PART 1 - GENERAL

1.1 SYSTEM SUMMARY DESCRIPTION

A. The standby diesel engine generator system shall consist of the following key elements:
   1. kW/kVA standby diesel engine generator set per project requirements
   2. Integral weather housing (NEMA 3R)
   3. Engine-mounted radiator
   4. Critical silencer and exhaust pipe
   5. Output circuit breaker
   6. Generator controls and transfer logic
   7. Battery and charging system
   8. Subbase tank with secondary containment
   9. Remote status annunciator and start/stop controls

1.2 RELATED DOCUMENTS

A. The general conditions, Division 26, and Basic Electrical Materials and Methods (Section 260500) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.

B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

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

1.3 QUALITY ASSURANCE AND STANDARDS

A. Contractor shall ensure that the manufacturer has a minimum of ten (10) years experience in the production of diesel engine generators. Manufacturer shall have ability to provide replacement parts within 24 hours to protect continuity of service.

1.4 SUBMITTALS

A. Submit shop drawings per Section 260500 for review including the following as a minimum:
   1. Engine generator drawings with singleline diagram, elevation, floor plan, overall dimensions, weights, layout of components and devices, enclosure type, short circuit withstand ratings, fuel connections, nameplate schedule, interconnecting wiring diagrams, rated voltage, rated current, conductor sizes, and conduit entry points.
   2. Layout of engine generator in room, area, or yard including horizontal and vertical clearances.
   3. Vibration isolation calculations for Seismic Design category D shall be provided by the Contractor stamped and signed by a Registered Professional Structural Engineer in the State of California.
   4. Available fault current withstand ratings of all devices.

5. Manufacturer's product data sheets indicating compliance with specifications for engine, generator, generator controls, system protection, voltage regulation, fuel tank, battery, battery charger, critical silencer, cooling system, jacket water heater, output circuit breaker, and annunciators.
6. Seismic Qualification Certificates: For engine-generator set, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails identify center of gravity and total weight including full fuel tank, supplied enclosure, external silencer, subbase-mounted fuel tank, and each piece of equipment not integral to the engine-generator set, and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
7. Ground fault testing and setting of main over-current device shall be submitted with the Contractor's electrical testing and ground testing data.
8. Interconnection wiring diagram showing control connections between engine generator, transfer switch(es), and ancillary equipment.
9. Installation and operation manual.
10. Technical and performance data cut-sheets for engine, generator, automatic transfer switch, critical silencer and other components.
11. Factory test procedures and certified prototype test reports.
12. A copy of the specification indicating compliance or deviation for each paragraph.
13. Bill of Material, itemizing all equipment submitted.
14. Qualifications of the engine-generator manufacturer and of the authorized distributor including 24-hour emergency service capability.
15. NFPA-110 prototype test verification.
16. Altitude and temperature derating procedures.
17. Frequency and voltage regulation.
18. Engine emission data for "pre-permitting" purposes provided on the current application form for the air quality agency having jurisdiction. Exhaust and crankcase emission control equipment devices.
19. Generator performance data: Motor and load starting capability verification; temperature rise and insulation classification; short circuit sustaining capability; over-voltage safety shutdown; decrement curve for specific voltage specified.
20. Output circuit breaker size, manufacturer, model, and short-circuit capability.
21. Control panel features and performance.
22. Critical exhaust silencer attenuation rating.
23. Jacket water heater system.
24. Fuel storage and delivery system.
25. Remote annunciator and start/stop panel.
26. Weather enclosure details.
27. Engine exhaust back pressure calculations.
28. Warranty

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1.6 OPERATOR MANUALS

A. The Contractor shall furnish a minimum of six (6) operator manuals for the engine generator system at the time of start up, including, but not limited to installation procedures, assembly and rigging instructions, troubleshooting guidelines, wiring diagrams, maintenance procedures and spare parts list. Included shall be the name, phone number, and organization of contact person for 24-hour emergency service.

1.7 FACTORY PROTOTYPE TESTING

A. The Contractor and system manufacturer shall submit certification of engine, generator, controls, and switchgear prototype testing as complete systems of representative engineering models. Testing shall comply NFPA-110.

