SECTION 16620

STANDBY POWER
(ADDITIVE ALTERNATE NO. 1)

PART 1 – GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other sections for work related to those other sections and required to be included as work under this section.
   2. General provisions and requirements for electrical work.

B. Engine Generator

   1. Furnish and install emergency continuous standby diesel (USA-grade #2 ULSD-CARB) fuel engine driven generator with all accessories and other appurtenant work and materials required for a complete operational installation.
      a. The fuel provided shall comply with; be listed by; and shall be approved by, the California Air Resources Board (CARB Fuel Specifications and Test Methods).
   2. The standby power system shall include an electric generating set rated to deliver 200 kW, 250 kVA at 0.8 power factor. Engine not less than 347 Bhp minimum, 6 cylinders at 1800 rpm.
   3. Unit rating shall not be based on the peak output curve of the prime mover. Unit rating shall be based on the continuous standby rating at the altitude above sea level of the engine generator installation site. Performance engine curves shall be submitted.
   4. The engine generator output voltage shall 480/277 volts, 3 phase, 4 wire, 60 Hertz AC.
   5. The engine generator set shall be built, tested and shipped by the manufacturer of the unit so there is one source of supply and responsibility. As manufactured by Cummins, Kohler, or Caterpillar.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. General
   1. The factory authorized Distributor supplying the equipment shall have full service and parts capability on a 24-hour basis located within 200 miles of the project site. Instruct the involved contractors on the proper method of installing the engine generator unit and related equipment.
   2. Make shop drawings to scale, showing overall dimensions and other dimensions required for proper installation of equipment and external connections. Identify clearly each item on drawings to show piece of equipment it represents. Indicate corrosion resisting treatment and finish.
   3. Shop drawings shall include complete layout of room and/or area where new equipment is being installed indicating equipment layout, conduits, junction boxes, etc., complete with dimensions and clearances for review of the OWNER'S Representative.

4. Diagrams shall be schematic and point-to-point using standard symbols and with components arranged in logical sequence, so that system operation can be checked easily. Where special symbols are used or where function of components is not obvious, include suitable legend or functional guide. Number all terminals for external wiring connections on diagrams. A composite control wiring diagram shall be provided showing the integrated control and load connections of the following:
   a. Engine generator and control panel.
   b. Engine generator remote annunciator panel.
   c. Automatic transfer switch.
   d. Battery charger.
   e. Special interlocks noted on drawings.
   f. Fuel system.
   g. Load testing system.
5. Submit prototype, independent test lab, certified test reports for engine generator unit of identical size, type and construction showing conformance with performance requirements outlined in the contract documents. Plus the following additional tests:
   a. Maximum power level.
   b. Maximum motor starting capacity.
   c. Fuel consumption.
   d. Engine/alternator cooling air flow (heat rejection).
   e. Transient response and steady state governing.
   f. Alternator temperature rise.
   g. Single step load pickup.
   h. Harmonic analysis and voltage wave form.
   i. Three phase short circuit test for mechanical electrical strength.

B. Pollution Emissions
1. The engine generator shall comply with the air pollution controls and pollution emission limits regulations of the authorities having jurisdiction (AHJ), including but not limited to the following: A manufacturer's "Certified Equipment Permit" shall be provided showing the proposed equipment AHJ approval permits.
2. United States Federal Government.
   a. Environmental Protection Agency (USEPA) – Local Region having jurisdiction.
3. State of California:
   a. California Environmental Quality Act – CEQA.
   b. California Environmental Protection Agency (CALEPA) and California Air Resource Board (CARB).
   c. California Air Quality Management District (AQMD) district office having local jurisdiction at the project site location.
   d. Additional local and City/County Pollution Control District authorities having jurisdiction.
4. The emission pollutants tests and reports shall include but not be limited to the following:
   a. Reactive organic gases – (ROG)
   b. Nitrogen oxides – NOX)
   c. Carbon monoxide – (CO)
   d. Particulate matter – (PM)
   e. Sulfur oxides – (SOX)
   f. Non Methane Hydrocarbons - NMHC
   g. Non Methane Organic Gas – NMOG
   h. Total Organic Compounds - TOC
   i. Carbon Dioxide – CO2
   j. Fuel storage containment, fuel leak detection and leak monitoring system.
5. Particulate Matter (PM):
   a. The engine generator particulate emissions shall not exceed AHJ requirements, but in no case shall particulate emissions exceed the following:

b. The engine combustion air exhaust (discharge) shall not exceed particulate matter (PM)emissions of 0.15 grams/Bhp-HR (engine brake horsepower each hour)at all engine generator load factors. Where the install location is within 500 ft. of a school property line or on a school site, then the PM emissions limit shall be reduced to not exceed 0.01 grams/Bhp – HR at all engine generator load factors.

6. The engine generator manufacturer shall prepare pollution emissions reports for the proposed engine generator. The reports shall be in the format and include the documentation required by the AHJ for emissions regulations. The engine generator operational pollution emissions and controls shall comply with the requirements and regulations of the AHJ for the intended engine generator use. If the engine generator requires the addition of emission controls and/or abatement controls to comply with AHJ requirements, provide said controls as part of the contract document requirements.

