

SECTION 263213 - ENGINE GENERATORS

Latest Update 5-10-2017 See underlined text for Edits.

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all "Underlines".)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
 - 1. Diesel engine.
 - 2. Unit-mounted cooling system.
 - 3. Unit-mounted control and monitoring.
 - 4. Performance requirements for sensitive loads.
 - 5. Load banks.
 - 6. Outdoor enclosure.
 - 7. Sound-attenuated enclosure.
 - 8. Sub-base storage tank.
 - 9. SCADA or BMS interface.

1.3 DEFINITIONS

- 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.

1.4 SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Thermal damage curve for generator.

2. Time-current characteristic curves for generator protective device.
 3. Engine performance and specs.
 4. Alternator performance and specs.
 5. Fuel tank and sub-base tank capacities and alarms.
 6. Water jacket heater wattage, voltage and phases.
 7. Muffler and connecting pipes.
 8. Radiator duct flanges.
 9. Output circuit breaker.
 10. Control panel and monitoring system.
 11. Enclosure.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 4. Wiring Diagrams: Power, signal, and control wiring.
- C. Overcurrent Protective Device Coordination Study: Submit study prepared by a licensed professional engineer that proves the emergency power supply system and the normal power system will coordinate and can withstand the available short-circuit faults.
- D. Manufacturer Sizing Calculations: The manufacturer shall submit a generator sizing calculation to verify the generator will start and maintain the connected loads. In addition, the generator shall be oversized by 25% for consideration of future loads. The following list of equipment and steps are provided for the basis of the calculation:
1. Step Load 1:
 - a. Fluorescent Lighting: () kVA
 - b. UPS System: 6-Pulse, () % THD input filter, 0.90 pf () kVA output, 0.85 efficiency, 115% current limit while on generator
 - c. General Misc. Loads: () kVA, 0.90 pf
 - d. Lab Equipment: () kVA, 0.90 pf
 - e. Motor: () HP, (0.) efficiency, () pf
 - f. ACU: () Tons, 0.85 efficiency, 0.87 pf
 - g. Fan: () HP, () efficiency, () pf
 2. Step Load 2:

- a. Fluorescent Lighting: () kVA
 - b. UPS System: 6-Pulse, () % THD input filter, 0.90 pf () kVA output, 0.85 efficiency, 115% current limit while on generator
 - c. General Misc. Loads: () kVA, 0.90 pf
 - d. Lab Equipment: () kVA, 0.90 pf
 - e. Motor: () HP, (0.) efficiency, () pf
 - f. ACU: () Tons, 0.85 efficiency, 0.87 pf
 - g. Fan: () HP, () efficiency, () pf
3. Step Load 3:
- a. Fluorescent Lighting: () kVA
 - b. UPS System: 6-Pulse, () % THD input filter, 0.90 pf () kVA output, 0.85 efficiency, 115% current limit while on generator
 - c. General Misc. Loads: () kVA, 0.90 pf
 - d. Lab Equipment: () kVA, 0.90 pf
 - e. Motor: () HP, (0.) efficiency, () pf
 - f. ACU: () Tons, 0.85 efficiency, 0.87 pf
 - g. Fan: () HP, () efficiency, () pf
4. Step Load 4:
- a. Fluorescent Lighting: () kVA
 - b. UPS System: 6-Pulse, () % THD input filter, 0.90 pf () kVA output, 0.85 efficiency, 115% current limit while on generator
 - c. General Misc. Loads: () kVA, 0.90 pf
 - d. Lab Equipment: () kVA, 0.90 pf
 - e. Motor: () HP, (0.) efficiency, () pf
 - f. ACU: () Tons, 0.85 efficiency, 0.87 pf
 - g. Fan: () HP, () efficiency, () pf
5. Performance Parameters:
- a. Maximum loading 85% of rated generator capacity.
 - b. Maximum frequency dip 5%.
 - c. Starting voltage dip maximum 25%.
 - d. Maximum running voltage dip 5%.
- E. Engine Certification: Provide a certified engine per the latest EPA's Nonroad Source Emissions Standard 40 CFR89. The appropriate tier level shall apply based upon the HP of the engine.
- F. Qualification Data: For testing agency.
1. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.