B. Specific prototype tests shall include:
   1. Maximum power (kW).
   2. Maximum starting (kVA) at 30% instantaneous voltage dip.
   3. Alternator temperature rise.
   4. Governor speed regulation under steady-state and transient conditions.
   5. Voltage regulation and generator transient response.
   6. Fuel consumption at no load, ¼, ½, ¾, and full load.
   7. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
   8. Three-phase line-to-line short circuit test.
   9. Engine alternator cooling air flow (heat rejection).
   10. Torsional analysis testing.
   11. Endurance testing.

1.8 FACTORY PRODUCTION TESTING

A. Each engine, generator, and generator set shall be subjected to production performance tests and quality controls to insure reliable operation. Testing shall comply with NFPA-110. These tests and controls shall include but not be limited to:
   1. Single-step load pickup.
   2. Transient and steady-state governing.
   3. Safety shutdown.
   4. Voltage regulation.
   5. Rated power at rated power factor.
   6. Maximum power.

B. A certified test report shall be provided within 10 days of factory testing.

1.9 WARRANTY

A. Contractor shall guarantee equipment and installation free from defects in materials and workmanship for a period of two (2) years from the date of acceptance.

1.10 MANUFACTURERS

A. Manufacturers of the diesel engine generator shall be Kohler, Cummins/Onan, Caterpillar or Detroit Diesel.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Engine-generator set housing, subbase fuel tank, engine-generator set, batteries, battery racks, silencers, and sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."
   2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst case normal levels. Water shall be substituted for diesel fuel in fuel tank during test.
   3. Component Importance Factor: 1.0.

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

C. NFPA Compliance:
   1. Comply with NFPA 37.
   2. Comply with CEC.
   3. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

D. UL Compliance: Comply with UL 2200.

E. Engine Exhaust Emissions: Comply with EPA Tier 3 and SCAQMD requirements and applicable state and local government requirements.

F. 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.

G. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
   1. Ambient Temperature: 5 to 40 deg C.
   2. Relative Humidity: Zero to 95 percent.
   3. Altitude: Sea level to 1000 feet.

2.2 GENERAL

A. Unit shall be rated for standby operation during any utility power failure. Rating shall be verified by published specification sheets of its nationally recognized manufacturer. Generator set shall be capable of accepting rated load in one step in accordance with NFPA-110 Para. 3-5.3.1. Unit shall be built and labeled in accordance with UL2200.

B. System rating shall be as follows:
1. kW/0.8PF/kVA per project requirements
2. 480Y/277V 3 phase 4W 60Hz
3. 4 cycle 1800 RPM engines
4. A full load current output capacity
5. Maximum 30% transient voltage dip with +2% recovery voltage upon application of single step 100% load.
6. No. 2 Diesel Fuel
7. Output circuit breakers sized per project requirements
8. Outdoor enclosure

C. The generator set shall consist of a diesel engine connected to a generator with brushless excitation. The generator set shall be mounted on a steel sub-base and provided with all necessary accessories, auxiliaries and control equipment for a complete and operating system.

D. The engine generator must be capable of providing rated power within 10 seconds after failure of normal power.

E. The engine generator must not be manufactured with Class I ozone depleting substances as defined by Federal Register Vol 57 No 86.

F. The materials herein shall be of new and domestic manufacturer. The engine generator shall be designed, tested, assembled, and furnished in accordance with the applicable standards.

G. The engine generator shall be an integrated assembly of a single manufacturer. Major components shall bear the label of a single manufacturer and shall be assembled in that manufacturer's plant(s) unless specifically approved otherwise.

2.3 GENERATOR-SET PERFORMANCE:

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

B. 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.

C. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

D. 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.

E. 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.

F. 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.

G. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

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

2.4 ENGINE

A. The engine shall be 4-cycle, direct connected to the generator by a semi-flexible coupling, and both shall be mounted on a common sub-base. The engine shall have sufficient power to produce the specified rating when operating at generator synchronous speed with all accessories required for normal operation including exhaust, fuel, cooling, and battery charging systems. Maximum engine speed shall be 1800 RPM. The engine shall have a pressure lubrication system and replaceable element oil filter. 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.

