26 32 13 ENGINE GENERATORS: SIGNIFICANT (OR TOTAL) DELETION OF EXISTING TEXT

Delete the following current section in its entirety (deletions are shown struck through).

~~**.01 General**~~

~~A. When use of a generator is approved by Engineering Services, coordinate manufacturer, silencer type, fuel type, amount of fuel storage, and other options.~~
~~B. Maintenance: Not more than four hours' normal travel time from Installer's place of business to University.~~
~~C. Equipment shall not be installed on building roof or other locations that are difficult for service and replacement.~~
~~D. 250 kW and above, provide a BACnet or Modbus interface. Specify that the BAS contractor coordinate with the Generator and/or Interface Manufacturer to communicate with this Interface.~~
~~E. 500 kW and above, discuss the use of paralleling equipment with Engineering Services, to allow for testing under load and include demand side reduction.~~
~~F. Specify a 5 year full coverage warranty.~~
~~G. Coordinate monitoring with the BAS Specification. At Minimum, require monitoring of the following points through the BAS to the PSU CCS:~~
~~1. Generator Fault Status~~
~~2. Low Fuel Level Status~~
~~3. Fuel Tank Leak Detector Status~~
~~4. Hand/Off/Auto switch position at generator control panel (initiate Alarm when the switch is not in Auto position)~~
~~5. Air Damper Status~~
~~H. Emissions - Internal combustion engines rated at greater than 100 brake horsepower for use at the University Park campus must comply with Section 01 41 00 Regulatory Requirements as well as the following:~~

~~Design professional must review all applicable emissions regulations including, but not limited to, Sub parts to EPA 40CFR60 and EPA 40CFR63.~~

~~Professional shall specify that each engine manufacturer provide emissions data for the identified pollutants that are the lowest achieved by the proposed engine type in practice, and that can be guaranteed when installed at University Park. One manufacturer should be the base bid, and the "equals" as bid alternates so that the material costs can be compared versus each engine pollutants during the bid process. Non-responsive bidders may be eliminated from consideration. Note that the successful bidder will be judged only partially on the cost, the emissions data will also weigh heavily in the final equipment selection. The manufacturer shall submit the following:~~

~~1. Copy of applicable regulations with highlighting of emissions limits for this specific unit of units.~~
~~2. Chart comparing identified pollutant limits to those of the proposed engine.~~

~~If the engine is to be utilized as other than a standby source, these emission limits will have to be supported by data collection. Professional shall specify equipment to collect, record, and report such data. Discuss provisions and costs of installing CEMS (Continuous Emissions Monitor System) and CPMS (Continuous Parametric Monitoring System) equipment with Engineering Services.~~

Replace with following text.

.01 General

A. When use of a generator is approved by Engineering Services, coordinate manufacturer, silencer type, fuel type, amount of fuel storage, and other options.

B. Equipment shall not be installed on building roof or other locations that are difficult for service and replacement.

C. 500 kW and above, discuss the use of paralleling equipment with Engineering Services, to allow for testing under load and include demand side reduction.

D. Emissions - Internal combustion engines rated at greater than 100 brake horsepower for use at the University Park campus must comply with Section 01 41 00 Regulatory Requirements as well as the following:

Design professional must review all applicable emissions regulations including, but not limited to, Sub parts to EPA 40CFR60 and EPA 40CFR63.

One manufacturer should be the base bid, and the “equals” as bid alternates so that the material costs can be compared versus each engine pollutants during the bid process. Non-responsive bidders may be eliminated from consideration. Note that the successful bidder will be judged only partially on the cost, the emissions data will also weigh heavily in the final equipment selection.
If the engine is to be utilized as other than a standby source, these emission limits will have to be supported by data collection. Professional shall specify equipment

to collect, record, and report such data. Discuss provisions and costs of installing CEMS (Continuous Emissions Monitor System) and CPMS (Continuous Parametric Monitoring System) equipment with Engineering Services.

.02 Guide Specifications

A. Design Professional shall carefully review and edit the guideline specifications below, adapting them as needed to achieve application-specific, fully developed specifications for each project.

B. These shall be edited using the process described in the instructions contained at the beginning of the document. Proposed modifications shall be reviewed with OPP Engineering Services.

C. Finalized version shall be included in the project contract documents. Use of other specifications is not acceptable.

Document	Version Date	Description
Engine Generators Guide Specification.docx	June 2016	University's guide specification for Engine Generators; to be used by the design professional.
Engine Generators Datasheet.docx	June 2016	Typical University Engine Generators Datasheet for the Professionals use. The datasheet instructions are found in the guide specification and a sample is found in Division 26 00 00.