7. Apply for and obtain in the name of the CONTRACTOR and the OWNER respectively the Permits to Construct and Permits to Operate the engine generator system as a Building Code mandated Emergency Stand-by Power System. Provide four (4) copies of each permit application for review by the OWNER'S Representative prior to submittal to AHJ. Obtain the AHJ approval of the permits, along with a written description of any additional actions the OWNER must accomplish. Submit all documents to the OWNER'S Representative.

   a. The design intention hours of engine operation (engine running) are less than 199 hours in a 12-consecutive month period of time, to supply Building Code mandated emergency electrical power. The actual operating (running) time of the engine generator will be determined by uncontrollable and unpredictable conditions, such as; acts of God; equipment failures; utility company outages; rolling blackouts, etc. The design intent estimated engine operating time includes an estimated 30-hours of programmable time for testing (exercising) maintenance of the engine generator system.

   b. The following is a partial list of "non-code" mandated electric loads that will be connected to the standby engine generator system:
      - All building 3 loads
      - Elevator
      - Intrusion detection/security alarm
      - HVAC air conditioning
      - Other loads as shown in the contract documents

C. Quality Control

1. General

The equipment shall be listed, labeled and approved for the application shown in the contract documents, as building code mandated, emergency electrical power supply equipment, complying with the most recent versions of the requirements of the following Applicable Standards. The following standards shall become requirements of and are included in the contract documents:

2. Underwriters Laboratory – UL
   a. UL – 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.
   b. UL - 2085, Fire Rated (vaulted) above tanks for Flammable and Combustible Liquids. Fuel Tanks.
   c. UL – 508, Industrial Control Equipment.
   d. UL – 2200, Standard for Safety for Stationary Engine Generators.

3. National Fire Protection Association – NFPA
   a. NFPA – 30, Flammable and Combustible Liquids Code.
   b. NFPA – 37, Stationary Combustion Engines and Gas Turbines.
   c. NFPA – 70, National Electrical Code.
   d. NFPA – 99, Essential Electrical Systems for Healthcare Facilities.

e. NFPA – 110, Emergency and Standby Power Systems.

4. National Electrical Manufacturer's Association – NEMA
   a. NEMA – MG1.1, Electric Motors and Generators
5. American National Standards Institute – ANSI
   a. ANSI – 43, Recommended practice for Testing Insulation Resistance of Rotating Machinery
6. Institute of Electrical and Electronic Engineers – IEEE
   a. IEEE – 446 Recommended Practice for Emergency and Standby Power Systems
7. National Electrical Contractors Association – NECA; National Electrical Installation Standards – NEIS.
   a. NECA – EGSA404, NEIS – Recommended Practice for Installing Generator Sets.
8. State of California Air Resources Board (CARB).

D. Operating Manuals
1. Provide in acceptable form, three (3) bound copies of operating manuals for electrical equipment.
2. Provide catalog cuts, functional description of operation, wiring diagrams, operating and maintenance instructions, parts lists and other data useful and necessary for complete maintenance and operation of equipment.
3. Deliver operating manuals to the OWNER'S Representative.

E. Special Considerations
1. Manufacturer shall have printed literature and brochures on the complete unit describing the standard series specified.
2. Critical Speeds: Each complete engine-generator unit shall be free of critical speeds of either a major or minor order that will endanger the satisfactory operation of the unit or cause undue vibration in any part of the plant equipment or structure. Satisfactory operation will be considered endangered if torsional vibration stresses exceed 5,000 psi within 10 percent above or below rated engine speed. Copies of a summary of computations of critical speeds shall be submitted.
3. All openings for fuel lines, air intake/discharge, engine exhaust, conduits etc. shall be temporarily capped or plugged prior to shipment.

F. SHORT CIRCUIT AND ARC-FAULT
1. Perform and submit engineered settings for each fuse and adjustable circuit breaker device, showing the correct time and current settings to provide the coordination within the limits of the specified equipment, per the latest applicable standards of IEEE and ANSI. Provide Electric ARC-FLASH calculations as part of the coordination study recommendations. The information shall be submitted in both tabular form and on time current log-log graph paper, with a engineering narrative, (6) six copies.
2. The goal is to minimize an unexpected but necessary electrical system outage and personnel exposure to the smallest extent possible within the fault occurrence location, using the specified contract equipment, including but not limited to:
   a. IEEE-242, Recommended Practices for Protection and Coordination of Industrial and Commercial Distribution.
   b. IEEE-1584, Guide to Performing ARC-FLASH Hazard Study.
   c. CEC/NEC

PART 2 - PRODUCTS

2.01 ENGINE

A. General

1. The engine shall be diesel drive, two or four cycle, water cooled type with unit mounted radiator cooling, turbo-charged, operating speed of 1800 RPM. Engine speed shall be governed by a electronic governor with electrical activator, as manufactured by Barber Colman; Woodward Governor Company.
2. A unit mounted, 24 volt, D.C. 30 ampere battery charging alternator and solid state regulator shall be provided.
3. Engine shall be rated for continuous standby duty.
4. The engine lubrication system shall be pressure type with engine driven lubrication oil pump and replaceable oil filter element, full flow oil filter. Breather pipe suitable for adding engine lubricating oil while the engine is running shall be provided. Provide lubricating oil per manufacturers recommendations.
5. The engine throttle control system shall provide a minimum discrete engine speed adjustment sensitivity of 0.15 Hertz, measured at the generator output under all loading conditions.
6. Engine Governor:
   a. The Engine Generator shall be furnished with digital electronic Isochronous Engine Governor and Generator Voltage Regulator.
   b. The Engine Governor shall provide measurement of the engine operating temperature, automatically adjust the engine governing gains as a fraction of the engine temperature to prevent unstable governor operation due to temperature.
   c. The engine generator output frequency control shall incorporate output frequency adjustable transient slew-rate, to prevent engine generator instability resulting from "pulsing" emergency loads.
7. The engine generator set package shall comply with the manufacturing requirements and test requirements of UL-2200.
8. Provide modifications for remote control operation from the ATS. Generator speed, frequency, power factor and load sharing shall be controlled from the ATS. The engine generator shall be modified for parallel and synchronized operation with the electric Utility Company incoming electric service. Provide additional engine generator controls required by the ATS manufacturer, to ensure correct and safe operation of the engine generator parallel and synchronized operation with the Utility Company. The engine generator interconnection additional protection shall comply with:
   a. IEEE-1547, 1547.1, 1547.2 and 1547.3 including pending draft standards.
   b. Serving electric utility company requirements.
   c. State of California Rule #21 recommendations and requirements.

