

SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each generator system include rated capacities, operating characteristics, electrical characteristics, weights, wiring diagrams, thermal damage curves, output breaker specific model numbers, finish, air flow requirements warranty, furnished specialties and accessories. etc. Include detailed drawings of pad dimensions, clearances, elevations, etc.

B. Training

1. Cover installation, maintenance, troubleshooting, programming, repair and operation of the system.

1.2 EXTRA MATERIALS

- ##### **A. Filters:** Furnish (1) set of lubricating oil filter(s), (1) set of air filter(s).

1.3 GENERAL

- ##### **A.** Provide unit with performance characteristics of the emergency generator system components that are equal to (or exceed) the quality and performance of the Design Base unit specified below. Equal KW/KVA ratings alone shall not necessarily equate another manufacturer or model to that specified below. Component Finishes: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer unless noted otherwise on plans or finish matrix.
- ##### **B.** 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 QUALITY ASSURANCE

- ##### **A.** Qualifications: Manufacturer's authorized representative who is trained and approved for installation and/or supervision of installation of units required for this Project. Maintain, within 40 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs, with not more than one-hour normal travel time from manufacturer representative's place of business to Project site.
- ##### **B.** Source Limitations: Obtain packaged generator sets, transfer switches and auxiliary components through one source from a single manufacturer.

- C. Comply with NFPA 37. Comply with applicable local code requirements of the authority having jurisdiction and NFPA 70 Articles 517, 700, 701, and 702 pertaining to construction and installation of emergency and standby systems. Comply with NFPA 70E, with NFPA 101, and with NFPA 110 requirements for Level 1 emergency power supply system. Perform Level 1 prototype tests required by this standard on a complete and functional unit; do not substitute component level type tests for this requirement.
- D. Comply with applicable requirements of UL 1008, UL 486A, and UL 486B, and UL 2200. Comply with ASME B15.1. Comply with applicable requirements of ANSI/NEMA MG 1, and MG 2. Comply with applicable requirements of NEMA's Stds Pub No. 250. Comply with applicable portions of IEEE Std 446.
- E. Comply with applicable federal, state and local government requirements for engine exhaust emissions. 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.
- F. Service Conditions: Ambient temperatures within limits specified and rated by manufacturer; Altitude not exceeding that specified by manufacturer. Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: Minus 15 to plus 40 deg C.
 - 2. Altitude: Sea level to 1000 feet.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide generator sets of one of the following (for each rating of generator set):
 - 1. Kohler Co.; Generator Division.
 - 2. Caterpillar; Engine Div.
 - 3. Onan/Cummins Power Generation; Industrial Business Group.
 - 4. Generac Power Systems, Inc.

2.2 ENGINE-DRIVEN GENERATOR SET

- A. Provide packaged electrical power engine-driven generator assembly unit as indicated on the electrical drawings that is Continuous Standby rated, accepting 100 percent of nameplate kW rating in one step.
 - 1. Connect engine drive directly coupled to 4-pole revolving-field type single, maintenance-free, bearing generator through semi-flexible steel disk coupling.
 - 2. Provide unit rated at 80 percent power factor for continuous operation.

3. Provide direct-coupled generator to fly wheel by semi-flexible steel disk coupling.
 4. Disconnecting Means: Provide one or more disconnecting means, each with permanent lock-out/tag-out provisions. Each disconnecting means shall simultaneously open all associated ungrounded conductors. Each disconnecting means shall be lockable in the open position in accordance with Article 110.25 of NFPA 70.
 5. Shutdown of Prime Mover: Generators shall have provisions to shut down the prime mover, with permanent lock-out/tag-out provisions. The means of shutdown shall comply with all of the following:
 - a. Be equipped with provisions to disable all prime mover start control circuits to render the prime mover incapable of starting.
 - b. Initiate a shutdown mechanism that requires a mechanical reset. Additionally, provide an additional means to shut down the prime mover. This additional shutdown means shall be located outside the equipment room or generator enclosure and shall also meet the requirements of NFPA 70 445.18(B)(1) and (B)(2).
- B. Provide unit mounted main line output circuit breaker(s), with adjustable trips behind dead front, with overcurrent ampere ratings as indicated on the electrical drawings. Provide dedicated enclosures (or equivalent barriers compliant with NFPA 70) to separate the emergency power breakers from standby power breakers. Provide dedicated enclosures (or equivalent barriers compliant with NFPA 70) to separate the legally-required standby power breakers from optional standby power breakers.
- C. Wiring and Accessory work:
1. Provide output wiring from generator terminals in compliance with Article 445.13 of NFPA 70, and do not de-rate grounded (“neutral”) conductors. Provide necessary equipment, accessories, components, conduit, wiring, etc. to render the system fully operational.
 2. Provide vibration control for engine-driven generator units including pads, springs, rails, bases, hangers, and connectors.
 3. Provide fuel system, piping and associated accessories required for installation of engine-driven generator units.
 4. Provide a complete factory assembled generator set equipment with digital electronic generator set controls, digital governor and digital voltage regulator.
 5. Provide lugs, lug kits and related accessory work as required to accommodate the conductor sizes and quantities needed for each application. Coordinate with single-line diagram, field conditions, etc.
- D. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments. Provide fork lift sockets. Inscribe rigging diagram on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

