

ATTACHMENT A: SECTION 26 32 13

PACKAGED ENGINE GENERATOR SYSTEMS - DIESEL

PART 1 GENERAL

1.1 S/C - SCOPE

This section provides two packaged diesel engine generator systems that include but are not limited to engine generator set, cooling system, combustion air intake and engine exhaust systems, starting system, enclosure, and the additional features specified herein.

The generator sets provided under this specification section will be purchased directly by the Owner from a generator manufacturer's authorized distributor ("Supplier") for installation by the construction contractor ("Contractor") under a separate construction contract providing renovations to an existing facility to construct a new data center facility.

Assignment of specification compliance responsibilities is defined in this specification section by the inclusion of the terms "S" (Supplier) and "C" (Contractor) at the beginning of the specification paragraphs. However, the equipment supplier and construction contractor shall coordinate with each other in completion of the work specified herein to provide a complete and operable system. The term "S/C" indicates contract provisions that apply to both the Supplier and the Contractor.

The generator set installation and related work shall conform to the requirements of all applicable specification sections and drawings issued as a part of the overall project construction contract

1.2 S/C - REFERENCE CODES AND STANDARDS

A. The generator set shall conform to the requirements of the following codes and standards for the editions currently in effect:

1. EN50082-2, Electromagnetic Compatibility-Generic Immunity Requirements, Part 2: Industrial.
2. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
3. IEC8528 part 4, Control Systems for Generator Sets.
4. IEC Std 61000-2 and 61000-3 for susceptibility, 61000-6 radiated and conducted electromagnetic emissions.
5. IEEE446 Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
6. NFPA 70, National Electrical Code, Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
7. NFPA 99, Essential Electrical Systems for Health Care Facilities.
8. NFPA 110, Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit. Component level type tests will not substitute for this requirement.

1.3 S/C - DEFINITIONS

- A. Emergency or Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage, with capability for 100% rated load for the duration of the power outage.
- B. Operational Bandwidth: The total variation from the lowest to the highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- C. Power Output Rating: Gross electrical power output of generator set minus total power requirements of electric motor-driven accessories normally constituting part of the engine assembly.
- D. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hz or cycles per second.

1.4 S/C - SYSTEM DESCRIPTION

- A. System Includes: Standby-rated, automatically started diesel engine mechanically coupled to an a.c. generator unit. Engine and generator shall be factory-mounted and aligned on a structural steel skid. Subsystems and auxiliary components and equipment shall be as indicated or specified. Provide all labor, materials, and equipment to furnish, install, and place in operation the power generation system in accordance with the contract documents and manufacturer's drawings and installation instructions. These specifications also describe requirements for the design, fabrication, and testing of the power system.

The installation of the power generation system shall include the following:

- 1. Engine-driven generator set
 - 2. Control system
 - 3. Cooling system
 - 4. Fuel supply and storage system
 - 5. Generator set accessories
 - 6. Mounting system
 - 7. System controls, including control and monitoring panel.
- B. Functional Description: When the mode selector switch on the control and monitoring panel is in the "automatic" position, remote control contacts in one or more separate automatic transfer switches initiate the starting and stopping of the generator set. When the mode selector switch is placed in the "on" position, the generator set shall start manually. The "off" position of the same switch shall initiate shutdown of the generator set. When the unit is running, specified system or equipment failures or derangements shall automatically shut the unit down and initiate alarms. Operation of a remote emergency stop switch shall also shut down the unit. Automatic transfer switches are specified in Section 16495.

- C. The engine-generator and related work shall be provided as a complete and operable system, in full compliance with all requirements on the drawings and all specifications requirements. The drawings are diagrammatic and the specifications are performance-based, and the contractor shall provide all work required to comply with the drawings and specifications, even if not explicitly indicated or specified. The contractor shall be responsible for coordinating installation of the engine-generator system with all field conditions and the work of other trades. Minimum clearances and work required for compliance with NFPA 70 "National Electrical Code" and the manufacturer's instructions shall be provided.
- D. All equipment shall be new and of current production by an international, power system manufacturer of generators, transfer switches, and paralleling switchgear. The manufacturer shall be a supplier of a complete and coordinated system. There will be single-source responsibility for warranty, parts, and service through a factory-authorized representative with factory-trained technicians. The power system shall be furnished by a single manufacturer who shall be responsible for the design, coordination, and testing of the complete system. The entire system shall be installed as shown on the plans, drawings, and specifications herein. The equipment shall be produced by a manufacturer who is ISO 9001 certified for the design, development, production and service of its complete product line. The power system shall be produced by a manufacturer who has produced this type of equipment for a period of at least 10 years and who maintains a service organization available twenty-four hours a day throughout the year. System manufacturer shall maintain a service center capable of providing training, parts, and emergency maintenance and repairs at the Project site with 2 hours maximum response time.