B. Engine Horsepower

1. The engine horsepower output shall be sized to provide sufficient capacity to operate all specified engine generator accessories and still maintain the electrical output and performance characteristics specified for the engine generator unit. The engine horsepower rating shall be increased to compensate for the following factors at the installation location. Submit calculations showing allowances for each condition:
   a. Installation altitude above sea level and specified ambient air temperatures.
   b. Engine driven radiator cooling fan.
   c. Cooling air positive and negative back pressure increases caused by radiators, radiator mounted load banks, generator housing, sound attenuation baffels, air louvers and cooling air intake/discharge air ducts.
   d. Engine driven fuel pumps.

e. Engine driven coolant pumps.
f. Engine driven battery charger.
g. Generator coupling/transmission gearing losses.
h. Engine driven lubrication pumps.
i. Engine combustion exhaust mufflers and engine exhaust system piping.
j. Engine combustion air intake filters and intake air silencers.
k. Engine driven super chargers and turbo chargers.
l. Engine fuel source/type derating factors.
m. Engine combustion exhaust emission controls, with back pressure monitoring and reporting system.

C. Engine Controls
1. Oil pressure, and temperature gauges.
2. Water temperature and pressure gauges.
3. Battery charge alternator rate ammeter.
4. Solid state, plug-in module monitor system including visible low water temperature alarm, individual fault lights, alarm terminals and engine shutdown with manual reset for overcrank, overspeed, high water temperature, low fuel, high oil temperature and low oil pressure. Low oil pressure, high water temperature and low fuel shall provide pre-alarm prior to engine shutdown. Overspeed shall provide both positive air and fuel supply shut-off at approximately 110-percent of operating RPM.
5. Solid state plug-in type cycle "cranking" start control. After three (3) failed cranking attempts of approximately 75 seconds each, the crank/rest cycles will be terminated, with alarm and manual reset.

2.02 ALTERNATOR (GENERATOR)

A. General
1. The line voltage alternator shall be a revolving field, broad range, 4 pole, brushless, designed for minimum reactance, low voltage waveform distortion and maximum efficiency. The rotor amortissuer windings shall improve the AC waveform, reduce field heating with single phase or unbalanced loads and act as a stabilizer for paralleling. The rotor shall be dynamically balanced, connected and aligned to the engine by a semi-flexible disc coupling.
2. The three phase alternator shall be twelve lead reconnectable. The insulation shall be Class B per NEMA MG1-1.65. Temperature rise 130 degrees centigrade per NEMA MG1-22.40. Insulation shall be vacuum impregnated for improved protection and cooling.
3. The exciter shall be brushless, 3 phase, full wave rectified, with silicon diodes mounted on common rotor shaft and sized for electric induction maximum motor starting capacity.
4. The voltage regulator shall be digital type solid state, including silicon controlled rectifiers with three phase-controlled sensing circuit. The system shall feature automatic voltage reduction if the load demand exceeds the engine capacity, to eliminate engine stalling due to an occasional engine misfire or temporary overload such as motor starting and shall prevent overheating or blowing of fuses of the load circuit, due to saturation of magnetic components, when the voltage remains constant at reduced frequency. The voltage reference shall be a temperature compensated zener diode. The voltage regulator shall eliminate voltage regulator incorrect operation caused by voltages distortion resulting from non-linear emergency loads.
5. Anti-condensation heater in the generator line voltage alternator with automatic "on-off" control, shall prevent condensation from occurring inside the alternator. 120/208 volt 60 Hz operation, single or three phase as indicated on the drawings. Provide automatic cut-off when engine is running and automatic thermostat control.

B. Harmonic Load compensation

1. The engine generator alternator system, generator windings, voltage regulator and exciter shall be compensated for "SCR" type loads on the output side, with 50 percent 3rd, 5th, 7th and 9th harmonic voltage and current content in the connected loads.
2. SCR emergency type loads include Variable Speed Motor Drives (VFD), uninterruptible power supplies (UPS), computer/data processing equipment, lighting electronic dimming equipment, audio/video equipment, etc.

C. Generator Controls

1. Manual reset exciter automatic circuit breaker.
2. Output load voltmeter, true RMS.
3. Output load ammeter, true RMS.
4. Output load power factor meters, for both negative and positive power factors.
5. Combination voltmeter-ammeter selector switch for phase-to-phase and phase-to-neutral meter input.
6. Analog meters shall be not less than 4-inch in size. Digital meter digits shall be not less than 0.25-inch high. Meter accuracy □ 1-percent.
7. Elapsed running time meter, 0-99999 hours minimum, non-resettable.
8. Output load frequency meter. (True relative to engine speed).
9. Output load voltage manual adjusting rheostat, plus or minus 5-percent rated output voltage and voltage regulator.
10. Startup cranking controls.
11. Solid state digital electronic protection devices with adjustable settings for; loss of excitation; output overvoltage protection; under/over frequency; generator winding differential overcurrent protection; reverse VAR (loss of field) protection to prevent pole-slippage and mechanical impact damage because of out-of-phase paralleling action with the utility source or other engine generators.
12. Generator control panel illumination, with on-off manual switch illumination control.
13. Output load circuit breaker mounted in NEMA I enclosure on the side of the generator control panel. A signal light shall be provided to indicate breaker is in the "off" or tripped position. Circuit breaker shall be mounted on vibration isolators. Circuit breaker shall be rated for "service entrance" use. Circuit breaker shall be 100 percent continuous load rated. The circuit breaker shall be sized at not less than 115-percent of the generator rated electric load output and voltage. The output load circuit breakers shall be provided with adjustable trip settings as follows:
    a. Instantaneous pickup.
    b. Long time pickup and long time delay.
    c. Provide ground fault detection sensor on the generator main disconnect. The sensor shall provide audio/visual alarm indication in the event of a ground fault detection occurring in the electrical line voltage output connecting into the generator main disconnect. The ground fault condition shall also provide audio/visual alarm indication at the engine generator remote annunciator panel.
14. Three position control selector switch "Automatic-Off-Run" when the switch is in the "off" position a red pilot light shall activate with a nameplate "Generator is not operable" when light is on.
15. Remote stop-start connection terminals.
16. Reset pushbutton to reset automatic shutdown lockout circuits.
17. All controls shall be identified as to function with engraved nameplates or engraved control panel. Nameplates shall be fastened with bolts, nuts and lock washers.
18. Combination engine and generator control panel shall be shock mounted over the rear end of the alternator, and include switched panel lights, controls shall be solid state type.

