SECTION 26 3213.13 - DIESEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - **GENERAL**

1. SUMMARY

a. Section includes packaged engine generators used to supply non-emergency power, with the following features:

1) Diesel engine.
2) Diesel fuel-oil system.
3) Control and monitoring.
4) Generator overcurrent and fault protection.
5) Generator, exciter, and voltage regulator.
6) Vibration isolation devices.

b. Related Requirements:

B. Section 26 3600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1) Section 26 3600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

2. ACTION SUBMITTALS

a. Product Data: For each type of product.

b. Shop Drawings:

1) Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2) Include details of equipment assemblies. Indicate dimensions, weights, 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) Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5) Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6) Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

3. INFORMATIONAL SUBMITTALS

a. Qualification Data: For manufacturer.

b. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

c. Source quality-control reports.

d. Field quality-control reports.

e. Warranty.

4. CLOSEOUT SUBMITTALS

a. Operation and maintenance data.

5. QUALITY ASSURANCE

a. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

b. Testing Agency Qualifications: Accredited by NETA.

1) Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

6. 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.

1) Warranty Period: 5 years from date of Substantial Completion.

PART 2 - **PRODUCTS**

1. MANUFACTURERS

a. Basis of design: Generac SD600/Optional two MG300

b. Acceptable alternate: Cummins 600DGCA / Optional two DQDAC

2. PERFORMANCE REQUIREMENTS

a. Seismic Performance: Engine generator housing, subbase fuel tank, engine generator, batteries, battery racks, silencers, load banks, sound attenuating

equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1) The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

b. B11 Compliance: Comply with B11.19.

c. NFPA Compliance:

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

3. Comply with NFPA 99.
4. Comply with NFPA 110 requirements for Level 1 EPSS.

a. UL Compliance: Comply with UL 2200.

b. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.

c. Noise Emission: Provide with Level 2 enclosure.

d. 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 104 deg F.
2) Relative Humidity: Zero to 95 percent.
3) Altitude: Sea level to 1000 feet.

e. Unusual Service Conditions: Engine generator equipment and installation are required to operate under the following conditions:

1) .

5. ENGINE GENERATOR 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 qualified testing agency, and marked for intended location and use.

c. Power Rating: Standby.

d. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.

e. EPSS Class: Engine generator shall be classified as a Class 48 according to NFPA 110.

f. Governor: Adjustable isochronous, with speed sensing.

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 engine generator center of gravity.

h. Capacities and Characteristics:

1) 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.
2) Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

i. Engine Generator 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:

a) Comply with NFPA 110, Type 10 system requirements.
b) 10 seconds.

6. DIESEL ENGINE

a. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.

b. Rated Engine Speed: 1800 rpm.

c. Lubrication System: Engine or skid-mounted.

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.

d. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499 and with NFPA 110 requirements for Level 1 equipment for heater capacity.

e. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator 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 110 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-, UV-, and abrasion-resistant fabric.

a) Rating: 50-psig 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.

f. 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 25 feet from exhaust discharge after installation is complete shall be 78 dBA or less.

g. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

h. Starting System: 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 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 specified.

4) Battery: Nickel cadmium, 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 Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
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 35-A minimum continuous rating.
9) Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for nickel-cadmium batteries. Unit shall comply with 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 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.

7. DIESEL FUEL-OIL SYSTEM

a. Comply with NFPA 37.

b. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 23 1113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel 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.

e. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

f. Fuel-Oil Storage Tank: Comply with requirements in Section 23 1323 "Facility Aboveground Fuel-Oil Storage Tanks."

1) Fuel Tank Capacity:48 hours at 100% load.
2) Duplex Fuel-Oil Transfer Pump: Comply with requirements in Section 23 1213 "Facility Fuel-Oil Pumps."

g. 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 planned operation plus fuel for periodic maintenance operations between fuel refills.
3) Leak detection in interstitial space.
4) Vandal-resistant fill cap.
5) Containment Provisions: Comply with requirements of authorities having jurisdiction.

8. 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 engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

b. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator 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 gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

f. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.

g. Control and Monitoring Panel:

1) Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2) Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
3) Instruments: Located on the control and monitoring panel and viewable during operation.

a) Engine lubricating-oil pressure gage.
b) Engine-coolant temperature gage.
c) DC voltmeter (alternator battery charging).
d) Running-time meter.
e) AC voltmeter, for each phase.
f) AC ammeter, for each phase.
g) AC frequency meter.
h) Generator-voltage adjusting rheostat.

4) Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:

a) Cranking control equipment.
b) Run-Off-Auto switch.
c) Control switch not in automatic position alarm.
d) Overcrank alarm.
e) Overcrank shutdown device.
f) Low-water temperature alarm.
g) High engine temperature prealarm.
h) High engine temperature.
i) High engine temperature shutdown device.
j) Overspeed alarm.
k) Overspeed shutdown device.
l) Low fuel main tank.

i. Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required for the indicated EPSS class.

m) Coolant low-level alarm.
n) Coolant low-level shutdown device.
o) Coolant high-temperature prealarm.
p) Coolant high-temperature alarm.
q) Coolant low-temperature alarm.
r) Coolant high-temperature shutdown device.
s) EPS load indicator.
t) Battery high-voltage alarm.
u) Low cranking voltage alarm.
v) Battery-charger malfunction alarm.
w) Battery low-voltage alarm.

x) Lamp test.
y) Contacts for local and remote common alarm.
z) Low-starting air pressure alarm.
aa) Low-starting hydraulic pressure alarm.
bb) Remote manual stop shutdown device.
cc) Air shutdown damper alarm when used.
dd) Air shutdown damper shutdown device when used.
ee) Generator overcurrent-protective-device not-closed alarm.
ff) Hours of operation.
gg) Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

h. Engine Generator Metering: Comply with Section 26 0913 "Electrical Power Monitoring and Control" and Section 26 2713 "Electricity Metering."

i. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

j. Remote Alarm Annunciator: An LED indicator light 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- or flush-mounting type to suit mounting conditions indicated.

1) Overcrank alarm.
2) Low water-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) Fuel tank derangement alarm.
16) Fuel tank high-level shutdown of fuel supply alarm.
17) Lamp test.
18) Low-cranking voltage alarm.
19) Generator overcurrent-protective-device not-closed alarm.

k. 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.

l. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

9. GENERATOR OVERCURRENT AND FAULT PROTECTION

a. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

10. 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.
11. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

a. 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) Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
4) Mounting: Adjacent to, or integrated with, control and monitoring panel.

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 engine generator is shut down by other protective devices.
4) Mounting: Adjacent to, or integrated with, control and monitoring panel.

c. Generator Disconnect Switch: Molded-case type; 100 percent rated.

1) Trip Rating: Matched to generator output rating.
2) Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

d. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1) Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2) Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3) As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4) Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

e. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1) Indicate ground fault with other engine generator alarm indications.
2) Trip generator protective device on ground fault.

12. 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. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six -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 rating, and heat during operation at 110 percent of rated capacity.

g. Enclosure: Dripproof.

h. Instrument Transformers: Mounted within generator enclosure.

i. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1) Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2) Maintain voltage within 20 percent on one step, full load.
3) Provide anti-hunt provision to stabilize voltage.
4) Maintain frequency within 10 percent and stabilize at rated frequency within 5 seconds.

j. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

k. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

l. Subtransient Reactance: 12 percent, maximum.

13. 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.

1) Material: Standard neoprene separated by steel shims.

b. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

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

c. Comply with requirements in Section 23 2116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.

d. Comply with requirements in Section 23 3113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

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

14. SOURCE QUALITY CONTROL

a. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1) Tests: Comply with IEEE 115 and with NFPA 110, Level 1 Energy Converters.

PART 3 - **EXECUTION**

1. INSTALLATION

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 10 working days in advance of proposed interruption of electrical service.
2) Do not proceed with interruption of electrical service without Owner's written permission.

b. Comply with NECA 1 and NECA 404.

c. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

d. 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 03 3000 "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.
3) Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."

e. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

f. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1) Piping materials and installation requirements are specified in Section 23 2113 "Hydronic Piping."
2) Install flexible connectors and steel piping materials according to requirements in Section 23 2116 "Hydronic Piping Specialties."
3) Insulate muffler/silencer and exhaust system components according to requirements in Section 23 0719 "HVAC Piping Insulation."
4) Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9 inches of clearance from combustibles.

g. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

1) Piping materials and installation requirements are specified in Section 23 2113 "Hydronic Piping."
2) Drain piping valves, connectors, and installation requirements are specified in Section 23 2116 "Hydronic Piping Specialties."

h. Fuel Piping:

1) Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 23 1113 "Facility Fuel-Oil Piping."
2) Copper and galvanized steel shall not be used in the fuel-oil piping system.

i. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

2. CONNECTIONS

a. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

b. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.

c. Connect cooling-system water piping to engine generator and heat exchanger with flexible connectors.

d. Connect engine exhaust pipe to engine with flexible connector.

e. Connect fuel piping to engines with a gate valve and union and flexible connector.

f. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

g. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

h. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3. IDENTIFICATION

a. Identify system components according to Section 23 0553 "Identification for HVAC Piping and Equipment" and Section 26 0553 "Identification for Electrical Systems."

b. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

4. FIELD QUALITY CONTROL

a. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

b. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

c. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

d. Perform tests and inspections with the assistance of a factory-authorized service representative.

e. Tests and Inspections:

1) Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two

subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.

a) Visual and Mechanical Inspection:

i. Compare equipment nameplate data with Drawings and the Specifications.
ii. Inspect physical and mechanical condition.
iii. Inspect anchorage, alignment, and grounding.
iv. Verify that the unit is clean.
v. Perform vibration test for each main bearing cap.
vi. 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 Emissions Test: Comply with applicable government test criteria.
7) 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.
8) Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
9) Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet from edge of the generator enclosure, and compare measured levels with required values.

f. Coordinate tests with tests for transfer switches and run them concurrently.

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

h. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

i. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

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

k. Remove and replace malfunctioning units and reinspect as specified above.

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

m. 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.

5. 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 26 3213.13