

**SPECIFIER SHALL REMOVE COMMENTS IN BOLD TEXT PRIOR TO SUBMITTING.**

SECTION 16621 - PACKAGED NATURAL GAS GENERATOR

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including but not limited to General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. All Sections of Division 15 and 16 apply to this Section.
- C. Other related Divisions are as follows:
  - 1. Division 2 Fencing
  - 2. Division 3 Concrete.

1.2 SUMMARY

**ADJUST LIST BELOW TO SUIT PROJECT.**

- A. This Section includes packaged natural gas fired engine-generator sets for emergency power supply including the following components:
  - 1. Engine generator set.
  - 2. Radiator.
  - 3. Exhaust silencer muffler, exhaust piping external to set, and fittings
  - 4. Batteries and charger.
  - 5. Outdoor enclosure.
  - 6. Remote annunciator.

1.3 SUBMITTALS

- A. Product Data: Provide data showing model numbers, dimensions, weights, ratings for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, radiator, and insulation. In addition, include the following:
  - 1. Thermal damage curve for generator.
  - 2. Time-current characteristic curves for generator protective device.
  - 3. Engine's power output curve with changing gas pressure starting at 3.0 inches water pressure.

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4. Minimum and maximum gas pressure requirements.
- B. Shop Drawings:
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, plan and elevation views with overall and interconnection point dimensions, and location and size of each field connection.
  2. Indicate electrical characteristics and connection requirements. Include electrical schematic and interconnection diagrams. Provide legend of devices on each diagram.
  3. Indicate: maximum gas consumption per hour, sound power level for eight octave bands, ventilation and combustion air requirements.
  4. Identify center of gravity, locate and describe mounting and anchorage provisions.
  5. Provide detailed description of equipment anchorage devices and their installation requirements.
  6. Identify required maintenance access panel location.
  7. Submit the following drawings:
    - a. Dimensioned elevations and plan views of the natural gas engine generator set showing all fuel inlets and outlets, exhaust outlet, water inlets and outlets, and electrical connections.
    - b. Dimensioned elevations and plan views of outdoor enclosure.
    - c. Electrical interconnect wiring diagrams.
  8. Submit calculations for sound level data at three feet from natural gas engine generator set.
- C. Qualification Data: For installer and manufacturer.
- D. Source quality-control test reports.
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. Indicate results of the performance testing and field procedures and findings. A certified test shall be performed by the manufacturer of the Emergency Power Supply System prior to shipment from the manufacturers facility demonstrating the following: Results at full load to be reported are: Engine RPM, frequency, average voltage, line-to-line voltages for all three phases, average current, and observed power at 0.8 power factor. The results to be reported at no load are: Engine RPM, average voltage and line-to-line voltages for all three phases.
  3. Certified Summary of Performance Tests:
  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 and the Chicago Building Code.
- E. Field quality control test reports: refer to Part 3 for the list of tests to be reported.
- F. Project record documents: Record actual locations and installation conditions of the engine-generator set in the Project record documents.

- G. Provide Operation and Maintenance Data for: packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division I Section "Operation and Maintenance Data," include the following:
  - 1. List of tools and replacement items recommended being stored at Project site for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- H. Warranty: Warranty information as specified in this Section.

#### 1.4 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 four hours' normal travel time from Installer's place of business to Project site.
  - 2. Engineering Responsibility: Preparation of data for vibration isolators of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
  - 3. Company specializing in installing the Products specified with minimum five years documented experience.
- B. Manufacturer Qualifications: A qualified manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience. Maintain, within 50 miles of Project site, Authorized factory trained full time staffed service department with minimum ten years documented experience specializing in 24/7 servicing the Products specified capable of providing training, parts, and emergency maintenance repairs.
- C. Supplier: Authorized distributor of specified manufacturer with minimum ten years documented experience and with stock of replacement parts for each Product.
- D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer with responsibility for entire system. Unit shall be a representative product built from components that have proven capability and reliability and are coordinated to operate as a unit as evidenced by records of prototype testing.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Building Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. For the generator set installation and on-site testing conform to the requirements of the following codes and standards. Include necessary features to meet the requirements of these standards.
  - 1. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
  - 2. NFPA 30 – Flammable and Combustible Liquids Code.
  - 3. NFPA 37 – Stationary Combustion Engines and Gas Turbines.