1.5 S/C - SUBMITTALS

- A. S - General: Unless specified otherwise, the Supplier shall submit the following documentation with the RFP response to the Owner's Representative. RFP responses without the specified documentation or missing documentation may be rejected by the Owner's Representative, at the Owner's Representative discretion. Submit and obtain approval of all product data, shop drawings, wiring diagrams, protective device studies, coordination drawings, certifications, and compliance certifications prior to release of equipment for fabrication.
- B. S - Product data for products specified in this Section. Include data on features, performance, components, and ratings, including KW, KVA, starting KVA, voltage dip, transient reactance, sub transient reactance, and zero-sequence reactance. Include dimensioned outline plan and elevation drawings of engine generator set and other system components. Submit certified total harmonic current distortion ratings for voltage regulators.
- C. S - Submit as a part of project closeout documentation O&M operation and maintenance data for system and components for inclusion in Operating and Maintenance Manual specified in Division 1 of the construction contract. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay setting and calibration instructions. Include detailed operating instructions. Cover operation under both normal and abnormal conditions.
- D. S - Shop Drawings: Detail fabrication, piping, wiring, and installation of the field-installed portions of the system. Include general arrangement drawings showing locations of auxiliary components in relation to the engine generator set and duct, piping, and wiring connections between the generator set and the auxiliary equipment. Show connections, mounting, and support provisions and access and working space requirements.

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- E. S - Wiring Diagrams for System: Show power and control connections and distinguish between factory-installed and field-installed wiring.
- F. S - Computer calculations by generator manufacturer to verify proposed generator and engine ratings for compliance with specified/indicated ratings and applied loads indicated in the generator load schedule.
- G. S - Qualification Data for Manufacturer: Include capabilities and experience data required to demonstrate qualifications specified in Quality Assurance Article. Include list of five completed projects with equipment similar to the system specified herein, with project names and addresses and names of Engineers and Owners, plus other information specified.
- H. C - Field-Testing Organization Certificates: Signed by Contractor, certifying that the organization complies with the requirements specified in Quality Assurance below.
- I. S - Certified Summary of Prototype Unit Test Report: Submit certified copies of actual prototype unit test report if subsequently requested.
- J. S - Exhaust Emissions Test Report, where required by federal, state or local regulations.
- K. S - Certification of Torsional Vibration Compatibility: Conform to NFPA 110.
- L. S - Factory Test Reports: For units to be shipped for this Project showing evidence of compliance with specified requirements.
- M. S/C - After completion of field testing, submit field test report as a record of tests specified in Part 3.
- N. S/C – Coordination and installation/coordination layout drawings shall be submitted within 30 days of proposal acceptance
 - 1. The purpose of the submittals specified herein is not only to show compliance with the requirements, but is also for future identification, replacement, duplication, and servicing.
 - 2. The work described in all submittals shall be carefully checked by the contractor and proposed equipment manufacturer for all clearances, including those required for maintenance and servicing, field conditions, maintenance of architectural conditions, and proper coordination. Each submittal shall include a certification by the contractor and proposed equipment manufacturer that all related conditions have been checked and that no conflict exists. No submittal will be reviewed without such certification.
 - 3. Based on equipment drawings and diagrams provided by the Supplier as a part of project submittals, the Contractor shall prepare complete coordination layout drawings and field wiring diagrams for the generator set equipment, automatic transfer switches, and related equipment. Layout drawings will verify equipment locations, conduit and wiring provisions, and space allocated for maintenance and service. Layout drawings will indicate code-required clearances and manufacturer-recommended clearances around all equipment..
- O. S/C - Submittal Submission Schedule:

All drawings, etc., shall be submitted sufficiently in advance of field requirements to allow ample time for checking, and no claim for extension of contract time will be granted to Supplier or Contractor, by reason of his failure in this respect. All submittals shall be complete and shall contain all required and detailed information. Submittals with multiple parts shall be submitted as a complete package.

P. S - Compliance Certification:

Submit a complete copy of this specification section and all other related sections with each paragraph and subparagraph marked with either "compliance," "deviation," or "alternate." Submit copy of drawing equipment schedules and related drawing notes, marked in the same manner as specified above for specification paragraphs. All deviations and alternates to the specifications and drawings shall be fully described in attached documentation as to what the contractor and manufacturer propose to provide. Approval of deviations and will remain within the sole discretion of the Owner's Representative. If proposed deviations or alternates are disapproved, the contractor shall provide equipment and materials in full compliance with the specifications, at no additional cost and without schedule extension.

