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.

- D. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- E. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- F. Temperature Rise: Match insulation rating.
- G. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- I. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

## 2.11 **VIBRATION ISOLATION DEVICES**

- A. Restrained Spring Isolators: Freestanding, steel, linear-spring isolators.
  - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.



2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

## 2.12 **FINISHES**

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

## 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.

- 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. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

## 2.14 **PART 1 EXECUTION**

### A. EXAMINATION

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

## 2.15 **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 in

Section 033000 "Cast-in-Place Concrete."

2. Coordinate size and location of concrete bases for packaged engine generators .

Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

- C. Install packaged engine-generator to provide access, without removing connections or accessories, for periodic maintenance.
- D. Install packaged engine-generator in a walk-in enclosure with restrained spring isolators having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure enclosure to anchor bolts installed in concrete bases.
- E. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints.
- F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

## 2.16 IDENTIFICATION

- A. Identify system components according to Section 260553 "Identification for Electrical Systems."
- B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

## 2.17 **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. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections.
- C. 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.
    - b. Electrical and Mechanical Tests
      - 1) Perform insulation-resistance tests in accordance with IEEE 43.

- (a) Machines larger than 200 horsepower. Test duration shall be 10 minutes. Calculate polarization index.
  - 2) Test protective relay devices.
  - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
  - 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.
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.
  6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
  7. Exhaust Emissions Test: Comply with applicable government test criteria.
  8. Four hour reactive load bank test at 100% load for each generator. Upon completion of the commissioning of the paralleling gear, reactive load bank test the paralleled generators at 100% percent load for two hours.
- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- F. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Remove and replace malfunctioning units and retest and reinspect as specified above.
- J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- K. 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.

## 2.18 **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. Provide this in a contract between the owner and the manufacturer.

2.19 **DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

**END OF SECTION**