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- G. Conform to the requirements of the following standards for the generator set and supplied accessories:
  - 1. NEMA MG1 – Motors and Generators.
  - 2. UL 1236 – Battery Chargers.
  - 3. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
  
- H. Conform to the requirements of the following standards for the generator control panel:
  - 1. EN 50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
  - 2. EN 55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
  - 3. FCC Part 15, Subpart B.
  - 4. UL 508, Industrial Control Equipment.
  
- I. Comply with ASME B15.1.
  
- J. Comply with the Chicago Building Code.
  
- K. Comply with NFPA 110 requirements for Level 1 emergency power supply system, Type 10, Class X.
  
- L. Comply with UL 2200. Where provisions of the Chicago Building Code for the emergency generators do not agree with UL 2200, the Chicago Building Code shall be followed.
  
- M. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
  
- N. 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.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store generator set, components and accessories indoors in clean and dry space with uniform temperature to prevent condensation. Protect generator set, components and accessories from exposure to dirt, fumes, water, corrosive substances, and physical damage.
  
- B. If stored in areas subject to weather, cover generator set, components and accessories to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials. Install electric heating of sufficient wattage to prevent condensation.
  
- C. Deliver and accept generator set, components and accessories in original manufacturer's packaging.

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- D. Handling: Handle engine generator equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment. Replace damaged equipment with new.

#### 1.6 PROJECT CONDITIONS

##### **USE FOR REMODELING PROJECTS ONLY:**

- 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 Architect and Owner's representative no fewer than seven days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Architect's and Owner's representative written permission.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

##### **EDIT PARAGRAPH BELOW TO SUIT PROJECT REQUIREMENTS**

- 1. Ambient Temperature: Minus 15 to plus 40 deg C.
- 2. Relative Humidity: 0 to 100 percent.
- 3. Altitude: Sea level to 1000 feet.

#### 1.7 COORDINATION

- A. Coordinate under provisions of Division 1.
- B. Field meetings: Coordinate with other trades and field conditions within pre-installation meetings.
- C. Final measurements: Verify that field measurements are as shown on Drawings.
- D. Field locations: Verify locations of engine generator set assembly prior to rough-in.
- E. 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 3.

#### 1.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for

proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

#### 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 for every 10 of each type and rating, but no fewer than one set of three of each.
  - 2. Indicator Lamps: Two for every six of each type used, but no fewer than three of each.
  - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
  - 4. Belts: Two for every 6 of each type used, but no fewer than one set of three of each.
  - 5. Tools: 1 set of special tools that are required for the normal operation and maintenance of unit.
  - 6. Spark Plugs: 1 complete set.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 5 years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Caterpillar; Engine Div.
  - 2. Generac Power Systems, Inc.
  - 3. Cummins Power Generation; Industrial Business Group.
  - 4. Kohler Power System.
  - 5. Inland Detroit
  - 6. Kalolight

#### 2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Temperature Rise: 105 degrees C Continuous, 130 degrees C Standby.

- C. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation. Skid is free from sharp edges and corners. Lifting attachments are arranged to facilitate lifting with slings without damaging any components.
- D. Provide 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.
- E. Capacities and Characteristics:
  - 1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.

**FILL INFORMATION BELOW TO SUIT PROJECT REQUIREMENTS:**

- 2. Output Connections: [ ] kW, [ ] voltage, [ ]-phase, [three or four wire].
  - 3. Nameplates: For each major system component to identify manufacturer's name and address, model and serial number of component.
- F. Mounting: The engine and generator shall be assembled to a common base by the engine-generator manufacturer. The generator set base shall be designed and built by the engine-generator manufacturer to resist deflection, maintain alignment, and minimize resonant linear vibration. Provide unit with suitable pad-type vibration isolators.
- G. Insulation: The exhaust manifold and turbo-charger shall be insulated with high temperature insulation installed by the manufacturer. Insulation shall maintain a surface temperature not to exceed 150 degrees F.
- H. Enclosure: NEMA MG1, the regulator shall be shock-mounted and epoxy-encapsulated for protection against vibration and atmospheric deterioration.
- I. 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.