19. Provide a factory prewired terminal panel in the engine generator control panel. The terminal panel shall provide individual "landing" and termination points for each control/annunciator circuit entering and exiting the engine generator location. Each termination point shall be vibration resistant, insulated, barriered, and identified with individual circuit numbers/names.

20. Exposed control and monitoring wiring shall be installed in liquid tight fuel, oil and fire resistant flexible raceways within the engine generator housing.

21. Engine generator emergency shutdown:
    a. Provide "Emergency-Stop" manual control station switch to automatically stop-shutdown engine generators when the switch is activated.
    b. Weather resistant, tamper resistant manual operation, double action (breakglass) with auto-lockout on activation. Flush mounted or surface mounted +42-inches on wall to accommodate wall condition.
    c. Provide alarm indication on generator control panel when switch is activated. Provide a switch at each entry door location into the engine generator enclosure/room; each main fire alarm control panel; and at each engine generator automatic transfer switch. Provide 5#10 –
    1-inch conduit homerun to engine generator from each switch.
    d. As manufactured by ASCO #124 series, Square-D or equal.

D. Automatic Load Controls, Engine Generator Controls and Monitoring-Programmable Logic Controller
1. Engine generator shall be provided with microprocessor based, software controlled, engine generator management Programmable Logic Controller (PLC), rated specifically for engine generator monitoring and control. The respective remote annunciators and ATS units shall each also be provided with compatible matching software for Programmable Logic Controllers (PLC)engine generator systems.
2. The PLC shall provide monitoring, control and visual display of engine generator analog and digital operating parameters including output voltage, output frequency and output demand load.
3. In the event of an engine generator overload, the PLC shall automatically disconnect (shed) respective ATS load causing the overload condition.
4. The ATS load control process shall prioritize load "shedding" and load "adding" by ATS load types connected to the respective ATS, and shall provide software adjustable time delay for each load "shed/add" priority level. The PLC shall provide individual independent load "shed" and load "add" priority for each ATS connected to the engine generator.
5. The ATS units supplying building code mandated emergency loads (i.e., life safety exit egress lighting, fire alarm, etc.) shall have the highest priority to remain connected to the engine generator. Loads connected to other ATS units that are not mandated by building codes (i.e., non life safety loads – refrigerators, UPS, computers, air conditioning, telephone equipment, etc.) shall have the lower priorities to remain connected to the engine generator. The PLC load "shed/add" priorities shall be software programmable.
6. The PLC shall provide visual/audio alarm annunication of the overload condition(s), engine generator system status/alarms and each ATS load connection status, at each engine generator location, respective engine generator remote annunciator panel and at the respective ATS.
7. The PLC shall communicate the ATS load "shed/add" command controls to the respective PLC equipment in each ATS unit, and assign each ATS with a separate individual load "shed/add" priority. Provide the PLC equipment in each engine generator, remote enunciators and automatic transfer switches (ATS). Provide PLC common digital/multiplex communications protocols and operating software, to ensure correct, error-free interoperability among all the PLC units and related

equipment.

8. The PLC shall provide selective load "lockout" with manual reset upon shed or time delay automatic load restore of each ATS after a load shed event has occurred, software programmable at the PLC.
9. The PLC color display screen with LCD based "touch screen" function, shall display operating status and alarms of the engine generator, fuel system and each ATS unit. 10-inch diagonal or larger LCD screen size. PLC non-volatile memory storage shall store in memory a minimum of 30-days display information, plus the operating software program controls. Interface port for plug-in connection of portable lap-top computer interface to provide uploading to the PLC software programs and downloading system operating information from the lap-top computer.
10. Each PLC shall be rated for operation in the same ambient environments and vibration conditions as the engine generator.

2.03 UNIT ENGINE AND GENERATOR COMBINED PERFORMANCE

A. General

1. Frequency Regulation: Isochronous no-load to rated load.
2. Voltage Regulation: Steady state voltage regulation shall be within plus or minus 2-percent of rated voltage from no-load to full rated load.
3. Recovery to stable operation after application of full rated load shall occur within 5 seconds.
4. Steady State Operation: The frequency variation shall not exceed plus or minus 0.15 Hertz. Voltage variation shall not exceed plus or minus 1-percent of their mean value. The steady state operation shall be based on constant loads ranging from no load to full rated load.
5. Electromagnetic Interference Level Attenuation shall exceed requirements for generator connected loads including but not limited to: data processing equipment, uninterruptible power supplies (UPS), standard AM and FM radio, CATV and commercial television, marine radio-telephone equipment and [medical equipment]. Telephone influence factor shall be less than 50 pursuant to NEMA MG1-22.43.
6. Waveform Deviation Factor shall be less than 0.06 line-to-line and line- to-neutral per NEMA MG1-22.42.
7. RMS Voltage Dip: The sustained RMS voltage dip shall be less than 18-percent of rated voltage when full 3 phase load and rated power factor is applied to the alternator.
8. Peak kVA: The available peak kVA shall be suitable for simultaneous electric motor starting as shown on the contract documents. Quantity and size of motors as indicated on the drawings, shown connected to engine generator system. The generator shall sustain at least 90-percent of no load voltage for 10 seconds with 250-percent of rated load at zero power factor connected to its terminals. Submit test data.

2.04 ENGINE GENERATOR REMOTE ALARM ANNUNCIATOR PANEL

A. General

1. A remote mounted alarm annunciator panel in a NEMA 1 [NEMA 3R] flush [surface] mounted enclosure with clear tamper resistant locking cover door, at each location shown on the drawings, but in no case less than one (1) annunciator for each engine generator.

