SECTION 26 3213 - ENGINE GENERATOR SETS

Maintain Section format, including the UH master spec designation and version date in the center columns of the header and footer. Complete the header and footer with Project information.

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

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

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

Delete hidden text after this Section has been edited for the Project.

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.

B. The Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:

1. The current version of the *Uniform General Conditions for Construction Contracts*, State of Texas, available on the web site of the Texas Facilities Commission.
2. The University of Houston’s *Supplemental General Conditions and Special Conditions for Construction.*

1.2 DESCRIPTION OF WORK

A. Work Included: Provide standby engine-driven generator set work as shown, scheduled, indicated, and as specified.

[VERIFY TYPE & QUANTITY]

B. Type: The type of standby engine-driven generator set**[s]** required for the Project include, but are not limited to, **[diesel]** engine-driven generator sets. **[Refer to Section 26 3215, "Generator Paralleling Switchgear", for generator paralleling switchgear.]**

1.3 STANDARDS

A. Equipment shall comply with applicable sections of the latest edition of the following standards:

1. NFPA 70 - National Electrical Code (NEC).

2. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
3. NFPA 110 - Emergency and Standby Power Systems.
4. IEEE 446 - Recommended Practice for Emergency and Standby Power Systems.
5. NEMA MG1 - Motors and Generators.
6. TCEQ Requirements (EPA Tier Levels for Non-Road Engines) - Latest effective requirements.

1.4 QUALITY ASSURANCE

A. Manufacturers: Provide products complying with these Specifications and produced by one of the following:

1. Cummins Power Generation/Onan Corporation.
2. Caterpillar Tractor Company.
3. Kohler Company.
4. Stewart & Stevenson.

B. NEC and NFPA Compliance: Comply with applicable portions of the NEC (NFPA 70) including, but not limited to, emergency and standby power generation systems and with NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines", and NFPA 110, "Emergency and Standby Power Systems".

C. IEEE Compliance: Comply with IEEE 446 “Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications”.

D. Emissions Compliance: The generator set engine shall comply with all applicable **[Texas Commission on Environmental Quality (TCEQ)]** Regulations and Requirements for Houston-Galveston and shall comply with all applicable EPA Tier Levels for Non-Road Engines currently in effect for the Houston-Galveston area.

E. Testing:

1. The entire generator system **[and paralleling switchgear]** shall be assembled on the factory test bed and shall be submitted to the full factory standard test to demonstrate automatic operation, start time, full capacity acceptance, regulation, motor starting capability and function of all system safeties, prior to shipping to the job site. System shall be tested at 0.8 pf. An electronic recording shall be made of each unit to verify frequency, voltage transient, and output power and shall be provided to Architect, Engineer and Owner.
2. Paralleling switchgear shall be tested separately and then after construction is complete, an entire generator and paralleling switchgear function test shall be performed.
3. The reporting form for the factory test shall be submitted to the Engineer for review with the Shop Drawings submittal and the Engineer shall be notified a minimum of one month

prior to the factory test so that Owner's Representative can witness the test. [**These tests shall be conducted in Houston, Texas, or Contractor shall pay for air fare, accommodations, and similar expenses, so that Owner's Representative can witness the test]**.

F. Performance Tests: The performance tests of the generating set series shall be in accordance with procedures certified by an independent testing laboratory. The manufacturer shall have successfully tested a prototype of the generating set series offered, which shall include:

1. Maximum power level.
2. Maximum motor starting capacity.
3. Structural soundness.
4. Torsigraph analysis per MIL-STD-705B, Method 504.2.
5. Fuel consumption.
6. Engine-alternator cooling airflow.
7. Transient response and steady state governing.
8. Alternator temperature rise per NEMA MG1-22.40.
9. Single step load pickup per NFPA 76A-822.
10. Harmonic analysis and voltage waveform deviation per MIL-STD-705B, Method 601.4.
11. Three-phase short circuit test for mechanical and electrical strength.
12. Vibration limits per NEMA MG1.

G. Manufacturer: The system shall be built, tested, and shipped by the manufacturer of the Standby Electric Power System, who has been engaged in the production of engine-alternator sets and associated controls for a minimum of 10 years, so there is one source of supply and responsibility.