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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 and the Chicago Building Code for emergency generators.

**RETAIN SUB-PARAGRAPH BELOW AS A STANDARD FEATURE FOR ENGINE-GENERATOR SETS LARGER THAN 200 KW.**

- a. Provide permanent magnet excitation for power source to voltage regulator.

- J. Generator Termination Box: Provide oversized termination/conduit box for all load connections to the generator. Provide box with adequate size so no box extensions or enlargements need to be done in the field when terminating wiring with type THHN insulation. Provide bus bars with two hole compression lugs for all cable terminations.

2.3 ENGINE

- A. Four cycle,
- B. Fuel: Natural Gas.
- C. Rated Engine Speed: 1800 rpm.
- D. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm . Maximum Piston speed for two-cycle engines: 1725 fpm.
- E. 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.
- F. Engine Fuel System:
  1. Compliant with NFPA 30, NFPA 37, and Chicago Code.
  2. Gas pressure regulator and gas solenoid valve shall be engine-mounted and shall be connected to the engine with flexible gas connection which shall be a minimum 18 inches (457 mm) long and shall be as recommended by the engine generator equipment manufacturer. The solenoid valve coil shall be rated for the generator starting battery voltage.

**FILL INFORMATION BELOW TO SUIT PROJECT REQUIREMENTS:**

- G. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity. Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F and suitable for operation on [ ] Volts ac. Vee type engines of 8 cylinders or more shall have one heater per each bank of cylinders. Provide installed isolation valves.
- H. Governor: Adjustable isochronous, with speed sensing to maintain isochronous engine speed. Frequency regulation as follows.
  - 1. Within 0.5 percent, steady state
  - 2. Within 1 percent, no load to full load.
  - 3. Recovery to steady state within 2 seconds following sudden load changes.
- I. Engine Accessories: Gas pressure regulator, gas solenoid valve, lube oil filter, intake air filter, lube oil cooler, gear-driven water pump. Provide unit mounted instruments including service meter, water temperature gauge, and lube oil pressure gauge on engine/generator control panel.

**RETAIN PARAGRAPH BELOW FOR INTEGRAL RADIATOR:**

- J. 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, 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 deg F , and noncollapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

**RETAIN PARAGRAPH BELOW FOR REMOTE RADIATOR. EDIT TO SUIT PROJECT REQUIREMENTS:**

- K. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
  - 1. Configuration: [Vertical] [Horizontal] air discharge.
  - 2. Radiator Core Tubes: [Aluminum] [Nonferrous-metal construction other than aluminum].

3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  4. Fan: Blower type, sized to maintain safe engine temperature in ambient temperature of 110 degrees F. Driven by totally enclosed electric motor with sealed bearings.
  5. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer to protect the system at 0 degrees F.
  6. Maximum radiator inlet and outlet air flow restriction of 0.5 inches of water. Radiator shall be pretreated by the supplier for the inhibition of internal corrosion. Provide suitable duct flange.
  7. Flexible pipes for engine and radiator shall be provided by genset vendor.
  8. The radiator fans shall derive power from separate circuits connected to emergency power source.
  9. The genset supplier shall provide the motor starter, fused disconnect (installed on the radiator), remote fan control, temperature and pressure switch (installed).
  10. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- L. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed manufacturer's engine backpressure requirements.
1. Exhaust Silencer: Critical type silencer, with muffler companion flanges, flexible stainless steel exhaust fitting, and stainless steel expansion fitting sized sufficiently in accordance with engine manufacturers instructions to ensure that exhaust back pressure does not exceed the maximum limitations specified. Provide a suitable rain cap.
  2. Exhaust Insulation: The silencer and all indoor exhaust piping shall be insulated by the contractor to maintain a surface temperature not to exceed 150 degree F. The insulation shall be installed so that it does not cover or interfere with the functioning of the flexible exhaust fitting.