E. Capacities and Characteristics:

1. Power Output Ratings: Minimum rating as indicated on single-line diagram, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: As indicated on drawings.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
4. Provide alternator temperature rise not to exceed 130 degrees C above 40 degrees C ambient at 100 percent load with Class H insulation system.
5. Connect engine drive directly to 4-pole revolving-field type single, maintenance-free, bearing generator through semi-flexible steel disk coupling.
6. Provide 2/3 pitch stator and rotor that is direct coupled by flexible disc.
7. Rated 80 percent power factor for continuous operation.
8. Provide torque match (shunt) exciter type.
9. Provide A (U), B (V), C (W) phase rotation.
10. Direct-connect generator to fly wheel by semi-flexible steel disk coupling.
11. Provide brushless drip-proof construction.
12. Provide direct drive centrifugal blower.

F. 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 under varying loads from no load to 100 percent. Frequency shall recover and remain within the steady-state operating band within five seconds. Provide random frequency variation not to exceed plus or minus one-half percent of its mean value for constant loads, from no load to 100 percent load.
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 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. General:

1. Rated Engine Speed: 1800 rpm.
2. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
3. Lubrication System: The following items are mounted on engine or skid:
 - a. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 - b. 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.
 - c. 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. Engine Block Heater: Of wattage and voltage required for full functionality, with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements of NFPA 99.
5. Coolant Jacket Heater: Thermostatically controlled and arranged for plug-in connection. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
6. Governor: Isochronous electronic governor (Class 2).
7. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
8. Air Requirements: Include the following air requirements with submittals.
 - a. Combustion air CFM.
 - b. Alternator coolant air CFM.
 - c. Radiator coolant air CFM.
 - d. Minimum air opening size to room.
 - e. Minimum discharge opening size.
 - f. Exhaust gas flow CFM.
 - g. One-half inch water maximum static restriction at radiator discharge.

B. Gas Engine Fuel System:

1. Fuel: Natural Gas, with starting and operation on 7-11 inches H₂O, with Carburetor; Secondary Gas Regulator; Fuel-Shutoff Solenoid Valve; Flexible Fuel Connector.

C. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 3. Temperature Control: Self-contained thermostat capable of cooling engine with up to 0.5 inches water static pressure on fan.
 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 (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.
- D. Muffler/Silencer: Critical type, mounted within enclosure with side inlet, and with stainless steel flexible exhaust connector, insulated thimble and rain shield, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. Provide features and accessories as follows.
1. Side inlet.
 2. Stainless steel flexible exhaust connector.
 3. Insulated thimble at enclosure penetration of exhaust piping.
 4. Minimum sound attenuation of 25 dB at 500 Hz.
 5. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.
 6. Rain shield.
- E. Starting System: 24-V electric (or 12-volt system equal in performance), negative ground, starting system including 24-volt positive engagement solenoid shift-starting motor, batteries and 45-ampere, or greater, automatic battery charging alternator with solid-state voltage regulation. Provide unit mounted battery rack with batteries (625 minimum CCA, at 0 degrees F) and cables.
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 of project to provide specified cranking cycle at least three times without recharging.
 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg 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 deg C to 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.
 - e. Safety Functions: Provide audio/visual generator set monitoring system, solid state engine monitor with individual lights and common external alarm contact (with heater in control panel housing to prevent condensation) indicating each of the conditions listed in article 2.5 "Control and Monitoring". Also provide a minimum of one remote annunciator as well.
 - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 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. Provide control wiring, in conduit, between transfer switch(es) and the generator control panel for engine start and other accessory features. Provide 120V, 20A circuit to each interior battery charger and clock exerciser. Provide additional electrical work for other accessory components as required for a complete operational system (i.e. transfer switch, remote annunciator/monitoring equipment, engine accessories, dampers, heaters, etc.).
- C. 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. Current and Potential Transformers: Instrument accuracy class.