H. Warranty: All equipment bearing a manufacturer's guarantee, such as electrical equipment, devices, components, and similar items, shall be construed to have a 5 year parts, travel, and labor guarantee to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the warranty period is to be replaced by the Contractor in accordance with the manufacturer's guarantee.

1.5 SUBMITTALS

A. Shop drawing submittals shall include, but not be limited to, the following:

1. A written functional narrative/description of the system operation (written with this Specification format) with all exceptions and/or deviations clearly hi-lighted or identified. All exception and deviations shall be reviewed and approved by A/E and Owner.
2. Completely identified and marked catalog cuts of all associated equipment and devices, with all non-applicable items crossed out, and applicable equipment or devices clearly hi-lighted or identified.

3. A written description of the maximum "starting" and "running" kVA's and kW's of the system equipment (charts and graphs will not be acceptable).
4. A floor plan sketch complete with a dimensional description of the standby electric power system and associated equipment, locating the system equipment and accessories within the allotted space.
5. Interconnection wiring diagrams to indicate terminal connections between the remote alarm annunciator panel and the electric set.
6. Complete bill of material for all equipment.
7. Complete warranty information as specified.
8. A notarized letter from the system supplier certifying compliance with all requirements of this Specification.
9. Performance test as specified in Paragraph 1.4.E of this Section.
10. Additional information as required in Section 26 0501 "Electrical Basic Materials and Methods".

1.6 STORAGE AND HANDLING

A. The standby generator set(s) shall be stored at the factory until it must be shipped to the job site to prevent building construction delay.

B. The standby generator set(s) shall be crated and covered to protect it from damage during shipment and subsequent storage at the job site.

PART 2 - PRODUCTS

2.1 ENGINE-GENERATOR SETS

[VERIFY UNIT kW/kVA & VOLTAGE]

A. General: Provide **[a]** new **[diesel] [outdoor rated]** engine-driven generator set**[s]**, complete with safety devices, **[main output breaker]**, **[weatherproof enclosure]** and vibration isolators. Installation shall be complete with all necessary fuel connections, radiator cooling and engine exhaust from the building. **[Engine fuel tank fill, supply, return, and vent line, natural gas piping are specified under Division 22.] [Engine exhaust piping, silencer and exhaust system installation, cooling air supply and exhaust ductwork and dampers are specified under Division 23.]** Unit**[s]** shall be capable of continuous standby service.

B. Basis of Design: The standby generator set(s) specified and shown on the Drawings is based on **[one of the manufacturers listed in 1.4A]** generator and selected from data derived from manufacturer's engineering manuals.

C. System Capacity: The engine-generator set, as a unit, shall be rated for a continuous standby capacity of **[_____]** kW and **[_____]** kVA at 0.8-PF, with an output of **[_____]**

amperes while generating **[480Y/277]** volt, 3-phase, 4-wire, 60 Hz power, and with performance as specified herein.

1. The engine generator set short circuit current response shall be adequate for first cycle tripping of circuit breakers and clearing of fuses, and the motor generator set shall be capable of developing **[_____]** kW and **[_____]** kVA for motor starting with a maximum voltage dip of 15% and while complying with the performance requirements specified herein.
2. **[A permanent magnet generator (PMG) or equal shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by nonlinear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum motor starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices. Alternator rating with PMG: With ( ) motor starting kVA applied to the alternator, the maximum voltage dip shall be 15%, and comply with the performance requirements specified herein.]**

D. **[Diesel]** Engine: Engine shall be an 8, 12, or 16 cylinder, 4 cycle, turbocharged/aftercooled or normally aspirated **[fuel injected full diesel]** engine, water-cooled with mounted water pump. Following items shall be included:

1. Valves: Intake and exhaust valves shall be heat-resisting alloy steel, free rotating. Exhaust valve seat inserts shall be replaceable.
2. Battery Charging: Belt-driven engine alternator; 24 volt negative ground 35 Amp DC, with transistorized voltage regulator.
3. Governor: **[Hydraulic] [or] [electronic]** speed-sensing governor capable of isochronous frequency regulation from no load to full rated load. Speed droop shall be externally adjustable from isochronous to 5%.
4. Filters: Air cleaner **[fuel]** and lube oil filters shall have replaceable elements + clear glass.
5. Starting System: Remote 24 volt, 2-wire, negative ground, starting system, positive shift, gear engaging electric starter, cranking limiter.
6. Lubrication System: Forced feed gear design lube oil pump; full pressure lubrication to all bearings; dual, full flow oil filters; oil level indicator; low oil pressure shutdown; lube oil cooler; and oil pressure gauge.
7. Diesel Fuel System: Recommended No. 2 diesel fuel. System shall be fuel injected and shall include a fuel transfer pump, automatic fuel shutoff, fuel oil/water separator, and fuel filters. Average fuel consumption at full load shall not exceed **[_____]** gph.
8. Cooling System: The cooling system shall be **[unit mounted]** radiator cooled, self-sealing, pre-lubricated coolant pump; belt driven pusher fan with wire guard; thermostat temperature control; high coolant temperature shutdown; low coolant level shutdown; intercooler. The cooling system shall be tested for leaks. As soon as the system has been tested, it shall be filled with ethylene glycol rust inhibiting and antifreeze solution sufficient to protect the system to **[_____°F] [-10°F]**. Engine-driven pusher type cooling fan shall be sized to maintain safe operation at **[_____°F] [122°F]** maximum ambient

temperature. Airflow restriction from static pressure at the radiator discharge shall not be more than 0.5" of water.

9. Emissions Compliance: The generator set engine shall comply with all applicable **[Texas Commission on Environmental Quality (TCEQ)]** Regulations and Requirements for Houston-Galveston and shall comply with all applicable EPA Tier Levels for Non-Road Engines currently in effect for the Houston-Galveston area at the time of installation. The Engine shall be EPA Certified from the manufacturer's factory.

E. Set Characteristics: Set manufacturer shall certify that reserve horsepower is available from the engine with all accessories operating in the ambient conditions herein below. The diesel engine-generator set shall be capable of picking up 100% of nameplate kW and power factor, less applicable derating factors, in one step with the engine-generator set at operating temperature, in accordance with NFPA 110, Paragraph 5.13.2.6, and including the following constraints:

[VERIFY THE FOLLOWING]

1. Ambient conditions of **[_____feet] [50 feet]** altitude and an ambient temperature of **[_____°F] [10 to 122°F].**

2. The RPM of the engine shall not exceed 1800 RPM and the engine piston speed shall not exceed 2000' per minute.

F. Engine Protective Devices:

1. The engine protective devices shall provide automatic shutdown for overcrank, overspeed, high coolant temperature and low oil pressure. A low coolant level protective device shall be provided but shall alarm only and not initiate engine shutdown
2. The high coolant temperature and low oil pressure shall have pre-shutdown signals.
3. The overcrank alarm shall be the output of a solid-state cranking device preset at a 10 second cranking cycle and a 15 second rest cycle. If the engine fails to start on the third cranking cycle, the overcrank alarm shall sound and cranking shall stop. Unit shall be capable of repeating the above cranking cycle after the trouble has been cleared.

G. Generator: Generator shall be 4-pole, revolving field type, brushless, dynamically balanced, skewed laminated, two thirds pitch wound, rotating rectifier exciter, temperature compensated solid-state voltage regulator, open drip-proof, single bearing, permanently aligned generator connected to engine with flexible disc coupling, including the following:

1. NEMA Class F or better insulation as defined by NEMA MG1.65.
2. Temperature rise at rated load within NEMA MG1-22.40 definition.
3. Double-sealed ball bearings, lubricated for life.
4. Direct-drive centrifugal blower cooling.
5. A 120 volt, single phase space heater shall be provided to prevent condensation in the generator.

6. AC output leads shall be brought out to field connection busbars accessible through removable plates in the generator output junction box.
7. The automatic voltage regulator shall be a solid state design and include overvoltage and undervoltage protection functions. The voltage regulator shall be equipped with 3-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. Overvoltage protection shall sense the AC generator output voltage and in the event of regulator failure or loss of reference, shutdown regulator output on a sustained overvoltage of one second duration. Over excitation protection shall sense regulator output and shutdown regulator output if overloads exceed 10 seconds duration. Both overvoltage and over excitation protection shutdowns shall be latched, requiring generator set shutdown to reset.
8. The regulator shall include an under-frequency roll-off torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58-59 Hz. The torque-matching characteristic shall include differential rate of frequency change compensation to use maximum available engine torque and provide optimal transient load response. Regulators that use fixed Volts per Hertz characteristics are not acceptable.