2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 3. Report of sound generation.
 4. Report of exhaust emissions showing compliance with applicable regulations.
 5. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- I. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than 2 hours' normal travel time from Installer's place of business to Project site and shall be available on a 24-hour basis.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- F. Comply with ASME B15.1.
- G. Comply with NFPA 37.
- H. Comply with NFPA 70.
- I. Comply with NFPA 99.
- J. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- K. Comply with UL 2200.
- L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 PROJECT CONDITIONS

- 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 UMB no fewer than 14 days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without UMB's written permission.
- B. 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°C to 40°C.
 - 2. Altitude: Sea level to 1000 feet.

1.7 COORDINATION

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

- B. Provide services of a professional rigging company, where necessary, to provide proper handling and positioning of unit.
- C. Provide all labor and material, storage, etc. for receiving the equipment, storage, transportation to the project site and installation into final location.

1.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide twenty four (24) 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.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One (1) for every ten (10) of each type and rating, but no fewer than one (1) of each.
 - 2. Indicator Lamps: Two (2) for every six (6) of each type used, but no fewer than two (2) of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.10 WARRANTY/GUARANTEE

- A. See Division 26 Specification Section "Basic Electrical Requirements" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide or a comparable product by one (1) of the following:
 - 1. Caterpillar; Engine Div.
 - 2. Generac Power Systems, Inc.
 - 3. Kohler Co.; Generator Division.

4. Onan/Cummins Power Generation; Industrial Business Group.
5. MTU Onsite Energy

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

1. kW/kVA @ 0.8 pf:
2. Voltage:
3. Phase:
4. Wire:

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

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.

C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated.
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.
4. Heavy duty, single bearing, pre-lubricated type.
5. Temperature Rise: 125°C.
6. Self ventilating via direct drive blower.
7. Maximum speed not greater than 1,800 rpm.
8. Flexible coupling of generator shaft to engine flywheel.
9. Self regulating: Revolving field, 4-pole, brushless AC exciter with rotating rectifiers or static-exciter regulator assembly.
10. Stator twice impregnated with varnish, skewed to minimize heating and harmonics.
11. Excitor shall be full-wave rectifier with silicon diodes mounted on rotor shaft. Manual reset circuit breaker shall protect field circuit.
12. Class "H" for 150°C rise over a 40°C ambient, as defined by NEMA Standard MG1-1.65.
13. 2/3 Pitch. Sub transient Reactance: Maximum of 12%.

D. Generator-Set Performance for Non-Sensitive Loads:

1. Steady-State Voltage Operational Bandwidth: 3 % of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 20 % variation for 50 % step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three (3) seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 % 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% variation for 50 % 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 % total and 3 % for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 % of rated full-load current for not less than ten (10) seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

E. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 1 % of rated output voltage from no load to full load.
3. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 % 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 2-Hz variation for 50% step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three (3) seconds.
6. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 % total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 %.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 % of rated full-load

- current for not less than ten (10) seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
8. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet excitation for power source to voltage regulator.
 9. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

- A. Fuel: Fuel oil, Commercial Grade No. 2.
 1. Fuel Consumption @ Full Load:
 2. Housed/Wet Weight:
 3. Motor Starting kVA:
 4. Maximum Voltage Dip for skVA:
- B. Rated Engine Speed: 1,800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines (2-Cycle engines are not permitted): 2,250 fpm.
- D. Lubrication System: The following items are mounted on engine or skid:
 1. Filter and Strainer: Rated to remove 90 % of particles five (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.
 4. The lubrication system shall be of the full pressure type.
 5. Replaceable full flow oil filters.
- E. Engine Fuel System:
 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
 3. Solid injection, full diesel type.
 4. Fuel filter with replaceable element.