- D. 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. Battery charge-rate ammeter.
 4. AC frequency meter.
 5. DC voltmeter (alternator battery charging).
 6. Engine-coolant temperature gage.
 7. Engine lubricating-oil pressure gage.
 8. Reset circuit breaker.
 9. Static voltage regulator.
 10. Running-time indicator.
 11. Circuitry type of plug-in design capable of quick replacement, and of accepting a plug-in device which allows maintenance to test control panel performance without operating the engine.
 12. Ammeter-voltmeter, phase-selector switch(es).
 13. Console mounted generator-voltage adjusting rheostat for plus or minus 5 percent voltage adjusting.
 14. Remote fault signal dry contact relay package.
 15. Run relay package.
 16. Anti-condensation space heater (or equivalent means to prevent condensation).
 17. Oil temperature gauge.
 18. Emergency stop.
 19. Over/under voltage relay.
 20. Over/under frequency relay.
 21. Lamp test switch.
 22. Audible Alarm on generator shut down per NFPA 110.
 23. Start-stop switch for manual operation of unit.
 24. Overspeed shutdown device.
 25. Engine oil-pressure and water-temperature indicators.
 26. Coolant low-level shutdown device.
- E. 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.
- F. Common Remote Audible/Visual Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Events to be monitored include, but are not limited to:
- 1) High Battery Voltage (red light);
 - 2) Low Battery Voltage (red light);
 - 3) Normal Battery Voltage (green light);
 - 4) Normal Utility Power (green light);

- 5) EPS Supplying Load (green light);
 - 6) Low Battery Electrolyte (red light);
 - 7) Low Fuel (red light);
 - 8) Overcrank Shutdown (red light);
 - 9) Overspeed Shutdown (red light);
 - 10) High Coolant Temp. Shutdown (red light);
 - 11) Low Oil Pressure Shutdown (red light);
 - 12) Pre-warning for High Coolant Temp. Shutdown (yellow light);
 - 13) Pre-warning for Low Oil Pressure (yellow light);
 - 14) Low Coolant Temp. (red light-indicates inoperative coolant heater);
 - 15) Switch OFF (flashing red light – indicates genset is not in auto. Start mode);
 - 16) Audible alarm;
 - 17) Lamp test switch;
 - 18) Reset switch.
- G. Remote Alarm Annunciator: Comply with NFPA 70 and 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. See Section 26 36 00.00 “Transfer Switches” for additional requirements.
- H. Remote Emergency-Stop Switch: Flush; wall mounted, weatherproof, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation. Install at location compliant with prevailing codes, and coordinated with Owner’s Representative.
- I. Generator Control Wiring: Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 700.10(D)(1) of NFPA 70. The integrity of the collective generator system, including generator control wiring, shall be continuously monitored. Any malfunction of the collective generator system, including loss of integrity of the remote start circuit(s), shall initiate visual and audible annunciation of generator malfunction at the generator local and remote annunciator(s). Loss of integrity of the remote start circuit(s) shall start the generator(s).

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breakers Serving Emergency Branch(es) of Power and Standby Branch(es) of Power Requiring Selective Coordination: Electronic-trip type; 100 percent rated; complying with UL 489.
1. Manufacturer: Provide circuit breakers of the same manufacturer as those used in the building power distribution system. Coordinate with building power distribution system circuit breaker manufacturer to ensure selective coordination

will be achieved with every circuit breaker “downstream” of the respective generator output circuit breakers.

2. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
3. Trip Settings: Coordinate with generator thermal damage curve. Set field-adjustable overcurrent trip values as indicated on drawings (unless otherwise specified in the Overcurrent Protective Device Selective Coordination Study). Unless indicated otherwise on drawings, or directed otherwise by AHJ or prevailing codes, circuit breaker manufacturer shall furnish setting information based on project requirements and prevailing codes, while minimizing the possibility of nuisance tripping.
4. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
5. Mounting: Unit mounted. Adjacent to or integrated with control and monitoring panel.
6. Barriers:
 - a. Provide separately-enclosed/barriered assembly for each output breaker.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1. Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor. Provide Class H or Class F electrical insulation. Stator-winding leads shall be brought out to terminal box to permit future reconnection for other voltages if required. 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. Enclosure shall be drip-proof. Instrument transformers shall be mounted within generator enclosure. Voltage regulator shall be solid-state type, separate from exciter, providing performance as specified. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band. Provide thermostatically controlled strip heater arranged to maintain stator windings above dew point.

2.7 VIBRATION ISOLATION DEVICES

- A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint. Provide steel housing 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. Provide outside spring diameter of not less than 80 percent of compressed height of the spring at rated load. Provide minimum additional travel of 50 percent of required deflection at rated load. Provide lateral stiffness of more than 80 percent of rated vertical stiffness. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 ADDITIONAL ACCESSORIES FOR OUTDOOR INSTALLATIONS

- A. Outdoor Generator-Set Enclosure: Vandal-resistant, weatherproof steel housing, heavy gage reinforced steel (#12 and #14 gauge), fully rust resistant, mated and matched to the unit enclosed, which permits proper cooling, and access to controller, fluid fill/drain points and service points. 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. Provide fully weatherproof housing with Level 1 sound attenuation, with all necessary access doors, equipment and accessories to mount/house the following accessories and features.
1. Critical grade silencer mounted within enclosure with stainless steel flexible exhaust connector and rain shield. A lower grade silencer within the weatherproof enclosure that provides equal or greater performance to an external Critical grade silencer shall be considered equal. Provide drain, insulated thimble and piping of types and sizes required. Provide all silencer/muffler and exhaust piping, which can be reached by people standing on the ground at the unit, with 1500 deg. F class insulation with a minimum double layer of 1-1/2" thick Cal-Sil (Calcium Silicate) insulation and then covered with a .016" aluminum jacket held in place with stainless steel bands.
 2. Emergency-Power-Off (EPO) pushbutton within generator enclosure, provided by generator manufacturer for emergency manual shut-down of the generator set.
 3. Fixed air inlet and outlet louvers.
 4. Up-flow (vertical) radiator-air discharge, enclosed on all sides.
 5. Remote oil drain kit.
 6. Mounting to allow bottom entry of feeder conduits.
 7. Space heater (or equivalent means to prevent condensation and to ensure cold starts).
 8. Water jacket heater (thermostatically controlled and arranged for plug-in connection).
 9. Battery blanket warmer, if recommended by manufacturer for the project geographical region, thermostatically controlled and arranged for plug-in connection.
 10. Lockable flush doors, all keyed alike, with stainless steel hinges and hardware for full open interior access. Provide at least six keys. Place one key in the building "Knox Box". Coordinate with local fire department if the building has no "Knox Box", and provide equivalent means for fire department access into the enclosure, as directed by fire department.
 11. Provide enclosure components that are heavy gage reinforced steel (#12 and #14 gauge), fully rust resistant, mated and matched to the unit enclosed, which permits proper cooling, and access to controller, fluid fill/drain points and service points.
 12. Provide final enclosure color as directed in field as selected from standard factory offerings
 13. Rodent and insect barriers.
 14. Provide reinforced concrete pad beneath each unit, with mass equal to or greater than the collective wet-weight mass of the package generator set. Concrete pad shall be at least 8" thick, shall extend below frost line, and shall have straight and

- finished sides and a 1", 45-degree chamfer at the top perimeter. Concrete pad shall extend at least 12" beyond all edges of the housing. Reinforcing steel bars shall be placed in both directions of the concrete pad, tied on 12" centers.
15. Unless other methods are indicated on drawings or determined in field, provide 208Y/120 volt NEMA 3R circuit breaker panelboard within (or near) the weatherproof housing of sufficient ampacity and with sufficient pole space to provide circuit protected power to accessory electrically operated equipment/components located within and about the enclosure. Provide feeder from emergency power source. Provide factory and field wiring, per N.E.C., to accessory equipment, lighting and receptacles.
 16. Provide GFI protected weatherproof Type WR duplex receptacle, on dedicated circuit, mounted at minimum 24" above grade/pad to exterior of housing (or on nearby building wall within 25 feet of unit).
 17. Provide UL wet label photocell-controlled LED luminaire, with local weatherproof switch, at unit. Locate as designated by Design Professional.
 18. Convenience Outlets: Factory wired, Weatherproof-GFI. Arrange for external electrical connection.
- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