H. Generator Output Circuit Breaker(s):
Generator set shall have 3 pole output circuit breaker(s) with solid state trip units as shown on the Drawings. Breaker frame and trip ratings shall be as shown on the Drawings. Breakers serving emergency and standby loads shall have breaker position indicating contacts. Breaker position indicating contacts shall be wired to initiate a generator control panel alarm when the breaker is open or tripped. Circuit breaker manufacturer and type for all breakers serving emergency and standby loads shall match the Project electrical gear package to provide compatibility for selective coordination required by the NEC.

I. Engine/Generator Set Performance:

1. Frequency Regulation: Isochronous from no load to full rated load.
2. Voltage Regulation: ±2% from no load to full regulation load; rheostat for ±10% voltage adjustment.
3. Voltage Dip: Instantaneous voltage dip shall be less than 15% of rated voltage when full, 3-phase load and rated power factor is applied to the generator. Recovery to stable operation shall occur within 5 seconds. Stable or steady state operation is defined as operation with terminal voltage remaining constant with ±1% of rated voltage. All unit performance characteristics shall be verified using an oscilloscope.
4. Total Harmonic Distortion (THD): The sum of AC voltage waveform harmonies, from no load to full linear load shall not exceed 5% of the rated voltage (L-N, L-L, L-L-L) and no single harmonic shall exceed 3% of rated voltage. Telephone Influence Factor (TIF) shall be less than 50 per NEMA MG1-22.43. Temperature rise at rated load and power factor shall be within NEMA MG1-22.40 definition.
5. Motor Starting: The largest motor to be started is a **[_____ hp fire pump (star-delta reduced voltage starting)].**

6. Non-Linear Loads: As indicated within the Drawing package, generator shall also serve **[a _____ kVA UPS System with input filters].**
7. Voltage Dip Performance: A light beam oscilloscope test for the specific generator set, by model and serial number shall be provided for the four step loads listed herein below. Certified test results shall be reported via an electronic recorder with results submitted with generator factory test results.

    a. 0% to 25% kW load at 0.4 lagging PF.
    b. 0% to 50% kW load at 0.4 lagging PF.
    c. [0% to 75% kW load at 0.4 lagging PF.]
    d. [0% to 100% kW load at 0.4 lagging PF.]

J. Engine-Generator Instrument Panel: The instrument panel shall be mounted on vibration isolators and shall have DC controls, AC controls, and panel lighting. The top of the instrument panel shall not be more than 6'-6" above finished slab.

1. DC engine controls (2-wire, 24 volt system) including but are not limited to run-stop-automatic test-manual switch, remote start-stop terminals, oil pressure gauge, coolant temperature gauge, charge rate Ammeter and running time hour meter.
2. Solid state engine monitoring system with monitors in accordance with NEC Section 700, NFPA 110 and local code requirements with lamps, **[audible alarm,]** lamp test switch, individual alarm contacts and a common alarm contact for:

    a. Overcrank shutdown
    b. Low coolant temperature warning
    c. Pre-warning for high engine temperature
    d. High engine temperature shutdown
    e. Pre-warning for low lube oil pressure
    f. Low lube oil pressure shutdown
    g. Overspeed shutdown
    h. **[Low fuel in main tank warning]**
    i. Low coolant level warning
    j. Generator (EPS) supplying load.
    k. Generator control switch not in Auto position warning
    l. High battery voltage warning
    m. Low cranking voltage warning
    n. Low battery voltage warning
    o. Battery charger failure
    p. Generator output breaker(s) open warning
    q. **[Motorized damper(s) not open warning (Level 2 only)]**
    r. Generator output breaker tripped.
    s. Fuel tank leak detected.
    t. [Customer alarm]
    u. [Customer alarm]

v. [Customer alarm]