B. The generator set shall be mounted on a heavy duty steel base incorporating a battery tray and battery charger rack. The fuel and electrical connection stub-up points shall be within the footprint of the base. The base shall have Seismic Design Category D vibration isolators included.

C. The engine shall be equipped with a fuel system suitable for operation on #2 diesel fuel. Fuel system shall include fuel filter, transfer pump, manual priming pump, flexible fuel lines, and primary fuel/water separator. Fuel system shall comply with the requirements of NFPA-37 and NFPA-110. The fuel pump shall be an engine-driven positive displacement type. The fuel filter shall be a replaceable spin-on canister type.

D. The engine cooling system shall be designed to provide adequate cooling at rated load in ambient temperatures up to 120 degrees F. The system shall include a unit-mounted closed-loop radiator, belt-driven blower fan, water pump, thermostat and OSHA guards. Cooling system shall meet the performance requirements of NFPA-110. Provide a low water level shutdown device.
   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. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
   a. Rating: 50-psig 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.

E. The engine governor shall maintain frequency within a 0.25 % band under steady state conditions and isochronous from no-load to full load. Regulation shall be as defined by IEEE Std 126-1959/83. Governor performance shall comply with EGSA 100E.

F. Starting shall be by means of a solenoid operated positive engagement gear driven electric starter for operation on 12 or 24 volt D.C. Note the cycle-crank requirement specified within the generator control panel. Provide a primary and a secondary means of cranking termination in accordance with NFPA-110 Para. 3-5.4.2. The engine shall start and provide power within ten (10) seconds.

G. Engine protective devices shall meet the performance requirements of EGSA 100F and shall include the following:
   1. Overcrank – lockout
   2. Low oil pressure - preliminary alarm
   3. Low oil pressure – shutdown
   4. High water temperature - preliminary alarm
   5. High water temperature – shutdown
   6. Low water temperature – alarm
   7. Low water level – shutdown
   8. Overspeed – shutdown
   9. Low fuel level - alarm

H. The engine lubrication system shall be a full pressure system supplying a continuous flow of lubricant to all moving parts. Circulation shall be by means of positive displacement gear pump. Full flow lubrication oil filters and series-connected oil cooler shall be provided. The filter shall be replaceable and easily accessible.

I. Engine crankcase emissions shall be filtered to prevent oil mist from contaminating the engine space and to comply with Air Pollution Control District requirements for visible emissions. Filter device shall consist of a replaceable filter element and a removable reservoir for collected fluids. Filter shall be sized for the allowable crankcase back pressure established by the engine manufacturer.

J. Emissions: Comply with EPA Tier 3 requirements. Provide passive emission system to comply with SCAQMD requirements.

1. Diesel Particulate Filter (DPF) shall use passive regeneration technology that utilizes a continuous regeneration technology.
2. Unit shall meet CARB Level 3+ to achieve a minimum 85% PM reduction.
3. Controller shall indicate abnormal operation and shall annunciate alarms to the generator controller.
4. Regeneration shall be automatic and shall keep the filter cartridges functioning at low back pressure and peak efficiency.
5. DPF shall incorporate an integrated diesel oxidation catalyst to reduce the soluble organic fraction, gaseous hydrocarbons and carbon monoxide.
6. DPF shall incorporate a Hospital Critical Grade Silencer with 25-35 dBA attenuation.
7. DPF shall be Johnson Matthey CRT or equal.
8. Housing shall be constructed of carbon steel with high temperature zinc base primer and painted to match generator housing.

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

2.5 BATTERY SET

A. A lead acid battery set shall be provided and installed on the generator base with seismic restraints. System voltage shall match that of the starter. Cold-cranking amperage capacity shall conform to the requirements of SAE Standard J-537 for zero degrees Fahrenheit. Provide insulated, stranded copper conductors to connect to the starting system. Provide specified cranking cycle at least twice without recharging.

B. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.

C. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.

2.6 BATTERY CHARGER

A. An automatic float/equalize type battery charger shall be provided, installed with vibration isolators, and wired on the generator set. Connections to the battery shall be solid wired (clip-on type clamps not acceptable). Input voltage shall be 120 VAC. Charger shall be UL listed. Output capacity shall be a minimum of 10 amps.