B. Annunciator Display

1. The annunciator shall include the following with appropriate sensors "sending" units installed in each engine generator, fuel system and ATS units.

a. Generating: Generating power ready for load.
b. Overcrank: Electric plant failed to start.
c. Low Oil Press: Low engine lube oil pressure.
d. Hi Eng Temp: Pre-alarm and final excessive cooling water temperature.
e. Low Eng Temp: Low engine cooling water jacket temperature.
f. Overspeed: Excessive RPM of electric plant.
g. Low Fuel: Pre-alarm and final low fuel supply.
h. Low Bat Voltage: Low starting battery voltage.
i. Hi Bat Voltage: High starting battery voltage.
j. Weak starting battery alarm.
k. Overvoltage: Generator output overvoltage.
l. Fuel Spill: Each fuel storage unit rupture basin fuel spill detection.
m. Low coolant: Engine low coolant level.
n. Low oil level: Low engine lube oil level.
o. Generator ground fault alarm.
p. ATS alarms for each ATS.
   1) ATS: connected to normal utility source.
   2) ATS: connected to generator source.
      Engine generators supplying more than one Automatic Transfer Switch (ATS) shall include the following additional alarm annunciation for each individual ATS:
   3) ATS: generator overload shed.

2. Audible alert:
   a. An audible signal will sound with the visual signals, except for conditions 1.a; 1.n.1 and 1.n.2. A switch will be incorporated to silence the audible alarm until the alarm condition is corrected. The audible alarm shall then sound until the switch is repositioned to the "normal" position.

2.05 FUEL

A. Fuel Connections
   1. Engine mounted and piped dual parallel, in line "Dahl Fuel" combination oil filter/water Separator (with valving for replacing individual filters while engine is running and valves for draining accumulated water).
   2. Flexible, bronze, fuel line connectors minimum 24-inch in length for supply and return fuel line connections. Leakproof connectors, type and size to match and be compatible with respective fuel lines and engine connectors.

2.06 COOLING

A. Liquid Cooling
   1. The engine shall have an engine driven centrifugal type water circulating pump with bypass, for circulating thermostat controlled water through the engine cooling system.
   2. 50-percent water and 50-percent permanent solution anti-freeze protection.

B. Radiator

   1. Radiator Cooling: A unit-mounted radiator and piping, with pusher type fan shall be provided for full load continuous standby operation in an ambient 24 hour temperature of 110 [130] degrees Fahrenheit and including the "load-bank" cooling airflow requirement. Provide a fan shroud and protective guard. Radiator coolant drain petcock and pressure relief filler cap.
   2. Radiator shall be provided with metal duct flanges for connection of flexible discharge air duct.

3. Provide, flexible metal, rust resistant, watertight, discharge air duct. The air duct shall connect air-tight from the radiator/radiator mount loadbank duct flanges to the respective wall louver air discharge opening located to the front direction of the radiator. Flair the air duct to direct all radiator/loadbank cooling discharge air through louvers and to match the size of the radiator/loadbank configuration to the larger size of the wall louver configuration.
4. The pusher radiator fan shall be sized to provide proper cooling air flow to overcome the static back pressure of the supply and exhaust cooling air ducts, radiator, plus the radiator mounted resistance "load-banks", plus the discharge air ducts and louvers associated with the engine generator installation. Submit back pressure air flow calculations for review.

C. Water Jacket Heater
1. Water jacket engine electric resistance preheater shall provide positive water circulation, thermostatically controlled to operate within range of 100 degrees to 120 degrees Fahrenheit. in an ambient temperature of zero degrees centigrade, 120/208 volt 60 Hz AC, single or three phase, as indicated on drawings. Provide automatic power cut-off contactor/relay when engine is running and to cycle the operation of the heaters. Provide shut-off bypass valves on heaters at both the inlet and outlet sides, readily accessible. As manufactured by "Kim-Hotstart".

2.07 ACCESSORIES

A. Batteries:
1. Starting batteries shall be lead acid type. Batteries shall provide sufficient capacity to provide the equivalent of three (3) 75-second duration engine cranking operations with a 60 second rest period between cranking operations at 77 degrees F. with a cold engine and final battery voltage of 1.75 volts per cell at 77 degrees Fahrenheit. Specific gravity of fully charged battery shall not exceed 1.220 at 77 degrees Fahrenheit. Batteries shall be equipped with removable cell caps utilizing catalytic conversion of hydrogen battery gases. Provide insulated stranded copper conductors to connect batteries to generator electric starting motors(s), sized to insure a full load voltage drop of not more then 5-percent when starting the engine.
2. Battery Box: Battery box shall be rated outdoor weatherproof. Acid resistant fiberglass battery box with hinged, padlocking cover. Electrically insulated seismic earthquake restraints and anchors. Install batteries in battery box. Install battery box on floor directly adjacent to engine generator for indoor locations. Install battery box inside engine generator housing for outdoor locations.
3. Battery Charger: Completely solid state. DC output shall be voltage regulated and current limited so as not to require a cranking disconnect relay. The charger shall include: full wave output, silicon semiconductors, automatic boost (equalize) mode, surge suppression, individual potentiometer adjustments for boost and float voltage, DC output voltmeter and ammeter, AC & DC fuse, input and output terminals, DC output completely isolated from AC input, and shall completely recharge full discharged batteries within a 12 hour period. Input voltage shall be 120 [208] volt, as indicated on the drawings. NEMA 3R for outdoor locations and NEMA 1 enclosure for indoor locations.
4. Weak Battery Alarm: Monitor the engine starting battery voltage under start-up load, while the engine is cranking in the start-mode. If the starting battery voltage drops for too long a time period, (as recommended by battery manufacturer) a "weak-battery" audible warning shall sound, along with annunciator visual alarm indication.