END of revision

Update Commentary:

Section was updated primarily for the following reasons:

1) *Deleted old section and replaced with new section, which includes a new guide specification section and new additional datasheet.*

SECTION 263213 - ENGINE GENERATORS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

General Notes:

1. *This guide specification is intended to provide the Design Professional with a basic guideline of minimum OPP requirements.*

2. *The guide specification shall be carefully reviewed and edited with respect to application-specific project requirements. Proposed modifications shall be reviewed with OPP Staff.*

3. *Finalized version shall be included in the project contract documents.*

Editing Notes

1. *This OPP Guide specification must only be altered by notation (i.e. deleted text with strikethrough and additional text with double underline). This shall be accomplished by using Tools /Track Changes / Highlight Changes, and select "Track changes while editing" in MS Word or equivalent.*

2. *The Review Submittal Specification section shall be provided in electronic form for OPP Review.*

3. *Leave the following Note ("For Construction Document Review, Design Submittal") as part of the Review Submittal, to aid any Reviewer to understand WHY there are strikeouts and underlines. Also, leave any "DESIGNER NOTE" placed in this Guide Spec.*

4. *AFTER comments are received from PSU and incorporated, the strikeouts and underlines shall be removed, and the REVIEWER NOTEs deleted, before the spec is issued for Bidding.*

5. *Data Sheet Instructions:*

    a. *Engineer completes "SPEC DATA" column with information about equipment including but not limited to ratings, features and options. The data sheet is then submitted with completed specifications for bid.*

    b. *Manufacturer completes "VENDOR DATA" column and returns completed data sheet with bid or submittal.*

    c. *Engineer verifies that design specifications have been met by checking that specified features match submitted features.*

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

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

B. All sections of the project manual are directly applicable to this specification section. Should a conflict arise between specification sections or between specifications and drawings and/or code requirements, the contractor shall notify the Architect/Engineer of the conflict in writing. If direction is not provided prior to the submission of the bid, the contractor shall price the more extensive system.

1.2 SUMMARY

A. Section includes packaged engine-generator sets for [**emergency**] [**standby**] power supply with the following features:

Adjust list below to suit Project.

Designer note: Natural Gas units shall only be considered for applications of less than or equal to 125HP.

1. [**Diesel**] [**Natural Gas**] [**Natural-gas with LP backup**] engine.
2. [**Unit-mounted**] cooling system.
3. [**Unit-mounted**] [**and remote-mounted**] control and monitoring.
4. Performance requirements for sensitive loads.
5. Fuel system.
6. Outdoor enclosure.

B. Related Requirements:

Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

A. 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.

B. LP: Liquid petroleum.

C. EPS: Emergency power supply.

D. EPSS: Emergency power supply system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.

Retain first option in first subparagraph below for diesel-fired units. Retain second option for gas, spark-ignition units.

4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
6. 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.
7. Include generator characteristics, including, but not limited to kw rating, efficiency, reactances, and short-circuit current capability.
8. Include address of nearest service center. Must be within 4 hours response time of equipment installed location.
9. Include product information confirming the unit meets proper EPA and Pennsylvania requirements for state and local governments.
    a. Highlight emissions limits for specific engine type.
    b. Provide chart comparing identified pollution limits with proposed engine type.
10. Include finish color of outdoor enclosures for Owner approval.

B. Shop Drawings:

1. Include plans and elevations for engine-generator set and other components specified. Indicate access requirements affected by height of sub base 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 EPS equipment and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article.

A. Qualification Data: For [**Installer**] [**manufacturer**] [**and**] [**testing agency**].

Retain "Seismic Qualification Certificates" Paragraph below if required by seismic criteria applicable to Project. Coordinate with Section 260548.16 "Seismic Controls for Electrical Systems." See ASCE/SEI 7 for certification requirements for equipment and components.

B. Seismic Qualification Certificates: For engine-generator set, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails identify center of gravity and total weight[**including full fuel tank**], [**supplied enclosure,**] [**external silencer,**] [**subbase-mounted fuel tank,**] and each piece of equipment not integral to the engine-generator set, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

Coordinate paragraph below with "Source Quality Control" Article.

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

See the Evaluations for discussion about prototype-unit testing.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

Retain first subparagraph below for generator sets specified to meet performance requirements and for generator sets serving sensitive loads.

3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

Retain "Field quality-control reports" Paragraph below if Contractor is responsible for field quality-control testing and inspecting.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

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.

1.7 MAINTENANCE MATERIAL SUBMITTALS

Extra materials may not be allowed for publicly funded projects.

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

Quantities below are examples only.

1. Fuses: One for every 10 of each type and rating but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.8 QUALITY ASSURANCE

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

Retain "Testing Agency Qualifications" Paragraph below if Contractor selects testing agency or if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article. Qualification requirements are in addition to those specified in Section 014000 "Quality Requirements," which also defines "NRTL" (nationally recognized testing laboratory).

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

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

1.9 WARRANTY

When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

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.

Verify available warranties and warranty periods for units and components. Suggested 5 year minimum full coverage warranty is suggested.

1. Warranty Period: [**5**] <**Insert number**> years from date of Substantial Completion.

Retain Extended Warranty paragraph below per Owner request.

2. Extended Warranty: <**Insert number**> years from date of Factory Warranty expiration.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. For an explanation of options and Contractor's product selection procedures, see Section 016000 "Product Requirements."

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Caterpillar; Engine Div.
2. Cummins
3. Generac Power Systems, Inc.
4. Kohler Power Systems.
5. MTU Onsite Energy Corporation.

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

2.2 PERFORMANCE REQUIREMENTS

Retain "Seismic Performance" Paragraph below with "Seismic Qualification Certificates" Paragraph in "Informational Submittals" Article for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

A. Seismic Performance: Engine-generator set housing, [**subbase fuel tank,**] [**day tank,**] engine-generator set, batteries, battery racks, silencers, and sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

Retain first subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

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**]."
2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst case normal levels.[**Water shall be substituted for diesel fuel in fuel tank during test.**]

For life-safety components required to function after an earthquake (such as fire-sprinkler systems, components that contain hazardous content, and storage racks in structures open to the public), the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.