B. Features shall include the following:
1. 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.
2. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
3. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

4. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
5. Low battery voltage alarm contacts, set to close if battery voltage drops below 90% of rated.
6. Neon light to indicate the selector switch is in the "equalize" range.
7. DC Voltmeter
8. DC Ammeter
9. AC Circuit Breaker on input line
10. DC Circuit Breaker on output line
11. 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.
12. Power "ON" indicating lamp

C. Battery charger enclosure shall be NEMA 1 construction arranged for convection cooling and located within the generator enclosure.

2.7 JACKET WATER HEATER

A. A jacket water heater, thermostatically controlled, shall be installed on the engine. Heater shall be 2500 watts, 120 VAC input or as noted on the shop drawings. Heater shall be mounted on the generator base rails and provided with flexible hoses to the engine. Flexible hoses shall be rated at 300 degrees F. and 100 PSI. Provision shall be made for isolation of the jacket water heater with 3/4 inch NPT ball-valves installed at the engine side of the flexible hoses. Provide a disconnect safety switch, or disconnect plug, to isolate the heating element from the electrical source for maintenance purposes. The jacket water heater shall be U.L. listed and labeled.

2.8 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 30.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 “Facility Fuel-Oil Piping.” Cast iron, aluminum, copper, and galvanizing shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

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

2.9 FUEL STORAGE SYSTEM

A. Provide a sub-base mounted fuel storage tank capable of supporting the generator set at rated load for a duration determined by the project requirements. Overall dimensions of the tank shall not exceed those of the generator enclosure. Tank shall not extend within 12 inches of the generator end to provide access for electrical

conduit from below. Tank shall be built and labeled in accordance with UL-142. Mounting feet shall provide clearance between bottom of tank and foundation. The tank construction shall be welded-steel, pressure tested to 5 PSI minimum with interior rust preventative coating.

B. Tank features shall include:
1. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills, plus fuel for the hours of continuous operation for indicated EPSS class.
2. Vandal-resistant fill cap.
3. 2 inch filler with 6 inch stub and locking cap.
4. Engine supply and return openings and draw tubes.
5. Vent per UL for both primary and secondary containment.
6. Tank leak port.
7. Fuel level indicator gauge.
8. Low fuel level alarm switch, set at 2 remaining hours.
9. Secondary containment, totally closed, by double wall tank construction. Provide alarm contact for "liquid in containment basin". Wire contact to alarm light in the generator control panel.
10. Manual priming pump.

C. Provide flexible fuel lines rated for duty at 300 degrees F and 100 PSI.

2.10 EXHAUST SYSTEM

A. A critical degree silencer shall be provided and installed within the generator set enclosure. Supplier shall furnish back pressure calculations for the installation verifying that engine limitation is not exceeded. Silencer shall be arranged for horizontal mounting with bottom (or side) inlet and end outlet; the weight of the silencer shall not be carried by the engine. Provide a stainless steel bellows type flexible exhaust connector at the engine exhaust outlet. Provide a long radius type elbow to discharge exhaust gases vertically. Provide suitable raincap and condensate drains. A "Critical Degree" silencer is considered to be one capable of attenuating engine exhaust noise component to 85 dBA at 10 feet in a free-field environment.

2.11 GENERATOR

A. The generator shall be single bearing 4-pole, revolving field, two-thirds (2/3) pitch or five-sixths (5/6) pitch with rotating brushless exciter. The generator shall be air cooled and drip proof. The generator shall be directly connected to the engine with a flexible drive disk.

B. The rotor shall have amortissuer windings and be dynamically balanced. The amortissuer windings shall be layer wound mechanically wedged construction.

C. The generator insulation shall be Class F and rated for insulation temperature rise not to exceed 105 degrees C at full load. The generator and exciter insulation shall be vacuum impregnated to withstand severe environments of sand, salt, and sea spray.

D. 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.

E. The exciter shall be brushless, three phase, with full wave silicon diodes, surge suppression and exciter circuit breaker.

F. The voltage regulator shall be solid state, three-phase RMS sensing, temperature compensated, asynchronous pulse width modulated. Voltage regulation shall be +/- 0.5% of rated voltage for any constant load between no load and rated load. Voltage regulator shall turn off when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds. The regulator shall allow frequency output to decline to 58Hz before correcting the output voltage in a linear volts/hertz manner. The regulator shall not be sensitive to SCR or Thyristor interference.