3. Provide two dry auxiliary contacts one for common alarm and one for engine running to be monitored via Ethernet and/or by the BAS.
4. AC output controls include, but are not limited to, an AC voltmeter; AC Ammeter; Voltmeter-Ammeter phase selector with an "off" position; voltage adjusting rheostat; frequency meter; manual reset exciter circuit breaker and fine speed control potentiometer.
5. Two sets of double pole auxiliary contacts shall change state when engine starts; **[both sets shall be spare] [one set shall be monitored by the BAS and one set is spare] [one set shall de-energize damper motor operators (Level 2 only) and one set is spare.]**

K. Accessories:

1. Remote Annunciator(s): **[Flush] [Surface]** mounted remote annunciators shall be **[hardwired] [microprocessor based annunciator with network communication]** type, located as shown on the Drawings, and shall have audible and LED visual signal devices, powered by the electric set lead acid battery set, to provide a warning of derangement or alarm conditions in the electric set in compliance with the National Electrical Code Section 700, NFPA 110 level 1, 20 lamp and the requirements of these Specifications. The enclosure shall be constructed of sturdy sheet steel with white finish, and shall have removable front panel and adapter ring for flush mounting. The face of the front panel shall contain LED's (visual signals), an audible alarm, an alarm silence push button, and a LED test push button. The internal wiring, terminal block, and battery voltage sensors shall be accessible by removing the front panel of the enclosure. Remote annunciators shall indicate the following conditions:

   a. Visible and Audible alarm for:

      1) Overcrank shutdown
      2) Low coolant temperature warning
      3) Pre-warning for high engine temperature
      4) High engine temperature shutdown
      5) Low lube oil pressure shutdown
      6) Overspeed shutdown
      7) Low coolant level warning
      8) Generator control switch not in Auto position warning
      9) Low cranking voltage warning
      10) Low battery voltage warning
      11) Generator output breaker(s) open warning
      12) Generator power available
      13) **[Spare/Customer alarm] [Low fuel in main tank warning]**
      14) [Spare/Customer alarm] [Fuel in outer tank]

15) **[Spare/Customer alarm] [Motorized damper(s) not open warning (Level 2 only)]**
16) **Spare/Customer alarm**
17) **Spare/Customer alarm**
18) **Spare/Customer alarm**
19) **Spare/Customer alarm**

b. Visible indicator for:

1) Battery voltage okay.

[EDIT QUANTITY OF JACKET HEATERS. UNITS 500 KW AND SMALLER SHALL HAVE ONE HEATER AND UNITS 600 KW AND LARGER SHALL HAVE TWO HEATERS]

2. Jacket-Water Heater: The engine shall have **[one] [two] [KIM #Hot start (480 volt, 1-phase)] [KIM #Hot start (208 volt, 1-phase)]** or approved equal, **[5000W]** jacket-water heater[s] supplied from a "normal" branch circuit. The jacket-water heater shall be complete with a thermostat capable of maintaining a water temperature of 25°C, with an ambient temperature of 0°C. A water temperature alarm, consisting of a contact closed when the jacket water temperature is below 20°C, shall be supplied.
3. Exhaust System: Exhaust silencer(s) of the **["critical"]** type, with side or end inlet as **[required shall be shipped pre-installed and piped on top of the generator enclosure.] [shown on the Division 23 Drawings, shall be provided by this Contractor for installation by the Division 23 Contractor as recommended by the generator set manufacturer.]** The exhaust silencer(s) shall be of chambered construction and shall provide maximum degree silencing, and shall be sized to assure proper operation without excessive back pressure when installed in the exhaust system. The exhaust silencer(s) shall be supplied with condensation drains, flexible exhaust tubing, wall thimbles and rain caps, as required.
4. Starting Batteries: Furnish and install fully charged 24 volt lead acid, impact resistant, storage batteries mounted on the unit or on a separate rack. Batteries shall have sufficient capacity for 60 seconds of continuous cranking per NFPA 99. Provide all required battery cables, connections, electrolyte and a battery hydrometer.
5. Solid-State Battery Float Charger: A suitable 120 volt Automatic SCR voltage regulated battery charger with a maximum charge rate, as recommended by the manufacturer, but not less than 10 amperes shall be provided to maintain each set of batteries at full capacity during standby conditions. The maximum charging time to bring the batteries up to full charge shall not exceed 12 hours. The charger shall be provided with a remote alarm contact to indicate a charger failure condition. An Ammeter shall indicate the charge rate and the circuit shall be protected by either fuses or circuit breakers. The charger shall be so designed that it will not be damaged during the engine cranking and shall be interlocked such that it is not damaged during generator set operation. The charger may be furnished as a separate item with necessary cables and leads.