3. Component Importance Factor: [**1.5**] [**1.0**].

B. ASME Compliance: Comply with ASME B15.1.

C. NFPA Compliance:

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

Retain first subparagraph below for healthcare facilities.

3. Comply with NFPA 99.

Retain subparagraph below if generator is automatically started. See the Evaluations for discussion of emergency generator Level requirements.

4. Comply with NFPA 110 requirements for Level [**1**] [**2**] emergency power supply system.

D. UL Compliance: Comply with UL 2200.

Selection of Tier 2, 3, or 4 in "Engine Exhaust Emissions" Paragraph below is dependent on the size of the engine. See discussion in the Evaluations and refer to EPA and manufacturer's documentation. See RICE NESHAP/NSPS Applicability Determination matrix for appropriate emission standards. Coordinate with Owner if any special requirements above regular EPA standards are needed.

E. Engine Exhaust Emissions: Comply with the EPA Emissions Tier that applies to the specific engine size, fuel type, application, date of production, and applicable state and local government requirements

"Class" as used in the "EPSS Class" Paragraph below refers to the number of hours the EPSS is required to operate at full load without refueling. This is determined by application of generator.

F. EPSS Class: Engine-generator set shall be classified as a [**Class 2**] [**Class 6**] [**Class 48**] [**Class 96**] <**Insert Classification**> in accordance with NFPA 110.

Retain "Noise Emission" Paragraph below for installations with critical noise-abatement requirements, particularly outdoor generator sets. Coordinate with noise-reduction features in the design, including those relating to cooling-air intake and discharge arrangement and muffler specification and its location and orientation as shown on Drawings. See the Evaluations for discussion of noise generation and regulations.

G. Noise Emission: Comply with [**applicable state and local government requirements**] <**Insert Project criteria**> for maximum noise level at [**adjacent property boundaries**] <**Insert critical locations**> due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

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

Retain first option in "Ambient Temperature" Subparagraph below if generator-set start time must be within NFPA 110 limits. This temperature range usually implies installation indoors in heated space. Coordinate with Drawings.

1. Ambient Temperature: [**5 to 40 deg C**] [**Minus 15 to plus 40 deg C**].

Delete "Relative Humidity" Subparagraph below for outdoor units.

2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to [**6600 feet**] <**Insert altitude**>.

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. Induction Method: [**Naturally aspirated**] [**Turbocharged**].

D. Governor: Adjustable isochronous, with speed sensing.

E. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

Retain "Rigging Diagram" Subparagraph below if rigging is required.

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.

Coordinate "Capacities and Characteristics" Paragraph below with prototype test requirements in "Informational Submittals" Article and in "Source Quality Control" Article.

F. 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. Output Connections: Three-phase, four-wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

Retain "Generator-Set Performance" Paragraph below for loads involving little or no sensitive electronic equipment, adjustable frequency drives, or uninterruptible power supply systems. See the Evaluations.

G. 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.

Below requires 10-second maximum start time under specific conditions and includes startup only, not load assumption.

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

Retain "Generator-Set Performance for Sensitive Loads" Paragraph below for loads involving sensitive electronic equipment, significant nonlinear load elements, or uninterruptible power supply systems. Coordinate with "Governor" Paragraph in "Assembly Description" Article and with "Generator, Exciter, and Voltage Regulator" Article. See the Evaluations. See Section 263353 "Static Uninterruptible Power Supply" for coordination with UPS equipment.

2.4 ENGINE

Depending on NFPA 110 class and local codes, LP-gas standby may not be required for natural gas-fueled systems. Verify requirements with authorities having jurisdiction. Tier 4 engines have more restrictions on diesel fuel characteristics than Tier 3 or lower engines. Insert specific fuel requirements if specifying Tier 4 engines. PSU to provide fuel requirements for project.

A. Fuel: [**Fuel oil, Grade DF-2**] [**Natural gas with automatic LP-gas standby**] [**Fuel oil, Grade DF-2 start, natural gas run**] [**Natural gas**].

Coordinate specific requirements with owner per application and location.

1. 231113- Facility Fuel-Oil Piping

2. <**Refer to Owner Fuel Specification**>.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).

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.

Retain "Jacket Coolant Heater" Paragraph below where required by NFPA 110, which prescribes engine jacket-water temperature requirements. Coordinate with Drawings for electrical supply.

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.

Retain one of two "Cooling System" paragraphs below. Coordinate with Drawings. See the Evaluations for further discussion of cooling cycle and effect of location on radiator effectiveness.

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.

Retain "Size of Radiator" or "Expansion Tank" Subparagraph below. Retain "Expansion Tank" Subparagraph if containment of coolant expansion by radiator is marginal or inadequate. Coordinate with Drawings.

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-, ultraviolet-, and abrasion-resistant fabric.

a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

Retain one of three "Muffler/Silencer" paragraphs below. Modify dBA requirement in second subparagraphs to accommodate environment in which engine-generator set is operating. If unit is specified with an enclosure, consider specifying sound level requirements at specified distance from enclosure on each of four sides. See the Evaluations for discussion of muffler types and noise criteria.