G. The generator must be capable of maintaining control with a total harmonic distortion of up to 10%.

H. Provide shielding of generator, exciter and regulator to prevent radio frequency interference.

I. A permanent magnet generator (PMG) shall provide excitation power to the voltage regulator and immunity against voltage distortion caused by nonlinear loads. The PMG shall cause rapid voltage build-up on starting, and sustain main field excitation short circuit current for selective operation and coordination of system overcurrent devices. The PMG shall maintain 300% current for ten (10) seconds.

J. The application of rated load at rated power in one step with the generator initially at rated speed, rated voltage and no load shall not cause a transient voltage deviation of more than 30% of the rated voltage. The voltage shall recover to and remain within a band of 2% of rated voltage.

K. Motor starting kVA shall be per the project requirements at near zero power factor with no more than 10% sustained RMS voltage drop of no load voltage.

L. The generator shall have random wound or form wound coils.

M. The generator shall be a single bearing machine with an assembly that permits easy removal and replacement. The bearing shall be designed to prevent leakage of lubricants.

N. A generator output circuit breaker shall be provided as follows:
   1. Molded-case, thermal-magnetic type; 100 percent rated; complying with UL 489 mounted at the generator.
      a. Tripping Characteristic: Designed specifically for generator protection.
      b. Trip Rating: Matched to generator output rating.
      c. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
      d. Mounting: Adjacent to or integrated with control and monitoring panel.

2. The device shall be rated for an ambient temperature of 104 degrees F. This rating shall include at least 10% additional capacity for overload and operating temperature rise over 104 degrees F
3. The device shall operate manually for normal switching operations and automatically during current overload and short circuit conditions.
4. The circuit breaker shall be U.L. listed and meet the requirements of NEMA and CEC.
5. The circuit breaker shall have a battery voltage operated shunt trip in the event of an engine failure or safety shutdown initiation as indicated by conditions listed in Paragraph 2.9.2.2.
6. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.
   a. Indicate ground fault with other generator-set alarm indications.
   b. Trip generator protective device on ground fault.

2.12 MOTORS

A. Description: NEMA MG 1, Design B, medium induction random-wound, squirrel cage motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

E. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Temperature Rise: Match insulation rating.

G. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

I. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

2.13 GENERATOR CONTROLLER

A. A solid state controller shall be vibration isolated above the generator. The microprocessor control board shall be moisture proof and capable of operation from –40 degrees C to 85 degrees C. Relays will only be acceptable in high current circuits. Generator set instrumentation, control, and auxiliary equipment shall meet the performance standards of EGSA 100G. Circuitry shall be of plug-in design for quick replacement. Controller shall be equipped to accept a plug-in device capable of allowing maintenance personnel to test controller performance without operating the engine. The controller shall include:
   1. Fused DC circuits.

2. Complete two-wire start/stop control, which shall operate on closure of a remote contact.
3. Speed sensing and a second independent starter motor disengagement system shall protect against the starter engaging with a moving flywheel. Battery charging alternator voltage will not be acceptable for this purpose.
4. The starting system shall be designed for restarting in the event of a false engine start, by permitting the engine to completely stop and then re-engage the starter.
5. Cranking cycler with 15-second ON and OFF cranking periods.
6. Overcrank protection designed to open the cranking circuit after 75 seconds if the engine fails to start.
7. Engine cool down timer factory set at five (5) minutes to permit unloaded running of the standby set after transfer of the load to normal.
8. Four-position (Automatic-Manual-Off/Reset-Stop) selector switch. In the test position, the engine shall start and run regardless of the position of the remote starting contacts. In the automatic position, the engine shall start when contacts in the remote control circuit close and stop five (5) minutes after those contacts open. In the off position, the engine shall not start even though the remote start contacts close. This position shall also provide for immediate shutdown in case of an emergency. Reset of any fault lamp shall also be accomplished by putting the switch to the off position.
9. Provide minimum run time control set for 30 minutes with override only by operation of a remote emergency-stop switch.
10. Comply with UL 508A.