2.9 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. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115. 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. Rated power.
 4. Maximum power.
 5. Voltage regulation.
 6. Transient and steady-state governing.
 7. Single-step load pickup.
 8. Safety shutdown device testing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions. Comply with NFPA 110 and NEMA standards. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance. Provide packaged engine generator with vibration isolators. Secure sets to hot-dipped galvanized or stainless-steel anchor bolts embedded in concrete support. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A, B and NFPA 70. Install electrical devices, accessories, etc. furnished by equipment manufacturers but not specified to be factory mounted.
- B. Provide Schedule 40, black steel exhaust piping with welded joints and connect to engine muffler. Install insulated thimbles at walls and flexible connectors at engine. Piping shall be same diameter as muffler outlet. 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. Coordinate with related work of Division 23 where applicable.
- C. Align shafts of engine and generator within tolerances recommended by engine-generator unit manufacturer. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance. Connect cooling-system water piping to engine-generator set and heat exchanger with flexible connectors. Connect engine exhaust pipe to engine with flexible connector. Connect fuel piping to engines with a flexible connector.
- D. Natural-gas piping, valves, and specialties for gas distribution are specified under Division 22.
- E. Make wiring connections to generator terminals with 24" lengths of grounded "Seal-tite" flexible metallic conduit. Provide control wiring, in conduit, between transfer switches and the generator control panel for engine start and other accessory features. Provide 120V, 20A circuit to each battery charger and clock exerciser. Provide additional electrical work for other accessory components as required for a complete operational system (i.e. transfer switch, remote annunciator/monitoring equipment, engine accessories, dampers, heaters, etc.).
- F. Provide ground fault equipment protection circuit interrupter type receptacle (GFEPIC, per NEC Article 427-22) for accessory resistance heating elements. Fabricate and configure such accessories for cord & plug connection.
- G. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 05

53.00 "Identification for Electrical Systems." Device Nameplates: Label each compartment, and each disconnecting and overcurrent protective device, and each meter and control device with a nameplate complying with requirements for identification specified in Section 26 05 53.00 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform and document 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. Check fuel supply, lubricating oil, and antifreeze in liquid cooled models for conformity to the manufacturer's recommendations under environmental conditions present.
 4. Test prior to cranking engine for proper operation, accessories that normally function while the set is in a standby mode. Accessories include: engine heaters, battery charger, generator strip heater, remote annunciator.
 5. Test, by means of simulated power outage, automatic start-up by remote-automatic starting, transfer of load, and automatic shut-down. Prior to this test adjust, for proper system coordination, transfer switch timers. Monitor throughout the test, engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency.
 6. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages. 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. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of the battery after discharge. Verify that measurements are within manufacturer's specifications.
 7. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 8. 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.
 9. Exhaust Emissions Test: Comply with applicable government test criteria.
 10. General Tests: Check, during start-up test mode, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.

11. 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.
 12. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 13. 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 on the property line, and at additional locations as necessary, and compare measured levels with specified, factory-published and other required values.
 14. Coordinate all work with gas piping system installer before and during testing. Ensure that: Gas regulator(s) that are part of the gas piping system are set to proper pressures; have proper springs, plates and orifices; and are properly installed and calibrated overall for proper operation of the generator set under all load and no-load conditions. Procure services from the gas piping system installer as required to make any needed modifications to the gas piping system as needed for proper generator set performance and operation.
- B. Provide filling of all fluids, including crankcase oil, radiator-fill of coolant solution, etc. Top-off each again after testing as required.
- C. Perform on-site 100% load-bank test for a minimum two-hour period. Provide portable mobile load banks, cabling, etc. Test in 25 percent increments for at least 30 minutes per increment. Let engine fully cool, and then test with 25 percent load followed by 100 percent load after 30 seconds. Provide testing with Owner's Representatives present. Provide certified test record.
- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- F. 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.
- G. Perform startup service. Engage a factory-authorized service representative to perform installation and startup checks according to manufacturer's written instructions.

END OF SECTION 263213