B. Engine Exhaust Silencer
1. Residential grade exhaust silencer with companion flanges, raincap, and seamless stainless steel flexible exhaust tubing, 18-inch minimum length.

2. Provide approximately 8-inch length of rigid schedule 40 black iron pipe between the exhaust manifold and the flexible tubing. Sweep elbows a minimum radius of three times the exhaust pipe diameter shall be used for exhaust pipe bends.
3. Provide safety, continuous heat guards on all engine exhaust piping, manifolds and silencers located below 10 feet above finish grade.
4. Provide automatic gravity operated "rain-cap" on discharge, to prevent entry of rain and vermin. Horizontal or vertical exhaust discharge, for compatibility with install location.

C. Engine Exhaust Particulate Emissions Reduction (PER)
1. The PER shall be a self contained, passive, self-regenerating, continuously self-cleaning (regenerating) particulate filter, with internal precious metal catalysts in conjunction with the particulate filters. Connect the PER "in-line" with engine combustion air exhaust discharge system. PER high temperature 304 stainless steel housing, supports and fittings. The PER filter system, supports, and housing shall withstand and operate correctly with the engine exhaust flow output, pressures, physical characteristics and thermal conditions of the engine exhaust system. The PER shall be specially designed and manufactured for stationary, internal combustion engine operation and for 2-stroke or 4-stroke engines as applicable.
2. The PER shall actively reduce environmentally harmful products of ENGINE combustion present in the engine combustion air exhaust. The PER shall not cause an increase in any other engine exhaust toxic contaminants:
   a. Diesel particulates reduction (without increasing $N0^2$ content)not less than 85-percent reduction
   b. Carbon Monoxide (CO) not less than 70-percent reduction
   c. Total Hydro Carbons (THC) not less than 70 percent reduction
3. The PER shall be tested, approved and certified to comply with Federal - EPA, State and Local air quantity management districts and applicable AHJ, by the engine generator manufacturer, for safe correct operation of the proposed engine/PER combination and by the PER manufacturer for AHJ compliance and engine compatibility. The PER shall be listed and approved by and with each AHJ.
4. A microprocessor - based, data logger and alarm, with data logger and sensors installed to record PER temperature and engine exhaust back pressure, shall detect if engine combustion exhaust back pressure and/or PER operating temperatures comply with and/or exceeds engine and PER manufacturer's recommendations. The alarm status shall also be reported on the engine generator remote annunciator panel (EGAP) and the engine generator internal control panel.
5. Provide a permanent sign on the engine generator fuel input port and each related fuel storage tank, minimum 1/4" high block letters:

   "Warning this engine is equipped with an engine exhaust particulate combination filter/catalyzer. Diesel fuel for this unit shall be Ultra Low Sulfur Diesel fuel (ULSD), maximum of 15 PPM sulfur content or less, as measured by weight. The fuel shall be CARB tested and certified. Damage to the equipment and failure to operate may occur if the correct ULSD/CARB fuel is not used!"
6. PER systems requiring the addition of additives to the engine post production fuel supply are not acceptable.
7. Standby Emergency Unit Operation with Particulate PER Filter
   a. Standby Engine Generator Load Factor with PER Particulate PER filter. The particulate emissions shall not exceed AHJ requirements, but in no case shall particulate emissions exceed the following:

b. The engine combustion air exhaust (discharge) shall not exceed particulate emissions of 0.01 grams/Bhp-HR. (engine brake horse power each hour) at all engine generator load factors.

D. Enclosure and Mounting

1. Spring type, vibration/seismic isolators, with a (1) one-gravity lateral (horizontal) acceleration withstand rating seismic earthquake restraints.
2. Radiator, engine and alternator shall be mounted on a twin steel "I" beam base. Base shall be suitable for lifting, hoisting, or skidding of the entire unit into installation position.
3. The engine generator shall be completely housed in a NEMA 3R outdoor rated weather-protective sound proofed metal enclosure. The generator housing shall be attached to and mounted on the same skid steel frame "I" beam base as the engine generator. Provide at least four (4) hinged, removable side access doors and rear hinged control panel access doors. Provide locking hasps on all access doors. Engine exhaust silencer shall be side inlet type, mounted on top of housing and terminate with rain cap. Engine exhaust transitioning through housing shall be provided with a suitable rain shield to prevent water from entering the housing.
4. Engine generator unit and housing shall have a manufacturer's standard weather protective finish paint color, applied over a rust inhibitor prime coat on all exposed and concealed surfaces.

E. Engine Combustion Air

1. Engine combustion air intake silencers to limit the air intake noise to less than the engine exhaust silencer noise level.
2. Replaceable, dry element, heavy duty, intake combustion air filters.

2.08 LIQUID FUEL TANK (SKID BASE MOUNTED below the engine/generator)

A. General

1. The fuel day tank for each generator shall be of the self-contained skid base mount type. Tanks shall be completely housed within the generator enclosure. Tank shall be welded metal construction. The fuel tank shall structurally support the weight and provide the anchorage for the complete engine generator assembly, plus a 150% safety factor.
2. Tank finish and color to match generator finish and color. Interior of fuel tank shall be epoxy coated. The exterior bottom of the tank shall be provided with additional layer of anti-rust coating.
3. The fuel tank holding capacity shall provide a minimum of twenty four (plus 10-percent additional reserve) hours of continuous full load engine generator operation. Approximately 10-percent of fuel shall remain in tank to prevent fuel fouling and loss of fuel suction priming. Provide fuel filler neck with locking removable cap. The filler shall extend outside the engine generator enclosure.
4. The maximum height addition to the engine generator unit caused by the skid base mount tank shall not exceed 15-inches. The fuel tank footprint shall not extend beyond the engine generator/radiator footprint.
5. Tank shall be provided with two fuel level detection switches and floats, low level engine shut down (set at approximately 10-percent fuel remaining to prevent fuel fouling of engine) and low level pre-alarm (set at 90-minutes remaining fuel) prior to shut down. Provide fuel level float activated "sight" gage. Provide threaded connection points on the tank for auxiliary fuel pump/filter "polish" system.
6. Fuel tank assembly anchoring and attachment shall be designed for earthquake seismic zone 4 with the tank full of fuel, and with the engine generator installed on the tank. The engine generator spring/vibration seismic isolators shall be provided between the engine generator "I Beams" and top of fuel tank.