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- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
1. Thermostatically controlled, 4 kW (480V, 60 HZ, 1-phase) or 1.5 kW (120V, 60 Hz, 1-phase), isolation valves for servicing. Provide disconnect switch at generator.
- G. Governor: Adjustable isochronous, with speed sensing.
1. Cummins EFC or Woodward DSLC.
 2. Frequency variation shall not exceed +/- 0.25% for constant loads from 0-100%.
- H. 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 % ethylene-glycol-based antifreeze and 50% 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% load condition.
 - a. Radiator Cooling (CFM)
 - b. Generator Cooling (CFM)
 3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180°F, and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. 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 12 dB at 500 Hz.
 2. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 67 dBA at 300-3000 Hz or less.
 3. Condensate drain with manual valve on muffler.
 4. Flexible stainless steel connector from muffler to engine.
 5. Muffler sized per engine manufacturer
 6. Flanges, gaskets, fittings, connectors, brackets and piping as required.

7. Corrosion resistant rain cap on vertical pipe tip.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: 24-V electric, with negative ground.
 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" 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: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
 - a. Lead calcium type batteries.
 - b. CCA rated per engine manufacturer for 0°F starting.
 - c. Non-metallic, corrosion resistant rack.
 - d. Champion, Interstate, Exide, C&D Charter, or equal.
 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 10°C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. 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°C to plus 60°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 %.

- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30.
- B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
 - 1. Pressure testing of 5 psi on both inner and outer tank.
 - 2. Double wall tank.
 - 3. Tank level indicator.
 - 4. () gallon capacity.
 - 5. 12 gauge corrosion resistant steel tank.
 - 6. 12 gauge top and bottom baffles, 7 gauge steel channel side supports.
 - 7. All required fittings and connections, including, but not limited to, fuel supply and return, fuel level gauge, low fuel alarm, manual fill, vent, fuel in rupture tank alarm, etc. Pressure relief vent caps shall be supplied for both inner and outer tank. All alarms shall annunciate on the control panel digitally and on the remote annunciator.
 - 8. Maximum height of tank thirty (30) inches.
 - 9. Coordinate tank with electrical and plumbing connections.
 - 10. Provisions for electrical stub-up access and removable end wall.
 - 11. Painted to match the color of the generator enclosure.
 - 12. Capacity: Fuel for seventy two (72) hours' continuous operation at 100 % rated power output.
 - 13. Vandal-resistant fill cap.
 - 14. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.5 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is

running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

- B. 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.
- C. 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.
- D. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:
 - 1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
- E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
 - 1. AC voltmeter.
 - 2. AC ammeter.
 - 3. AC frequency meter.
 - 4. DC voltmeter (alternator battery charging).
 - 5. Engine-coolant temperature gage.
 - 6. Engine lubricating-oil pressure gage.
 - 7. Running-time meter.
 - 8. Ammeter-voltmeter, phase-selector switch(es).
 - 9. Generator-voltage adjusting rheostat.
 - 10. Fuel tank derangement alarm.
 - 11. Fuel tank high-level shutdown of fuel supply alarm.
 - 12. Generator overload.
- F. 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.
- G. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link

transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

- H. Common Remote Audible/Visual Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
 2. Low oil pressure.
 3. High engine temperature.
 4. Overspeed.
 5. System ready.
 6. Low battery voltage.
 7. Low fuel.
 8. High engine temperature (pre-alarm).
 9. Low oil pressure (pre-alarm)
 10. Coolant low-temperature alarm.
 11. Control switch not in auto position.
 12. Battery-charger malfunction alarm.
 13. Battery low-voltage alarm.
 14. Auxiliary alarm.
 15. Auxiliary (pre-alarm).
 16. Liquid in rupture tank.
 17. Ground fault indication.
 18. Engine running.
- I. Automatic Shutdown Control:
1. Emergency stop.
 2. Fail to crank.
 3. High AC voltage.
 4. High coolant temperature.
 5. Low AC voltage.
 6. Low oil pressure.
 7. Over-crank.
 8. Over-speed.
 9. Short circuit.
 10. Under-frequency.
 11. Low coolant level.
- 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 shutdown.
2. Low oil pressure.
3. High engine temperature.
4. Over-speed.
5. System ready.
6. Low battery voltage.
7. Low fuel.
8. High engine temperature (pre-alarm).
9. Low oil pressure (pre-alarm)
10. Coolant low-temperature alarm.
11. Control switch not in auto position.
12. Battery-charger malfunction alarm.
13. Battery low-voltage alarm.
14. Auxiliary alarm.
15. Auxiliary (pre-alarm).
16. Liquid in rupture tank.
17. Ground fault indication
18. Engine running.