[SELECT AND EDIT REQUIRED FUEL SYSTEM COMPONENTS]

[VERIFY TANK CAPACITY MINIMUM 8 GAL (175 KW AND BELOW), 25 GAL (200-250 KW), 40 GAL (400-500 KW), 60 GAL (600 KW), 90 GAL (750-900 KW) 125 GAL (1000 KW AND LARGER)]

6. **[In Skid Diesel Fuel Tank: Each generator set shall be provided with a UL 2085 listed manufacturer's standard in-skid fuel transfer day tank. If the project provides for a screen wall around the generator, the fuel tank can be configured to meet the requirements of UL 142 and listed as such, in lieu of UL 2085. The tank shall be [_____] gallons capacity, factory-installed in the generator set skid base with engine supply and return lines pre-plumbed. The tank capacity should be able to support the generator running at full load for 24 hours. The tank shall not extend outside the dimensions of the standard generator set skid base. The fuel tank shall be new and unused and shall not be galvanized. The fuel system piping to the generator shall be no smaller than the minimum recommended by the engine manufacturer to avoid fuel flow restriction. Flexible connections shall be provided in the generator full supply and return piping. Each fuel oil tank shall have a SPDT low fuel level sensing device set to change state when a 2 hour usable fuel level remains in the tank. Each tank shall be provided with a fill connection, tank normal and emergency vent connection with UL listed caps and a tank fuel level gauge calibrated in gallons. Tanks shall be provided with EPA approved secondary containment and shall include leak detection in the containment section and a leak detection alarm output to be wired to the remote annunciator. The second set of fuel level switch contacts shall be wired to a terminal block for field wiring to the fuel oil control panel.]**

7. Fuel Oil Transfer Pump: Engine generator set skid assembly shall incorporate an integral fuel oil transfer pump and control panel. Pump capacity shall be **[_____ gpm]** at **[_____]** lift using a **[_____ volt]**, single phase, **[_____ hp]** motor. The control panel shall incorporate an on/off emergency run switch, a test/reset switch, AC circuit breaker, DC circuit breaker and indicator with test button for the following:

   a. System ready (green) - AC and DC power available.
   b. High fuel (red) - pump shutdown and N.O. contact closure.
   c. Low fuel ((red) - pump start and N.O. contact closure.
   d. Low fuel shutdown (red) - N.O. contact closure.
   e. Overflow to basin (red) - pump shutdown and N.O. contact closure.
   f. Spare lamp (red) - with N.O. and N.C. contacts.
   g. Pump running (green).

SELECT ONE OF THE FOLLOWING.

8. **[Vibration Isolation: Suitable aluminum, or steel or cast iron housed, spring type vibration isolators be provided. Isolators shall be sized to properly support the generator set and to isolate 99% of the generators vibration from the supporting structure.]**

OR

9. **[Skid Base: The entire packaged unit shall be mounted on a skid base of welded structural steel, of box type construction suitable for mounting on spring vibration isolators. A sloped drip pan shall be provided for containing engine fluid spills.**

Provisions for stub up of electrical and fuel connections shall be within the footprint of the generator set base rails. Generator skid base support package shall be provided by the manufacturer.]

10. Painting: The entire engine generator set shall have all exposed metal surfaces primed with a rust inhibiting primer and multiple finish coats of the manufacturer's standard machinery enamel finish.
11. Generator Outdoor Housing: Provide a weatherproof and rodent-proof outdoor shelter to entirely enclose each generator set, including batteries. Silencers shall be installed **[on] [inside]** enclosure. Enclosure shall have a fixed intake louver with bird screen **[and motorized damper (Level 2 only)]** and a grill protected radiator discharge opening. **[Motor-operated intake dampers shall be interlocked to open on unit start-up and close on unit shutdown (Level 2 only).]** Enclosure shall have hinges and gasketed access doors and access panels to allow complete unit operation and maintenance without removal of the enclosure. All doors shall be lockable. Lighting shall be provided in the interior of the enclosure. All sheet metal shall be primed for corrosion protection and finish painted **[in a color selected by the Architect] [in the manufacturer's standard color.]**
12. **[Generator Set Mounted Load Bank Breaker: Provide a factory installed load bank connection breaker for generator load testing. Load bank kW and circuit breaker frame and trip shall be as shown on the Drawings.]**