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 25 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be [**78**] <**Insert number**> dBA or less.

H. Muffler/Silencer: Semicritical 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 18 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be [**85**] <**Insert number**> dBA or less.

I. Muffler/Silencer: Commercial 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 12 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be [**90**] <**Insert number**> dBA or less.

Retain second option in "Air-Intake Filter" Paragraph below if filters may not be serviced as often as recommended. If air contaminant level is excessive, consult manufacturers to determine if special filtration of combustion air is needed. Standard filtration is adequate and typically not worth additional cost. Let specific application guide filter requirements.

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

Select first option in "Starting System" Paragraph below for smaller engine-generator sets. Retain second option for units 175 kW and larger.

K. Starting System: [**12**] [**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.

Retain first option in "Cranking Cycle" Subparagraph below if system description in "Quality Assurance" Article specifies NFPA 110, Level 1 or 2; otherwise, retain second. See the Evaluations for further discussion of cranking cycle.

3. Cranking Cycle: [**As required by NFPA 110 for system level specified**] [**60 seconds**].

First option in "Battery" Subparagraph below complies with NFPA 110 requirements. Second is a more conservative rule used for some industrial applications. Lead-acid batteries are less expensive and perform as well or better than Nicad if temperatures are maintained between zero deg F (minus 18 deg C) and 100 deg F (plus 38 deg C). Note that valve-regulated lead-acid batteries are even more subject to thermal stresses and are not recommended for engine-generator starting service. Nicad batteries have better characteristics in more extreme temperature applications. Verify requirements for eyewash in the vicinity of the batteries with the authority having jurisdiction.

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.

Coordinate "Battery Cable" Subparagraph below with Drawings.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and minimum continuous rating sized according to unit size.

Coordinate "Battery Charger" Subparagraph below with Section 263600 "Transfer Switches." Retain if battery charger is not specified to be integral with transfer switch.

7. 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 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F (minus 40 deg C) to 140 deg F (plus 60 deg C) 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.

First "Safety Functions" Subparagraph below covers sensing for safety indications on control and monitoring panel. NFPA 110 requires sensing for Level 1 systems and makes sensing optional for Level 2 systems. See the Evaluations for discussion of emergency generator Level requirements.

    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

Retain this article for diesel-engine or diesel-start, natural-gas run units. Coordinate with seismic design criteria. NFPA 110 requires seismic categories C, D, E, and F to have a minimum 96-hour fuel supply for Level 1 engine-generator sets.

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.

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

Large sub base tanks can raise the generator, making maintenance access difficult. Design for access platform or other methods of maintenance access. Coordinate platform with room size, seismic qualification, stair requirements, height restrictions, and structural capacity. Note that handrails may be required depending on height above finished floor. Handrails may need to be removable for some maintenance activities.

F. Sub base-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, must provide electronic readout in gallons of fuel.

Consult tank manufacturers about capacities available for size of set in Project. Coordinate size with owner prio to specifying. See discussion of fuel tanks in the Evaluations.

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 for indicated EPSS class.
3. Top of tank must provide spill containment for leaks from piping, coolant system,etc.
4. Leak detection in interstitial space must have a means of testing to ensure proper operation.
5. Visible and audible overfill alarm with means to silence, must have a means of testing to ensure proper operation.
6. Metal drop tube to prevent static discharge must be present in the fill port that extends to 6” from the tank bottom. This is not required if the tank is 12” deep or less.
7. Tank shall be grounded and all electric connections shall meet PA Department of Labor and Industry and NFPA requirements.
8. The primary vent pipe must be no smaller than the fill pipe and must terminate above the normal snow level. If the tank is located indoors, the vent must terminate outdoors.
9. Emergency vents must be present for the inner and outer tanks. If the generator is to be installed indoors, they must be terminated outdoors.
10. Locking spill box/basket around the fill pipe.
11. Vandal-resistant fill cap.
12. A port installed directly on the tank or has an extension pipe, with no bends, to allow for direct fuel sampling. The port shall have a sealable and lockable cap. This port shall be easily accessible and clearly labeled.
13. All ports, vents, pipes etc. must be labelled. Contents of the tank shall be identified on the tank exterior.
14. A “No Smoking” sign must be posted on the tank.
15. If fill is remote from tank, overfill alarm and tank level gauge must be able to be discerned at both the fill and tank location.

Determine applicable codes and regulations, and coordinate "Containment Provisions" Subparagraph below with Drawings.

16. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 GASEOUS FUEL SYSTEM

Retain this article for natural- or LP-gas-fueled generator sets.

Retain either "Natural-Gas Piping" or LP-Gas Piping Paragraph below.

A. Natural-Gas Piping: Comply with requirements in Section 231123 "Facility Natural-Gas Piping."

B. LP-Gas Piping: Comply with requirements in Section 231126 "Facility Liquefied-Petroleum Gas Piping."

C. Gas Train: Comply with NFPA 37.

D. Engine Fuel System:

Revise subparagraph below if generator will be connected to a single LP-gas or natural-gas service. Duel fuel systems may be required by the authorities having jurisdiction in seismic risk areas.