B. An engine and generator instrument panel shall be installed on the unit with vibration isolators, and include the following:
1. Instruments (RMS indicating to 0.5% accuracy)
   a. AC Voltmeter,
   b. AC Ammeter,
   c. VM/AM phase selector switch
   d. Kilowatt Meter
   e. Frequency meter,
   f. DC Voltmeter,
   g. Engine water temperature,
   h. Engine oil pressure,
   i. Running time meter
   j. Engine speed
   k. EPS supplying load indicator.
2. Indicator Lamps And Alarm Contacts (Including RESET)
   a. Overcrank (red) – Shut Down Device & Alarm
   b. Overspeed (red) – Shut Down Device & Alarm
   c. Anticipatory low oil pressure (yellow)
   d. Low oil pressure (red) – Shut Down Device & Alarm
   e. Anticipatory high water temperature (yellow) – Pre-Alarm
   f. High water temperature (red) – Shut Down Device & Alarm
   g. Low water temperature (yellow) – Alarm
   h. Emergency stop (red)
   i. "Not in auto" (flashing red) – Alarm
   j. Low fuel (red) – Alarm
   k. System ready (green)
   l. Battery charger fault (red) – Alarm
   m. Low battery volts (red) – Alarm

n. Auxiliary lamp (red), spare - for fuel in Containment basin.
o. Low coolant level (red) – Shut Down Device & Alarm
p. Low cranking voltage alarm.
q. Battery high-voltage alarm.

3. Controls
   a. Lamp test switch
   b. Voltage adjusting rheostat, + or - 5 percent range
   c. Panel lamps (2)
4. Alarm horn, with silence switch, to meet the requirements of NFPA 110. Note: Silencing this horn after one fault, shall not prevent it from sounding again should another fault condition occur.

C. Connection to Datalink: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication. Provide connections for datalink transmission of indications to remote data terminals via ModBus.

D. Complete control panel shall be "rodent proof" to prevent damage to components by small rodents.

E. Provide the following fuel delivery system features:
1. Fuel shut off solenoid
2. On/Off test switch
3. AC/DC current breakers
4. Contacts and indicating lamps for:
   a. System Ready
   b. High Fuel
   c. Low Fuel
   d. Liquid in containment basin
   e. Pump Running

2.14 REMOTE ANNUNCIATOR AND START/STOP PANEL

A. Provide and install a remote alarm/status panel as shown on the drawings. Panel shall include all alarms as indicated on the engine generator instrument panel including:
1. Alarm indicators for:
   a. Pre-alarm high engine temperature
   b. Pre-alarm low oil pressure
   c. Low water temperature
   d. Low fuel
   e. Battery charger fault
   f. Low battery voltage
   g. Auxiliary fault
2. Remote Start/Stop Capability
3. Shutdown indicators for:
   a. High water temperature
   b. Low oil pressure
   c. Emergency stop
   d. Overspeed
   e. Overcrank
4. Status indicators for:
   a. Line power
   b. Generator power

c. System ready
d. Generator switch not in "auto"
e. Lamp test switch
f. Alarm horn, with "Silence/Normal" switch.

B. Annunciator panel shall be arranged for flush mounting as shown on the drawings.

C. Provide “GenTracker” control panel and software package for remote monitoring of the engine generator system.

2.15 WEATHER PROTECTIVE ENCLOSURE

A. Provide a steel weather-protective, sound-attenuating enclosure with removable or hinged side panels to allow inspection and maintenance. The enclosure shall be coated with ASA gray primer and two coats of high-gloss, weather-proof, sag resistant vinylac in the manufacturer's standard color through an electrical bonding process. The enclosure shall be equipped with hinged, removable doors with provisions for locking. The enclosure roof shall be peaked to allow water drainage. The enclosure shall be built as an integral part of the generator set and be delivered to the site as a complete assembly. Weather housing shall include sound attenuation treatment and radiator air discharge hood.

B. Doors shall have a common keyed latch. Provide two (2) sets of keys.

C. Exterior holes and openings in the enclosure shall be covered with 1/4 inch galvanized mesh to prevent entry of birds and rodents.

2.16 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
1. Material: Bridge-bearing neoprene, complying with AASHTO M 251 separated by steel shims.
2. Minimum Deflection: 1 inch.