PART 3 - EXECUTION

3.1 INSTALLATION OF ENGINE-DRIVEN GENERATOR SETS

A. General: Install standby engine-driven generator sets where shown, in accordance with the equipment manufacturer's written instructions and recognized industry practices, to ensure that the sets comply with the specified requirements and serve the intended purposes.

B. Standards: Comply with NEMA standards, requirements of the NEC and applicable portions of NECA's "Standard of Installation" pertaining to installation of standby engine-driven generator sets and accessories.

C. Vibration Mounts: Install units on properly sized **[inertia base with]** spring type vibration mounts and ribbed neoprene vibration isolators; comply with manufacturer's indicated installation method as applicable.
[SELECT AND EDIT MOUNTING REQUIREMENT]

D. [Concrete Pad: Mount the generator on a spring isolated 12 inch thick concrete inertia base in concrete pouring frame to isolate generator vibration from the building structure. The concrete pouring frame shall consist of 12 inch deep perimeter steel members with a pan base and reinforcing bars, generator skid mounting bolts and isolator mounting recesses welded in place. The concrete inertia base/frame shall be designed to properly support the

generator using spring isolators recessed into the perimeter of the base and shall extend a minimum of 4 inches past the generator mounting skids. Isolators shall be adjustable spring mounting selected for 3 inches deflection and having telescoping top and bottom sections separated by resilient elastomeric inserts to limit horizontal motion. Steel or cast iron housings may be used if they are hot-dip galvanized after fabrication. The isolator shall be designed for a minimum kx/ky (horizontal-to-vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches). An elastomeric pad having a minimum thickness of ¼ inch and sized for a maximum load of 60 psi with a rating of 40 durometers shall be bonded to the base plate. Nuts, adjusting bolts and washers shall be zinc-electroplated to prevent corrosion.

E. [Concrete Pad: Install generator set [inertia base] on a [6 inch] reinforced concrete pad. The generator pad shall extend 6 inches beyond the generator set [inertia] base, unless shown otherwise. Furnish the exact position of any block-outs, mounting bolts, and the dimensions and location of the generator pad in a timely manner so as to prevent delay of the concrete work. Refer to Section 26 0501 "Electrical Basic Materials and Methods" for additional requirements.]

F. [Steel Frame: Install generator set on a steel frame. Refer to Structural Drawings. Furnish the exact position of any block-outs, mounting bolts, and the dimensions and location of the generator with Contractor in a timely manner so as to prevent delay of the frame work installation. Refer to Section 26 0501, "Basic Materials and Methods", for additional requirements.]
[VERIFY THIS REQUIREMENT]

G. Wiring: All feeders/conduits for generator and emergency power feeders shall be installed as follows:

1. Horizontal feeder/conduits shall be installed below grade, below a slab on grade, be enclosed in an approved 2 hour enclosure or utilize UL listed 2 hour rated conductors. Where a 2 hour enclosure is required, coordinate enclosure with the Contractor.
2. Vertical feeders/conduits shall be installed in a 2 hour rated chase or room, be enclosed in an approved 2 hour enclosure or utilize UL listed 2 hour rated conductors.. Where a 2 hour enclosure is required, coordinate enclosure with the Contractor.

VERIFY GROUNDING.

3.2 GROUNDING

A. General: Install the generator(s) as a **[non-separately] [separately]** derived system. **[The generator neutral shall not be grounded to the generator frame. Ground the generator frame through the feeder grounding conductor.] [Ground the generator neutral at the paralleling gear.]** Refer to Section 26 0526, "Grounding and Bonding for Electrical Systems", for additional requirements.

VERIFY GENERATOR CONTROLS.

3.3 CONTROL WIRING

A. General: Provide generator **[start-up]** control wiring from each **[Automatic Transfer Switch (including the fire pump ATS)] [the paralleling switchgear]** to each standby generator set.