1. [**Dual Natural-Gas with LP-Gas Backup**] [**Natural-Gas**] [**LP-Gas**], Vapor-Withdrawal System:

a. Carburetor.

Retain "Secondary Gas Regulators" Subparagraph below if generator will be connected to a separate gas service.

b. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
c. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
d. Fuel Filters: One for each fuel type.

Locate valve in "Manual Fuel Shutoff Valves" Subparagraph below outside of the EPSS room.

e. Manual Fuel Shutoff Valves: One for each fuel type.
f. Flexible Fuel Connectors: Minimum one for each fuel connection.

Retain two subparagraphs below if generator will be connected to both LP and natural-gas services.

g. LP-gas flow adjusting valve.
h. Fuel change gas pressure switch.

2.7 CONTROL AND MONITORING

This article specifies the subsystem that monitors, protects, and controls the engine-generator. See the Evaluations for more discussion of control and monitoring panels.

Retain "Automatic Starting System Sequence of Operation" Paragraph below for automatically starting systems; retain "Manual Starting System Sequence of Operation" Paragraph below for Level 2 manually starting systems.

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more

separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

Retain "Manual Starting System Sequence of Operation" Paragraph below for Level 2 units.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

NFPA 70 requires a minimum of 15 minutes run time and NFPA 110 recommends a minimum of 30 minutes. Typical exercise set for 30 min.

C. Provide minimum run time control set for [**30**] <**Insert number**> minutes with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

Retain one of three "Configuration" paragraphs below to describe control and monitoring unit configuration. Coordinate retained paragraph with Drawings. Retain first "Configuration" Paragraph unless special requirements justify significant extra cost of one of the other two configurations. See the Evaluations.

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 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**] [**2**] system, including the following:

Retain first five subparagraphs below for Level 1 systems because they are required by NFPA 110. Consider retaining them for Level 2 systems also.

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**] [**2**] system, including the following:

See the Evaluations for typical local and remote alarm indications and shutdowns.

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. Air shutdown damper shutdown device when used.
8. Overcrank alarm.
9. Overspeed alarm.
10. Coolant high-temperature alarm.
11. Coolant low-temperature alarm.
12. Coolant low-level alarm.
13. Low lube oil pressure alarm.
14. Air shutdown damper alarm when used.
15. Lamp test.
16. Contacts for local and remote common alarm.

Retain first three subparagraphs below for Level 1 systems because they are required by NFPA 110. Consider retaining them for Level 2 systems also.

17. Coolant high-temperature prealarm.
18. Generator-voltage adjusting rheostat.
19. 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.

Retain first two subparagraphs below for automatic start systems. Delete for manual start systems.

20. Run-Off-Auto switch.
21. Control switch not in automatic position alarm.

Retain one of first two subparagraphs below for Level 1 pneumatic start engines. Consider retaining them for Level 2 systems also.

22. Low-starting hydraulic pressure alarm.

Retain first four subparagraphs below for Level 1 battery start engines. Consider retaining them for Level 2 systems also.

23. Low cranking voltage alarm.
24. Battery-charger malfunction alarm.
25. Battery low-voltage alarm.
26. Battery high-voltage alarm.

Retain subparagraph below for units with "generator-protector" feature.

27. Generator overcurrent protective device not closed 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.

Retain paragraph below if generator is greater than or equal to 250kW. Features in "Connection to Datalink" Paragraph below facilitate connection to building automation system or building control and monitoring system. Coordinate with Drawings and Section covering data transmission and data terminals.

I. Connection to Datalink: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication. Provide connections for datalink transmission of indications to remote data terminals via **ModBus** <**Insert other data protocol**>.
   1. Provide hardwired contacts for the following points:
      a. Not in Auto
      b. Generator Fault Status
      c. Low Fuel Level Status
      d. Fuel Tank Leak Detected

Retain "Remote Alarm Annunciator" Paragraph below and coordinate with Drawings for systems required to comply with NFPA 99 or where otherwise needed. Revise if all indications required by NFPA 99 are not needed. Consider locating remote alarm annunciator in switchgear room.

J. 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- or flush-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.

Retain first two subparagraphs below for automatic start systems. Delete for manual start systems.

   13. Run-Off-Auto switch.
   14. Control switch not in automatic position alarm.

Devices in first three subparagraphs below are optional.

   15. Fuel tank derangement alarm.
   16. Fuel tank high-level shutdown of fuel supply alarm.
   17. Lamp test.

Retain first subparagraph below for Level 1 battery start engines. Consider retaining it for Level 2 systems also.

   18. Low cranking voltage alarm.

Protective device alarm in subparagraph below may not be standard or available for all generator sets. Verify availability with manufacturers.

19. Generator overcurrent protective device not closed.

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.

2.8 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

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

Retain one or more paragraphs in this article to specify disconnect switch(es) and protective devices for the generator (alternator) component of generator set. Revise as required to accommodate multiple output devices. See the Evaluations for discussion of overload and fault protection.

Retain one of first two paragraphs below. Retain first for units smaller than 200 kW where initial cost is a concern. Device provides little or no generator protection and no selectivity with downstream circuit protective devices. Provide electronic trip-type breakers at 400A or larger.

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. Mounting: Adjacent to or integrated with control and monitoring panel.