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

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Insulated-case, electronic-trip type; 100 % 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.
- B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 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 F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 % of rating, and heat during operation at 110% of rated capacity.
- F. Enclosure: Drip-proof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 % adjustment of output-voltage operating band.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Subtransient Reactance: 12%, maximum.
- L. Manual digital adjustment.
- M. Synchronous operation for immunity to SCR tracking.
- N. Steady state output voltage maintained at +/- 0.5% of rated voltage from 0-100%
- O. Output voltage recovery to +/- 1% of final voltage in less than four (4) seconds after adding/removal 25% load increments.

2.8 SOUND ATTENUATED ENCLOSURE

- A. The generator set shall be housed in a ruggedly constructed, weatherproof aluminum enclosure enclosing control panel, battery charger, circuit breaker and all other generator-mounted devices. The enclosure shall have inspection doors located at all control and maintenance points for easy access. Doors shall be complete with continuous piano hinge gasketing and key locking handles. Expanded metal louvers or hoods shall be located for cooling air inlet. Roof shall be one piece construction with provisions for exhaust pipe penetration. A minimum of two lifting eyes shall be provided for hoisting of enclosure only. A steel perimeter frame shall be provided for mounting onto the generator set skid rails. All penetrations for conduit, piping, exhaust, etc. shall be sealed to maintain weatherproof and sound attenuating properties.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to one hundred (100) mph. 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.
- B. Description: Prefabricated enclosure with the following features:
1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed enclosure erected on concrete foundation.
 2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
 3. Space Heater: Thermostatically controlled and sized to prevent condensation.
 4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
 5. Hinged Doors: With padlocking provisions.
 6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
 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: External to enclosure.
- C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 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.
- D. Interior Lights with Switch: Factory-wired, vaporproof-type 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.

2.10 CONCRETE EQUIPMENT PADS

- A. Provide a concrete equipment pad for all generators.

- B. Install concrete pads and bases according to requirements of Division 3 Section "Cast-in-Place Concrete"
- C. Anchor each generator by bolting steel unit rails to vibration isolators. Secure vibration isolators to concrete pad.

2.11 VIBRATION ISOLATION DEVICES

- A. 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 one quarter (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 % of compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 % of required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 % of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 % of rated load, fully compressed, without deformation or failure.

2.12 FINISHES

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

2.13 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Full load run.
 - 3. Maximum power.

4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide fourteen (14) days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within ten (10) days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

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

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with restrained spring isolators having a minimum deflection of one (1) inch on four (4) inch high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. 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. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Specifications.
 1. 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. Flexible connectors and piping materials and installation requirements are specified in Division 23 Specification.

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

3.3 CONNECTIONS

- A. Mechanical Connections: The mechanical contractor shall be responsible for fuel oil piping, exhaust stack, and final connections to the engine generator.
- B. Connect engine exhaust pipe to engine with flexible connector.
- C. Storage Tank and Accessories: Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel oil systems are specified in Division 23, Specification Sections “Fuel Oil Systems and Accessories” and “Valves for HVAC Piping Systems”.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

- A. Identify system components according to Division 23 Section "Identification for HVAC Systems and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems"

- specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding forty (40) inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
 7. Exhaust Emissions Test: Comply with applicable government test criteria.
 8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 % and 100 % step-load increases and decreases, and verify that performance is as specified.
 9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 % and at 100 % of rated linear load. Verify that harmonic content is within specified limits.
 10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations identified by the Owner, and compare measured levels with required values.
- E. Coordinate tests with tests for transfer switches and run them concurrently.
- F. Test instruments shall have been calibrated within the last twelve (12) months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- G. Leak Test: After installation, charge system 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.
- 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 sixty (60) days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan eleven (11) months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: 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.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 263213