B. Annunciators: Provide control wiring to remote generator annunciators in locations specified and as shown on the Drawings.

C. [Fuel Oil Control Wiring: Provide all control wiring from generator/day tank to remote fuel transfer pump control panel as shown on the Drawings and as required.]

3.4 COORDINATION
VERIFY REQUIREMENTS

A. [Exhaust: Exhaust piping shall be furnished, installed and insulated under Division 23. [Division 26 Contractor shall furnish a ventilated wall thimble, exhaust flex connection(s), condensation trap, rain cap, and critical type silencer for installation and insulation under Division 23.] All exhaust piping shall be routed away from windows, no less than 25 feet from air intakes.

B. [Cooling Air: Cooling air supply and exhaust air ductwork and dampers shall be furnished and installed under Division 23.]

C. [Fuel Oil Tank Fill and Vent Lines: Fuel oil tank fill and vent lines shall be furnished and installed under Division 22.]

3.5 INITIAL START-UP AND SYSTEM CHECKOUT

A. A complete installation shall be initially inspected, adjusted and started and checked out for operational compliance by representatives of the manufacturer. All start-up documentation shall be turned over to the Owner.

B. The engine lubrication oil and antifreeze shall be provided by the supplier of the electric set for operation under environmental conditions as recommended by the manufacturer.

3.6 TESTING

A. General: Upon completion of installation of engine-driven generator set(s)**[, transfer switches and paralleling gear,]** and after building circuitry has been energized with normal power source, test emergency power system to demonstrate standby capability and compliance with specified requirements, including automatic start-up, controls, and full load acceptance. Tests shall include operation of standby power system with voltage check while the system is loaded to ensure proper operation of the emergency generator, transfer switches, **[paralleling gear,**

fuel oil system,] and other system components. Operation of the system shall simulate standby power conditions, that is, loss of main electrical power to the building. Test period shall be a minimum of **[_____ hours]** continuous trouble-free operation with at least four automatic transfer switch operations for each switch within the period of operation. **[All diesel fuel for testing and filling all day tanks and fuel oil tanks at completion of successful testing shall be provided under the Project scope.]**

B. Test Load: Testing shall be performed at 0.8 PF with loads as specified herein below. Where the specific set has been factory tested at 0.8 PF as specified herein below, field-testing may be performed at 1.0 PF. The supplier of the engine-generator set shall provide a load bank of sufficient capacity to complement the available building load for testing. The field test shall include running the emergency power system under loads as specified below:

1. 30 minutes at 25% of rated load (field load bank).
2. 1hour at 50% of rated load (field load bank).
3. 4 hours at 75% of rated load (field load bank).
4. 4 hours at 100% of rated load (field load bank).
5. Miscellaneous building loads may be used to supplement load bank.

C. Test Readings: The voltage, current and frequency readings shall be recorded at 15 minute intervals throughout the test. Each Automatic Transfer Switch shall automatically operate a minimum of four times during the test. There shall be a 15 minute unloaded run at the conclusion of the test to allow engine to cool before shutdown. The Contractor shall make all necessary hook-ups to facilitate field-test and shall furnish all fuel necessary for field-testing. Refer to Section 26 0125 "Electrical Testing" for additional testing requirements. Owner must be present during load testing.

D. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect/Engineer and Owner for review. Test reports shall include date and time of test, relative humidity, temperature, and weather conditions. Contractor shall provide minimum 15% of replacement parts as reviewed and agreed upon by Owner plus 3 spare filters.

3.7 OPERATOR TRAINING

A. The manufacturer's start-up representative shall provide a minimum of 4 hours of operating and maintenance training to the Owner's maintenance personnel. Training shall be provided at times convenient to the Owner. Approved Operating and Maintenance Manuals shall be available to the Owner prior to the training session. Training shall be specific to the unit that is purchased.

B. Instructions and Drawings: Complete instructions, consisting of operating and maintenance manuals, parts book, dimensional drawings, separate unit wiring diagrams and schematics and

interconnecting wiring diagrams shall be provided as part of the Project operating and maintenance manuals.

3.8 IDENTIFICATION

A. General: Refer to Section 26 0553 "Identification for Electrical Systems" for requirements concerning painting, nameplates, and labeling.

END OF SECTION 26 3213