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- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 1 inch.

C. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.17 SEISMIC RESTRAINT

A. The generator set shall be provided with isolators for installation between the base and the generator set. Isolators shall be pre-approved by California Division of State Architect (DSA) and Statewide Health Planning and Development (OSHPD) to satisfy Title 24 of the California Code of Regulations. The isolators shall be anchored directly to the concrete foundation by means of approved anchor bolts. A minimum of four (4) anchors for each isolator shall be provided by the generator set supplier. The fuel tank base shall be mounted directly to the foundation.

B. Provide calculations signed by a structural engineer registered in the State of California verifying compliance with California Code of Regulations Title 24 for Seismic Design Category D. These calculations shall be a part of the submittal data provided.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Inspect installation and equipment for physical damage, proper alignment, anchorage, grounding, and completeness.

B. Check continuity of all circuits.

C. Check polarity and phasing of bussing.

D. Inspect bus bar spacing, insulators, wiring and devices for compliance with ANSI, CEC, and UL standards.

E. Check tightness of all bolted connections.

F. Check nameplates and identification.

G. The Contractor shall protect all equipment during shipping, delivery, storage, installation, and at all times during construction. Engine generators or their components shall not be exposed to weather, moisture, dust, dirt, debris or damage during construction.

H. The Contractor shall engage the services of the supplier's factory trained technicians to perform start up and testing and shall furnish test equipment. Owner's personnel shall be notified in advance of this test. Deliver with recommended oil and coolant installed.
   1. Check all electrical, exhaust, fuel, and water connections for proper size, continuity, phase rotation, and tightness of fittings. Check all fluids for appropriate levels.
   2. Check jacket water heater operation.
   3. Check battery charger connections and operational voltage.
   4. Check automatic transfer switch control connections and annunciator connections.
   5. Start up engine and make initial start up check of all operational equipment.

6. Test all safety devices using methods recommended by the manufacturer.

3.2 EXAMINATION

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

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

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

3.3 INSTALLATION

A. Furnish labor and related materials, appliances, tools and equipment necessary for and incident to performing all operations in connection with furnishing, delivery, installation, training, and start-up of Diesel Engine Generators. Install engine generator in accordance with manufacturer's written instructions, NFPA 70, NEMA standards, CEC requirements and any state code.

B. Provide a clean, level surface for installation with suitable structural strength. Verify compliance with Seismic Design Category D requirements.

C. Equipment Mounting:
1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Install packaged engine-generator with elastomeric isolator pads or restrained spring isolators having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure enclosure to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Permanently install all nameplates and circuit identification.

F. Provide ground continuity through means of driven ground rods, bonding to building steel, or bonding to building grounding electrode.

G. Install device handles to a height no greater than allowed by CEC or governing authority.

H. Engine generator shall be plumb and square to building structure. Provide CEC and CBC required clearance on all sides.

I. The Contractor shall coordinate installation and schedule with all other trades and Owner's Representative.

J. The Contractor shall coordinate all components including their arrangement electrically and mechanically. The silencer, exhaust pipe, and insulation installation shall be installed as a part of the Electrical Contract.

K. The Contractor shall coordinate conduit entrances including method of entrance and connections.

L. The Contractor shall coordinate with all other trades necessary to provide a complete, proper installation. Grades, piping, structure, ducting, etc. shall be carefully reviewed by the Contractor prior to installation.

M. 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.

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

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

P. All electrical connections shall be made with oil-tight, flexible conduit.

Q. The Contractor shall be responsible for furnishing and installing the entire generator and automatic transfer switch. Refer to Sections 263600 as applicable for further requirements. The transfer switch equipment shall be furnished by the engine generator set supplier.

R. The Contractor shall require the engine supplier to perform the entire system start up and acceptance testing including the engine generator, automatic transfer switch, distribution equipment, generator controls, transfer signals, and overall system operation. The equipment supplier shall maintain a parts inventory, provide 24-hour emergency service and provide an equipment warranty.

S. The Contractor shall be responsible for verifying physical space constraints, clearances, and layouts prior to shipment.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine-generator to allow service and maintenance.

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

D. Connect fuel piping to engines with a gate valve and union and flexible connector.
   1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 231113 "Facility Fuel-Oil Piping."