7. Provided threaded removable insert plugs in all fuel tank line connections.
8. Fuel tank shall have a sump area at the bottom of the tank to collect water and sediment, with "drain-valve" to allow gravity draining of sump-fuel sediment.

B. Rupture Fuel Containment
1. Tank unit shall have rupture basin (double wall construction) with accidental spillage detection alarm contacts. Rupture basin capacity shall be sized at a minimum of 115-percent of fuel tank capacity. Rupture basin shall have 0.5 inch petlock valve at the bottom of the basin to drain contents into portable container. Basin shall be enclosed to prevent collection of dust, debris and water.

2.09 LOAD BANK

A. General
1. Engine generator set shall have a resistive load bank, which shall operate connected to the generator electric output only under exercising function of the engine generator. The total kW rating of the load resistors shall be not less than 50 percent of the full load output kW rating of the generator to which it is connected, but in no case less than required by engine generator manufacturer to maintain the unit manufacturer's warranty.
2. Load bank shall be housed in a NEMA 3R weather protective enclosure, mounted integrally to the engine on the front of the radiator, and cooled by the air flow across the radiator. Provide air duct metal flanges on the inlet and exhaust sides of the load bank. The load bank housing shall be rust inhibited galvanized steel after fabrication, with manufacturer's standard finish color finish paint. The load bank's load chamber shall have the physical dimensions coordinated with the radiator's duct flange. The radiator fan's cooling capacity (air flow)and engine standby rating horsepower shall be increased as necessary to prevent excessive static back pressure build up caused by the load bank.
3. The load bank resistors shall be mounted in field removable trays for servicing capability.
4. Resistors shall be constructed of high temperature alloy capable of continuous operation at 1920□ Fahrenheit with a melting point of 2750□ Fahrenheit and designed to operate at an average of 750□ Fahrenheit. The resistors shall be assembled in a three phase array with the phase-to-phase resistor current balanced within 2-percent and an overall kW tolerance within 5-percent of its nominal rating.
5. A circuit breaker and load bank connection circuits shall be provided in the engine generator supplying the load bank. The circuit breaker shall be sized at 125-percent of the full load current of the load bank. Provide fuse protection for each individual load bank section.
6. Provide automatic electric contactors as required to activate load bank in the exercising mode. Provide all control interlocks with the automatic transfer switch as required to provide the following functions:
   a. ATS exercising timer starts generator and brings load bank on-line.
   b. Exercising function operates for pre-selected period of time with load bank connected at 100-percent of load bank capacity.
   c. At end of exercise period, and prior to the engine "cool down" run out, the load bank shall be automatically taken off-line.
   d. If utility power outage occurs during the exercise period, the load bank shall immediately be de-energized (under any operating mode) before the emergency load automatic transfer switches change position; generator shall continue to run during the disconnect of the load bank.
   e. Provide a load bank "on-off-automatic" selector switch. The switch shall control the operational function of the load bank. The "on" position shall by-pass automatic operation and connect the load bank to the engine generator only when the generator is "running" at stabilized voltage output and rated RPM.

The "on" switch position shall not override the automatic disconnect of the load bank in the event of a "emergency power" generator operation mode. The "off" position shall by-pass automatic operation, disconnect the load bank and prevent automatic operation of the load bank.

f. Provide red (load bank connected) and green (load bank disconnected) indicating lights with "push-to test" for each load bank step load.

g. Load bank system shall be as manufactured by Load Technology, Inc., La Mirada, California; AVTRON; Simplex or equal.

PART 3 – EXECUTION

3.01 ENGINE-GENERATOR TESTS

A. General

1. Before delivery to the site, the engine generator assembled unit shall be given a preliminary operation and load test. The test shall be performed by an approved independent testing laboratory. The tests shall include full load test with a load bank of adequate capacity and shall assure performance of all specified function to the satisfaction of the OWNER'S Representative. Upon completion of the preliminary tests, the unit, complete with equipment, shall be delivered and installed at site. Provide four copies of complete test records. A copy shall be framed and mounted in the unit by the CONTRACTOR. All shop load tests shall be run at 80-percent lagging power factor.

2. Upon completion of the installation work, including the electrical connections, and grounding of equipment and neutral, the CONTRACTOR shall provide all necessary facilities, fuel, instruments and equipment, including full capacity load bank required for the load tests, and arrange for final test runs. Field tests to be run at unity power factor with CONTRACTOR provided unity power factor load bank, and fuel.

   a. Generator shall start and pick up full load at normal voltage and frequency within eight seconds, from a cold start. (No prerunning within the previous 12 hours prior to the test).

   b. Load test at 0, 1/4, 1/2, 3/4 full load and 105-percent overload until readings are constant for 10 minutes duration for each.

   c. Four hour duration 100-percent continuous full load test conducted consecutively with the above test.

3. Readings required during all tests shall be taken on recently calibrated laboratory instruments as well as those on the equipment and shall include not more than 15-minute intervals during the test period including initial start and at final conclusion prior to shutting down for the following:

   a. Output frequency.

   b. Output voltage.

   c. Load current.

   d. Load watts and volt-ampere

   e. Ambient temperature.

   f. Engine, coolant temperature.

   g. Radiator and engine exhaust air temperatures.

   h. Generator frame temperature at hottest spot.

   i. Engine lubricating oil pressure and temperature.

   j. Frequency and voltage tests shall include a record of response time recovery from load changes.

   k. All adjustments, replacement of unsatisfactory equipment, and retesting shall be made by the CONTRACTOR'S at the CONTRACTOR'S own expense.