Protection scheme specified in "Generator Protector" Paragraph below may be proprietary. Consult manufacturers. Microprocessor-based generator protectors in paragraph are susceptible to vibration and should be mounted in a separate enclosure not mounted on the generator skid.

C. 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 generator-set 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:

Coordinate load shed actions in subparagraphs below with Drawings. Indicate which loads will be shed on generator overload and sequence of action if more than one.

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 generator-set malfunction alarms. Contacts shall be available for load shed functions.

2. Under single or three-phase fault conditions, regulates generator to 250 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 generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

Retain "Ground-Fault Indication" Paragraph below and coordinate with Drawings for legally required emergency generator sets rated 1000 A or more at 277/480 V.

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

Retain one of two subparagraphs below. Retain first subparagraph for emergency and legally required standby systems. Retain second subparagraph for optional standby generator systems. See the Evaluations for discussion of ground-fault protection.

1. Indicate ground fault with other generator-set alarm indications.
2. Trip generator protective device on ground fault.

2.9 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.

Class H insulation in "Electrical Insulation" Paragraph below has a higher temperature rating than Class F. Class H insulation can give the alternator a longer life. Check with manufacturer to determine availability for the generator sized for the project loads.

C. Electrical Insulation: Class H.

Twelve lead alternator in "Stator-Winding Leads" Paragraph below is also known as a "reconnectable" alternator because the leads can be reconnected in the field in series or parallel to change between delta and wye configurations.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six lead alternator.

The output voltage adjustment in "Range" Paragraph below increases in each of the three ranges.

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.

Delete "Instrument Transformers" Paragraph below if instrument transformers are housed in control and power panel.

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.

One-step, full-load application in first subparagraph below should maintain voltage so load relays or contactors do not drop out. Verify percentage of voltage drop permissible to maintain loads.

2. Maintain voltage within [**15**] [**20**] [**30**] percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within [**5**] [**10**] [**15**] percent and stabilize at rated frequency within [**2**] [**5**] seconds.

Retain "Strip Heater" Paragraph below for high-humidity environments to limit condensation in alternator windings.

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

Retain "Windings" and "Subtransient Reactance" paragraphs below for units specified for "critical" performance. Coordinate with "Generator-Set Performance" Paragraph in "Assembly Description" Article. See "Installation Considerations" Article in the Evaluations for discussions on sensitive electronic equipment and nonlinear generator loads and on supplying significant harmonic currents.

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

2.10 OUTDOOR GENERATOR-SET ENCLOSURE

Retain one of two "Description" paragraphs below and coordinate with Drawings to define basic outdoor-enclosure type. Edit to specify enclosure features required. Coordinate requirements for water, fuel, power, controls, and alarms with Drawings. Consult with Owner on outdoor enclosure preference.

A. Description: Vandal-resistant, rodent resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

Coordinate "Description" Paragraph below with Drawings showing features, construction details, and equipment arrangement. Walk-in enclosures are suggested for 1MW units and larger but is project dependent.

B. Description: Prefabricated or pre-engineered galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure, erected on concrete foundation.

Revise wind speed in "Structural Design and Anchorage" Subparagraph below to suit local conditions.

1. Structural Design and Anchorage: Comply with ASCE 7 for wind loads up to 100 mph (160 km/h).
2. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

Fire protection in an outdoor generator enclosure is optional. Although the enclosure may be heated, failure of the heater should not endanger the unit or other fire suppression systems. Consider using a dry pipe system to reduce freezing problems.

3. Fire Protection: Provide fire protection in accordance with [**Section 211316 "Dry-Pipe Sprinkler Systems."**] Provide smoke detector in enclosure; mounted according to NFPA 72.
4. Hinged Doors: With padlocking provisions.

Coordinate "Space Heater" Paragraph below with gas piping and controls. Heater can be fueled by the gas service to a gas fueled engine-generator and should be interlocked to not run when the engine is running. This will prevent it from interfering with the engine fuel supply, and the heat will not be needed. Space heater in an enclosure for a diesel fueled engine-generator should be electrically powered via a circuit from the normal power supply. It also should be interlocked with the engine.

5. Space Heater: Thermostatically controlled and sized to prevent condensation.
6. Lighting: Provide weather resistant LED lighting with [**50 footcandles ((550 LUX))**] average maintained.
7. 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.
8. Muffler Location: [**Within**] [**External to**] enclosure.
9. Ensure all openings in enclosure sealed off prior to shipment.

C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

Retain "Louvers" or Automatic Dampers" Subparagraph below, or delete both and insert requirement. Some installations use a fixed louver for inlet or the exhaust and an automatic for the other. This is less costly and does not allow free air flow through the enclosure when the unit is not running, but it does lessen the effectiveness of space heaters in the enclosure. Consider specifying automatic dampers on both inlet and exhaust if space heaters are required. See Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for engine-generator, air-inlet and exhaust louvers.

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.

Revise "Ventilation" Subparagraph below if forced ventilation rather than convection ventilation is required.

3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

Coordinate "Interior Lights with Switch" and "Convenience Outlets" paragraphs below with Drawings for lighting types and location, and supply circuits. Insert requirements for ventilation equipment, luminaires, devices, and covers to match components in facility. Verify availability if not retaining walk-in enclosure.

D. Interior Lights with Switch: Factory-wired, vapor-proof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

E. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.11 MOTORS

Retain this article for generator sets with remote radiators.