**INCLUDE SOUND LEVEL REQUIREMENT BELOW TO SUIT ACTUAL PROJECT CONDITIONS:**

3. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be [ ] dBA or less.
- M. Air Intake Filter: Heavy duty, engine-mounted air cleaner with replaceable dryfilter element and "blocked filter" indicator.
- N. 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 the Chicago Building Code for emergency generator.

4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging and to provide 60 seconds of continuous cranking.
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 35-A minimum continuous rating.
7. 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 to maintain the batteries at full charge at all times.
  - 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 5 percent.
  - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
  - e. No on-off switch is allowed on battery charger.
  - f. 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.
  - g. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

#### 2.4 CONTROL AND MONITORING

- A. The generator shall provide continuous service and no alarms or pre-alarms can automatically cause the generator to shut down.
- B. 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.
- C. 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. Switch to be key operated. Key must be captive in all positions except "Automatic". Provide flashing pilot light to indicate when key is in any position other than "Automatic".
- D. 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.

- E. Indicating and Protective Devices and Controls: As required by the Chicago Building Code.
- F. Conditions required to be annunciated with an audible and visual alarm shall include:
  - 1. overcrank (failure to start)
  - 2. low oil pressure
  - 3. low oil pressure (pre-alarm)
  - 4. oil pressure sender failure
  - 5. low coolant temperature
  - 6. high coolant temperature
  - 7. high oil temperature
  - 8. excessive engine temperature (pre-alarm)
  - 9. engine temperature sender failure
  - 10. low coolant level
  - 11. over speed
  - 12. low DC voltage
  - 13. high DC voltage
  - 14. weak battery
  - 16. over current
  - 17. ground fault
  - 18. 80% load indicator\_(warning)
  - 21. voltage variation more than 5%
  - 22. cool down timer
  - 23. (4) configurable conditions (spare).
  - 24. Low natural gas pressure (leakage).
- G. Provide devices and controls to monitor the following functions:
  - 1. Voltage
  - 2. Current
  - 3. Frequency
  - 4. Running time
  - 5. Oil pressure
  - 6. Water temperature
  - 7. Generator voltage adjusting rheostat
  - 8. Ammeter-voltmeter, phase-selector switch(es).
- H. All gauges and meters to be permanently and clearly identified.
- I. Engine Status Monitoring. The following information shall be available from a status panel on the generator set control panel:
  - 1. engine oil pressure (psi)
  - 2. engine coolant temperature (degrees F)
  - 3. engine oil temperature (degrees F)
  - 4. engine speed (rpm)
  - 5. number of hours of operation (hours)
  - 6. number of start attempts
  - 7. battery voltage (DC volts)
  - 8. Low natural gas pressure (psi).

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- J. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or indications on the generator set, as well as total time of operation at various loads.
- 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.

**INCLUDE IF REQUIRED FOR THE SPECIFIC PROJECT AND DESIGNATE PANEL LOCATION:**

L. Remote Annunciator Panel: \_\_\_\_\_

**EDIT TO SUIT PROJECT REQUIREMENTS:**

**DELETE ARTICLE BELOW FOR INDOOR GENERATOR SET:**

1. Flush (or surface) mounted, single-membrane front face enclosure with integral test light and alarm acknowledge silence switches. Environmentally sealed, remotely mounted up to 1000 feet away from generator control panel. Designed for operation on 24VDC.
2. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator.
3. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided.
4. The interconnecting wiring between the annunciator and other system components shall be monitored and failure of the interconnection between components shall be displayed on the annunciator panel.
5. The annunciator shall include the following audible and visible LED indicators and alarms as required by the Chicago Building Code:

| Condition                   | Audible Alarm |
|-----------------------------|---------------|
| Normal Power (to Loads)     | No            |
| Genset Supplying Load       | No            |
| Genset Running              | No            |
| Not in Auto                 | Yes           |
| High Battery Voltage        | Yes           |
| Low Battery Voltage         | Yes           |
| Charger AC Failure          | Yes           |
| Fail to Start               | Yes           |
| Low Engine Temperature      | Yes           |
| Pre-High Engine Temperature | Yes           |
| High Engine Temperature     | Yes           |
| Pre-Low Oil Pressure        | Yes           |
| Low Oil Pressure            | Yes           |
| Overspeed                   | Yes           |
| Low Coolant Level           | Yes           |
| Network OK                  | Yes           |
| (4) Spares                  | Configurable  |
| Low Natural Gas Pressure    | Yes           |

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6. Low battery voltage lamp shall also be lighted for low cranking voltage or weak battery alarm.

## 2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Non-Fused Maintenance Disconnect: Heavy Duty, 100 percent rated.
  1. Rating: Matched to generator output rating.
  2. Operating handle or indicators must have visible indication if switch is in "ON" or "OFF" position.

## 2.6 GENERATOR EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages.
- E. 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.
- F. Enclosure: Dripproof.
- 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 percent adjustment of output-voltage operating band.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- J. Voltage Regulation: Include generator-mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Include 3 phase sensing. Include readily accessible manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain.
- K. Subtransient Reactance: 12 percent, maximum.

### **DELETE ARTICLE BELOW FOR INDOOR GENERATOR SET:**

## 2.7 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 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. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts is not acceptable. Fasteners to be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
1. Construct enclosure of minimum 12 gauge steel for framework and 14 gauge steel for panels.
  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. All hardware and hinges shall be stainless steel.
  7. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
  8. 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.
  9. Muffler Location: Within enclosure.
  10. Muffler connections to the generator set shall be through seamless flexible connections
- 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.
    - a. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
    - b. Dampers shall be spring open-motor close type.
    - c. Motorized operators for supply and exhaust dampers shall develop adequate torque to operate the dampers during normal and abnormal conditions such as sleet on dampers.
    - d. Voltage of motorized operators shall correspond to the voltage output of the engine generator control panel.

### **INDICATE SOUND LEVEL REQUIREMENT BELOW TO SUIT PROJECT CONDITIONS PER CURRENT CITY OF CHICAGO CODE**

- C. Housing to be sound attenuated to allow the generator set to operate at full rated load in an ambient temperature of up to 100F. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of [ ] dBA at any location at the property line.

### **EDIT REQUIREMENTS BELOW TO SUIT PROJECT CONDITIONS.**

**RETAIN DISTRIBUTION PANEL FOR LARGE GENERATOR SETS ABOVE 50 KW ONLY.**

- D. Provide a factory mounted and wired electrical distribution panel to serve the generator set and enclosure. The provisions required include:
1. 100-amp distribution panel board connected to a [ ] VAC utility service by the installer.
  2. Factory-wired normal AC service from the panel board to the engine coolant and alternator heaters, and battery charger.
  3. Factory-wired normal AC service from the panel board to two duplex GFI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure.
  4. Factory-wired normal AC service from the panel board to interior Lights with Switch: Factory-wired, vapor proof-type fixtures within housing; arranged to illuminate controls and accessible interior.

**RETAIN PARAGRAPHS BELOW IF NO PANELBOARD IS SPECIFIED:**

- E. Arrange for external connections:
1. To the engine coolant and alternator heaters, and battery charger.
  2. Two duplex GFI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure.
  3. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior.
  4. Lighting system for operation independently from the remote source. Provide lighting emergency battery unit.

2.8 VIBRATION ISOLATION DEVICES

**SELECT PARAGRAPH A FOR GENERATORS SMALLER THAN 250 KW. FOR GENERATORS 250 KW AND LARGER SELECT PARAGRAPH B.**

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer, arranged in multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
1. Material: Standard neoprene.
  2. Durometer Rating: 50.
  3. Number of Layers: Three.
- 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.