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

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

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

3.5 IDENTIFICATION

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

3.6 START-UP, TESTING, AND TRAINING

A. The Owner's Representative and Engineer shall be given ten (10) days notice prior to testing. The Contractor shall notify the appropriate Fire Marshal and governing air quality control agency.

B. Equipment inspection, start-up, testing, and training shall be supervised and documented by the manufacturer's local representative.

C. Tests and Inspections:
1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs as specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
a. Visual and Mechanical Inspection
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify the unit is clean.
b. Electrical and Mechanical Tests
1) Perform insulation-resistance tests in accordance with IEEE 43.
a) Machines larger than 200 horsepower. Test duration shall be 10 minutes. Calculate polarization index.
b) Machines 200 horsepower or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.
2) Test protective relay devices.
3) Verify phase rotation, phasing, and synchronized operation as required by the application.
4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
5) Conduct performance test in accordance with NFPA 110.
6) Verify correct functioning of the governor and regulator.

2. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.
3. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
4. 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.
5. Exhaust Emissions Test: Comply with applicable government test criteria.
6. 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.
7. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.

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

E. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

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

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

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

I. Remove and replace malfunctioning units and retest as specified above.

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

K. 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.

L. Check all circuits for continuity and safety prior to energizing. Operate all devices to ensure proper installation and performance. Notify Owner's Representative a minimum of seven (7) days prior to energizing such that adequate preparation is made for power.

M. Train Owner's Representative (or appropriate staff) for a period no less than two (2) hours in regard to start-up, operation, and maintenance of the engine generator and its components. All instructional training shall be professionally recorded by the Contractor and a DVD of the recording shall be provided to the Owner.

N. The Contractor shall schedule, coordinate and document all air quality testing. Notice shall be given to manufacturer's representative, Owner's representative, engineer and others as necessary.

O. The Contractor shall furnish all fuel, water, and lubricants necessary for the start-up and testing of the engine generator system.

P. Upon completion of field quality review and initial system start-up, provide system performance testing:
   1. The initial start-up of the engine-generator set shall be performed by a factory-trained representative of the engine generator set manufacturer. He shall furnish and install the recommended engine lubricants and fill the cooling system with mixture of water and corrosion inhibitor in accordance with the engine manufacturer's recommendations. He shall supervise the load test specified, and within one week of the conclusion of the test shall supply the Owner's Representative with a minimum of six (6) complete sets of operation, maintenance, and parts manuals for all equipment. He shall instruct the Owner's Representative (or other designated personnel) in the proper operating and maintenance procedures for all components of the engine generator system.
   2. Demonstrate proper operation of all systems.
   3. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. This shall include: engine heaters, battery charger, fuel system (including level and quantity of fuel), etc.
   4. Start-up under test mode to check for exhaust leaks, path of exhaust gases, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.
   5. Automatic start-up by means of simulated power outage to test remote automatic starting, transfer of load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper systems coordination. Engine temperature, oil pressure and battery charger level along with generator voltage, amperes, and frequency shall be monitored throughout the test. Transfer switches shall be shown to properly operate automatically under load no less than five (5) times during testing. All remote annunciation and controls shall be tested. Verify all time delay settings.
   6. The contractor shall maintain a log of data at 15 minute intervals during testing.
   7. Provide a certified copy of site test report showing compliance with specifications and approval of the installation for warranty purposes.
   8. Measure and record the transient frequency and voltage dip, and recovery time to steady state conditions, for the single step application of rated load. Verify compliance with the governor and voltage regulator performance specified in paragraphs 2.2.5, 2.8.5, and 2.8.9.

Q. All system deficiencies found during start-up and testing shall be immediately corrected by the Contractor at the Contractor's expense. All testing shall be

repeated until no deficiencies are found; retesting shall be at the Contractor's expense.

R. After the final testing the Contractor shall "top off" fuel to full.

3.7 CLEANING AND REPAIR

A. Clean weather housing interior and exterior of grease, dirt, debris, dust, excess paint, plaster, spackle, unused wire, etc.

B. Repair and paint enclosure as necessary to return the enclosure to the original factory condition.

C. Damage to electrical components shall be repaired in the factory.

END OF SECTION