4. Before acceptance of the equipment, the CONTRACTOR shall instruct the OWNER'S maintenance personnel in the operation and maintenance of this equipment. Four complete written instructions manuals, operating schedules, parts, lists, blueprints, wiring diagrams, maintenance and repair manuals, engine and

generator specifications including actual performance curves shall be submitted to the OWNER'S Representative before final approval.

5. Perform tests as specified and as requested by the OWNER'S Representative to prove installation is in accordance with contract requirements. Perform tests in presence of the OWNER'S Representative, and furnish all test equipment, facilities, and technical personnel required to perform tests.
6. Provide full fuel tank fuel supply, prior to transferring acceptance of the engine generator after completion of tests.

B. Commissioning (Additional Requirements)
1. Setup, testing, startup, and commissioning shall be performed by factory technician(s) trained, certified and authorized by the equipment manufacturer. Final commissioning shall be performed after installation and connections are complete.
2. Simulate normal source power failure by opening (turn-off) building main service disconnect and verify connections and operation of each electrical system device connected to the engine generator system on both normal power source and emergency power sources. Simulated test time duration for operating connected on the emergency systems shall be not less than 120 continuous minutes without failure or anomalies in the system operation.
3. Record and document electrical demand load and sequence of operations on the engine generator system with all connected loads operating, including but not limited to:
   a. Fire alarms
   b. Egress/exit lighting
   c. Doors
   d. Auto-loading and overload shedding controls
   e. Elevators]
4. Provide system programming and setup of all control sequences and related equipment including but not limited to:
   a. Automatic transfer switches (ATS)
   b. Lighting control system
   c. Fire alarm
   d. HVAC
   e. Other non-code mandated electrical loads]
5. Test all control system functions after the installation and connections are complete and the system has been energized. Verify each control sequence of operation and each device to be controlled are each operating correctly.
6. Record and document each device setup and program setting.
7. Submit written report (6 copies) to OWNER's Representative certifying commissioning has been performed; all respective systems are operating correctly and document all software setup and each device settings.

3.02 GENERATOR INSTALLATION

A. General
1. The engine-generator shall be mounted on seismic Zone-4 rated spring isolators and anchor bolts having telescopic top and bottom housing with vertical stabilizers to resist lateral and vertical forces. Constructed of shatterproof ductile iron per ASTM-A-536 grade G5-45-12, type RJ from California Dynamic Corporation or equal.
2. Engine generator furnished with a "Skid-Base" fuel tank. The seismic spring anchors shall attached between the fuel tank and engine generator skid-base "I" Beams. The seismic spring anchors shall isolate engine generator vibration from the "skid-base" fuel tank. The skid-base fuel tank shall be anchored to concrete slab for one gravity lateral acceleration seismic earthquake restraint.

3. Generator engine shall have a crankcase drain pipe that is at least 8-inch from the floor, equipped with a readily accessible positive locking shut-off valve. All units shall have a removable full length metal drip pan under the engine.
4. Provide expansion type or cast in place type anchor bolts to anchor generator to equipment slab. Installation shall comply with seismic requirements of California Code of Regulations Title 21 and Title 24.
5. Diesel engine fuel shall be Ultra Low Sulfer content (ULSD), CARB tested and certified, diesel fuel. Sulfer content shall not exceed 15 parts per million (PPM) content.
6. Complete all electrical connections, control connectors plumbing and mechanical connections.

3.03 DAY TANK INSTALLATION

A. General
1. Day tank shall be anchored to concrete slab for one -gravity lateral acceleration seismic earthquake restraint.
2. The day tank height and installation shall insure the engine fuel supply line connection point and the day tank "full fuel" level falls at least 6-inches below the elevation of the fuel injectors on the engine.
3. Coordinate fuel piping connections with plumbing contractor.

3.04 CONTINUOUS MAINTENANCE SERVICE AND PREVENTATIVE MAINTENANCE

A. The generator factory trained service personnel shall perform two field inspections and service maintenance visits, 4-hours duration each visit excluding travel time, at six and twelve calendar months after the engine generator installation connections and testing is complete. The manufacturer's standard recommended maintenance procedures shall be performed as part of the contract requirements. A certified and registered letter outlining and describing the maintenance visit work has been completed shall be sent to the OWNER'S Representative after each visit.

B. The supplier shall provide documentation of maintaining local 24-hour parts and factory-trained service personnel within a 200 mile radius of the project site with the shop drawing submittal.

3.05 ELECTRIC POWER AND CONTROL CIRCUITS

A. General
1. Provide NEC Class-1, Division-1 explosion-proof conduit fittings and seals on each conduit entering or exiting the engine generator location.
2. Provide quantity and AWG conductor size/type capacity, circuit conductor "lug" connection landings, compatible with connections shown on the drawings".
3. The final conduit/raceway connections to any part of the engine generator from any "fixed" location entrance to the engine generator shall be made with liquid-tight flexible raceway. The raceway shall be UL label and approved for use in the atmosphere environment at the engine generator, shall be oil and fuel resistant.

B. Additional Conduit Homeruns
1. Provide the following minimum quantity and size conduit and wire, to connect each emergency generator, controls and annunciators. Install the conduit and wire from each engine generator to the respective monitoring and control equipment. Refer to drawings for additional requirements. Install conduit underground and/or concealed in building structure at all locations.
   a. 1.5-inch conduit - 18#14 and 3#10 to remote engine generator annunciator panel.

b. Branch circuit conduit/wire for CPP panelboard connections to generator lighting, receptacles, engine block heaters, alternator anti-condensation heater, battery charger, etc.
c. Generator load output feeder circuits.
d. 1.25-inch conduit with 8#10 to main fire alarm control panel, generator "run-fail-ready" monitoring and emergency "run-stop" bypass controls from the fire alarm control panel location.
i. 1-inch conduit with 5#10 to each respective engine generator emergency shutdown control station.

END OF SECTION