## 2.9 FINISHES

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

## 2.10 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 the Chicago Building Code , NFPA 110 Level 1 Energy Converters and 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 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
  - 9. Report factory test results within 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, Chicago Building Code and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

### **EDIT PARAGRAPH BELOW BASED ON SELECTION OF THE ISOLATORS:**

- C. Install packaged engine generator with [elastomeric isolator pads] [restrained spring isolators] having a minimum deflection of [1 inch (25 mm)] on 4-inch- high concrete base per manufacturer's installation instructions. Secure sets to anchor bolts installed in concrete bases.
- D. Install emergency branch circuits and control wiring for the engine generator accessories including the following:
  - 1. Battery charger.
  - 2. Engine jacket heater.
  - 3. Damper motors and controls
- E. Install engine generator automatic transfer switch control wiring under the provisions of Division 16 Section "Transfer switches".
- F. Install engine generator remote annunciator panels and wiring to generator control panel.
- G. Install battery starting cable within raceway sized in accordance with manufactures recommendations.
- H. 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 15 Section "Hydronic Piping."
  - 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 15 "Hydronic Piping."
- I. Electrical Wiring:
  - 1. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

2. Provide all the wiring specified by the manufacturer in the installation instructions as "Field Wiring".
  3. Install emergency systems wiring within separate raceways.
- J. Install natural gas engine generator set with adequate space allowed for removal, repair and code required clearances. Verify the exact dimensions of engine generator set and check for adequate room dimensions. Notify the architect/engineer of all discrepancies immediately.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in Division 15 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.
- C. Connect cooling-system water piping to engine-generator set.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Ground equipment according to Division 16 Section "Grounding and Bonding"
- F. Connect wiring according to Division 16 Section "Conductors and Cables".
- G. Provide equipment grounding connections for natural gas engine driven generator units as indicated on the drawings. Tighten connections to comply with tightening torques specified in UL 486A-486B-Wire Connectors to assure permanent and effective grounding.
- H. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B-Wire Connectors.

### 3.4 IDENTIFICATION

- A. Identify system components according to Division 15 Section "Mechanical Identification" and Division 16 Section "Electrical Identification."

### 3.5 CLEANING

- A. Clean work under provisions of Division 1.
- B. Clean engine and generator surfaces. Replace after testing all oil filters.
- C. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- D. Clean engine generator set using methods and materials as recommended by the manufacturer.
- E. Remove paint splatters and other spots, dirt and debris. Touch up scratches and mars on finish to match original finish.

### 3.6 CONTRACTOR START UP AND REPORTING

#### A. 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 perform start up service and testing.

#### B. 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. Acceptance Tests: Perform tests required by the Chicago Building Code that are additional to those specified here including, but not limited to, single-step full-load pickup test. Include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110 and the Chicago Building Code Provide a resistive load bank and make temporary connections for full load test, if necessary.
3. Perform tests required by the Chicago Building Code and NFPA-110 that are additional to those specified here.
4. 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.
5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
6. 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.
7. Exhaust System Back Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
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.
9. 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.
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 on the property line, and compare measured levels with required values.

#### C. Coordinate tests under load(s) with tests for transfer switches and run them concurrently.

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- D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 4 hours. Coordinate timing and obtain approval for start of test with site personnel. Test to be per Chicago code requirements. The test must be witnessed by an inspector from the Chicago Bureau of Electrical Inspection.
- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest and reinspect as specified above.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- J. 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.

### 3.7 COMMISSIONING AND DEMONSTRATION

- A. Demonstration: Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."
- B. Training: Engage a factory-authorized service representative to demonstrate packaged engine generators and their interface to the transfer switches and train Owner's maintenance personnel to adjust, operate and maintain equipment. Refer to Division 1 Section "Demonstration and Training".
  - 1. Conduct a minimum of two four hour of training in operation and maintenance as specified in Division 1 Section "Closeout Procedures." Include training relating to equipment operation and maintenance procedures.
  - 2. Schedule training with at least 7 days' advance notice.

END OF SECTION 16621

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