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:

Starting codes in first subparagraph below are adequate for most variable-torque loads encountered in HVAC applications; 15 hp is a common breakpoint in rating among manufacturers when Code F and Code G apply. Retain both subparagraphs and options below unless Project conditions or equipment characteristics dictate otherwise.

1. Motors [**15**] <**Insert number**> HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than [**15**] <**Insert number**> 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.

2.12 VIBRATION ISOLATION DEVICES

Isolation method is dependent on the application. Springs are recommended for all indoor application but final method shall be determined by designer and confirmed by Owner.

Note that natural rubber is not oil resistant and should not be specified if oil spillage is a problem in the vicinity of the generator. Minimum deflection should be verified with structural or seismic engineer.

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.

See the Evaluations in Section 260548.16 "Seismic Controls for Electrical Systems" for a discussion on vibration and seismic-control devices. Pads in "Material" Subparagraph below come in standard neoprene, natural rubber, and bridge-bearing neoprene. Verify availability of various materials with manufacturers. Costs range from least to most expensive in the order presented below.

1. Material: [**Standard neoprene**] [**Natural rubber**] [**Bridge-bearing neoprene, complying with AASHTO M 251**] separated by steel shims.

Durometer values in "Shore 'A' Scale Durometer Rating" Subparagraph below range from 30 to 70 on the Shore "A" scale and are measures of hardness or, indirectly, deflection. Lower durometer values indicate softer material with more deflection. The durometer rating needed is dependent on the weight of the generator and the number and contact area of pads used. Other factors also affect the selection but are fairly constant across all generators. Durometer values in the middle of the range in subparagraph below are most common. Refer to manufacturer's data once generator characteristics are known before selecting the desired durometer rating. Pad selection may be different for generator normal vibration than is required to withstand and dampen seismic shock. Consult with manufacturer to choose materials suitable for both criteria.

2. Shore "A" Scale Durometer Rating: [**30**] [**40**] [**45**] [**50**] [**60**] [**65**] [**70**] <**Insert number**>.

Use multiple layers, separated by steel shims, depending on supported equipment load. See manufacturer's data for load capacities.

3. Number of Layers: [**One**] [**Two**] [**Three**] [**Four**] <**Insert number**>.
4. Minimum Deflection: [**1 inch (25 mm)**] <**Insert value**>.

Coordinate "Restrained Spring Isolators" Paragraph below with Drawings and with Section 260548.16 "Seismic Controls for Electrical Systems."

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- (6-mm-) 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 (25 mm)**] <**Insert value**>.

C. Comply with requirements in Section 232116 Hydronic Piping Specialties" for vibration isolation and flexible connectors materials for steel piping.

D. Comply with requirements in Section 233113 "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.

2.13 FINISHES

Coordinate finish color with Owner, refer to 1.4A.10 for Owner approval of finish.

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

2.14 SOURCE QUALITY CONTROL

NFPA 110 does not require testing of the specific unit supplied to the Project but does allow a unit used for prototype testing to be utilized on a project if there was no damage to the unit and the authority having jurisdiction, the Owner, and the user are notified that it is a prototype unit. NFPA 110 does require Prototype testing for Level 1 units.

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.

Consider requiring Level 1 compliance in "Tests" Subparagraph below for other than Level 1 installations to obtain benefits of specific standard requirements.

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

The project-specific equipment tests in the "Project-Specific Equipment Tests" Paragraph below are in addition to the prototype tests listed above. They do not test the unit under the full range of conditions as the above tests but are useful to provide assurance that the specific unit supplied to the Project meets most of the critical parameters that can be tested without stressing the unit.

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 for 30 minutes at rated kW and .85 power factor.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

Delete "Interruption of Existing Electrical Service" Paragraph below if no interruption of existing electrical service is required.

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 [**Construction Manager**] [**Owner**] no fewer than fourteen working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Construction Manager's**] [**Owner's**] written permission.

3.3 INSTALLATION

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

Verify with Project participants which concrete section in the "Equipment Mounting" Paragraph below will be used for concrete pads and bases.

B. Equipment Mounting:

Retain first subparagraph below to require equipment to be installed on cast-in-place concrete equipment bases.

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."**] [**Section 033053 "Miscellaneous 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.

Retain subparagraph below for remote radiators located on roof.

3. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Section 077200 "Roof Accessories."

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

NFPA 110 requires indoor Level 1 engine generators to be installed in a dedicated room with 1 or 2 hour fire rating. Indoor installations also require the storage of fuel within the building and large air flows for

cooling and combustion. Consult NFPA 110 and the authority having jurisdiction for requirements. Minimum deflection should be verified with structural or seismic engineer.

D. Install [**packaged engine-generator**] [**engine-generator in a walk-in enclosure**] with [**elastomeric isolator pads**] [**restrained spring isolators**] having a minimum deflection of [**1 inch (25 mm)**] <**Insert static deflection**> on 4-inch- (100-mm-) high concrete base. Secure [**sets**] [**enclosure**] to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. 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. Install flexible connectors and steel piping materials according to requirements in Section 232116 Hydronic Piping Specialties."
2. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."

Refer to Section 077200 "Roof Accessories" for roof curbs, piping supports, and roof-penetration boots.

3. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9 inches (225 mm) clearance from combustibles.

Coordinate first paragraph below with Drawings.

F. 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.

G. Installation requirements for piping materials and flexible connectors are specified in Section 232116 "Hydronic Piping Specialties." Copper and galvanized steel shall not be used in the fuel-oil piping system.

H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

Coordinate piping installations and specialty arrangements with Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

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 service and maintenance.

Coordinate first two paragraphs below with Section 230716 "HVAC Equipment Insulation."

Coordinate first paragraph below with Section 232116 "Hydronic Piping Specialties."

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

D. Connect fuel piping to engines with a gate valve and union and flexible connector. Provide fusible link or interlocked generator shut-off to stop fuel flow to generator in event of fire.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90 degree bend in flexible conduit routed to the generator set from a stationary element.

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

3.5 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

Retain the following paragraph if the generator is not installed as a separately derived system.

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

3.6 FIELD QUALITY CONTROL

Retain one of first three paragraphs below, which identify who shall perform tests and inspections. If retaining second option in "Testing Agency" Paragraph or if retaining "Manufacturer's Field Service" or "Perform tests and inspections" paragraphs, retain "Field quality-control reports" Paragraph in "Informational Submittals" Article.

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

Retain "Manufacturer's Field Service" Paragraph below to require a factory-authorized service representative to perform inspections, tests, and adjustments.

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

Retain "Perform tests and inspections" Paragraph below to require Contractor to perform tests and inspections.

C. Perform tests and inspections.

Retain "Manufacturer's Field Service" Subparagraph below to require a factory-authorized service representative to assist Contractor to perform test and inspections.

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

Retain "Tests and Inspections" Paragraph below to describe tests and inspections to be performed by any of the entities in three paragraphs above.

D. Tests and Inspections:

NETA and other testing requirements indicated in subparagraphs below may be in excess of those required for Project. Review NETA and other tests listed and revise subparagraphs below to retain only those tests deemed necessary.

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 including all options tests unless waived by Owner. 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 (150 kilowatts). Test duration shall be 10 minutes. Calculate polarization index.
            b) Machines 200 horsepower (150 kilowatts) or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.

        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.

Retain "Exhaust-System Back-Pressure Test" Subparagraph below for long, restricted exhaust systems.

6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). 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.

Verify local requirements and delete "Exhaust Emissions Test" Subparagraph below for most projects. Few jurisdictions require this test for emergency or standby generator sets. See the Evaluations for discussion of Tier requirements.

7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. 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.

Retain "Noise Level Tests" Subparagraph below for projects subject to unwanted or illegal generator-set noise intrusion into adjacent properties or activities. Coordinate with Drawings and with requirements in "Action Submittals" and "Quality Assurance" articles and in "Assembly Description" Article. Note that some noise, such as the muffler noise, is directional and siting the generator can have a large impact on the measured noise in some directions. See the Evaluations for additional discussion of noise concerns.

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

F. 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.

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

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

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

J. Remove and replace malfunctioning units and **retest** as specified above.

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

L. 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.

M. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection

while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Perform two follow-up infrared scans of generator, one at four months and the other at 11 months after date of Substantial Completion.
3. Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 MAINTENANCE SERVICE

Retain this article for critical installations and consider including a provision for submitting a continuing maintenance agreement proposal. Revise starting date if required. Obtain a copy of maintenance agreement before retaining or editing below. Maintenance contracts may not be allowed for publicly funded projects.

A. Initial Maintenance Service: Beginning at Substantial Completion, provide [**12**] <**Insert number**> 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.

B. Provide additional bid for five years of scheduled maintenance.

3.8 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 263213

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END OF SECTION 263213

DATA SHEETS ENGINE GENERATORS		Equipment Name:	
DESCRIPTION	**UNITS**	**SPEC DATA**	**VENDOR DATA**
Manufacturer	N/A	By Manufacturer	
Model/Catalog No.	N/A	By Manufacturer	
SITE CONDITIONS			
Minimum Ambient Temperature	ºC		
Maximum Ambient Temperature	ºC		
Operating Noise Limit	dBA		
GENERATOR RATINGS			
Model No.	-	By Manufacturer	
Prime Power	kVA/MVA		
Standby Power	kVA/MVA		
Power Factor	-		
Terminal Voltage	V		
No. Phases / No. Wires	-		
Voltage Regulation	%		
Frequency	Hz		
Frequency Regulation	%		
Rated Engine Speed	RPM	1800	
Rated Full Load Amperes	A	By Manufacturer	
Ground Configuration	-		
Fuel Type	-		
EPSS Class	-		
EPA Tier	-		
ENCLOSURE			
Finish	-		
Weight as Installed	Lb	By Manufacturer	
Generator Dimension (L x W x H)	Inches	By Manufacturer	
Sound Attenuation Enclosure	-		
GENERATOR OVERCURRENT AND FAULT PROTECTION			
Manufacturer/ Model No.	-	By Manufacturer	
Main Breaker Frame/Sensor Rating	A		
Standard Functions	-	L,S, I,G	
Breaker Short Circuit Rating (Minimum Sym. Interrupting)	kA		
CONTROLS			
Remote Data Connection	Type	Modbus	
Hardwired Alarm Contacts	Y/N		
SPECIAL REQUIREMENTS			