Q. S - Certifications:

1. Seismic Design and Testing Certificate:: Document compliance with all specification and applicable building code requirements for equipment seismic design and testing.
2. EPA: Document compliance with all specification and applicable building code requirements for equipment emissions.

1.6 S/C - QUALITY ASSURANCE

- A. Manufacturer Qualifications: Refer to requirements specified above in paragraph "System Description".
- B. Field-Testing Organization Qualifications: To qualify for acceptance, a testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct the indicated testing satisfactorily.
- C. Comply with NFPA 70, "National Electrical Code."
- D. Comply with NFPA 110, "Standard for Emergency and Standby Power Systems," for requirements for a Level 1 emergency power supply system.
- E. Listing and labeling: Electrical equipment shall be listed and labeled by Underwriter's Laboratories (UL), or another nationally recognized testing laboratory (NRTL). All equipment, materials, and devices required to comply with referenced UL standards shall bear labeling from the NRTL to verify compliance. Engine-generator sets shall be listed and labeled to UL 2200.

The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
- F. Engine Exhaust Emissions: Comply with applicable Federal, State, and local government requirements.
- G. Single-Source Responsibility: Obtain engine generator system components from a single manufacturer with responsibility for entire system. Unit shall be a representative product built

from components that have proven compatibility and reliability and are coordinated to operate as a unit as evidenced by records of prototype testing.

1.7 S/C - DELIVERY, STORAGE, AND HANDLING

Supplier shall deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is made safe from such hazards. Supplier is responsible for transportation of equipment to the project site unloading area designated by the Owner's Representative. Contractor is responsible for unloading of all equipment and provisions for safe and protected storage at the project site until equipment is installed by the Contractor.

PART 2 - PRODUCTS

2.1 S - MANUFACTURERS

A. Subject to compliance with this specification, generators shall be from one of the manufacturers listed below:

1. Kohler – Basis of Design
Alternate manufacturers from which the owner will accept proposals for consideration:
2. Caterpillar
3. Cummins
4. Generac

Note: Listing of a manufacturer above does not commit the Owner to accepting any proposals from a manufacturer listed. All proposals must include the submittal data listed in paragraph "Submittals" specified hereinbefore. Substitutions and additional alternate manufacturers shall not be permitted.

2.2 S - SYSTEM SERVICE CONDITIONS

A. Service Conditions: Engine generator system shall operate within the following service conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 20 degrees F to plus 100 degrees F.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: 750 feet above sea level.
4. Fuel Type: Diesel.
5. Installation Location: Exterior location within a weatherproof enclosure.

2.3 S - ENGINE GENERATOR SYSTEM

- A. General: System shall be a coordinated assembly of compatible components.
- B. Ratings: Voltage, frequency, and power output ratings of the system shall be as indicated on the Engine-Generator Set Load Schedule.

- C. Output Connections: As indicated.
- D. Safety Standard: Comply with ASME B15.1, "Safety Standard for Mechanical Power Transmission Apparatus."
- E. Nameplates: Each major system component shall be equipped with a conspicuous nameplate of the component manufacturer. Nameplate shall identify manufacturer of origin and address, and the model and serial number of the item.
- G. Manufacturer: The engine-generator set along with all major items of auxiliary equipment shall be manufactured by a manufacturer currently engaged in the production of such equipment. The unit shall be factory-assembled and factory-tested before being shipped to the job site.
- H. Local Service and Maintenance: The engine-generator and automatic transfer switch manufacturer shall maintain a local service shop with an adequate stock of spare parts and trained mechanics within 100 miles of the site.
- I. Responsibility: The engine-generator set and its associated equipment shall be assembled, tested, and shipped by one manufacturer who shall accept full responsibility for the quality and performance of all components.

2.4 S - SYSTEM PERFORMANCE

- A. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
- B. Steady-State Frequency Modulation: Less than 1 Hz.
- C. Transient Voltage Performance: Not more than 20 percent variation for 100 percent step-load increase or decrease. Voltage shall recover to $\pm 0.5\%$ of rated voltage within 1 second.
- D. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
- E. Steady-State Frequency Stability: When the 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 regular or cyclical hunting or surging of speed.
- F. Transient Frequency Performance: No more than 3 Hz variations for a 50 percent step-load increase or decrease. Frequency shall recover to remain within the steady-state operating band within 3 seconds.
- G. Output Waveform: At no load, the harmonic content measured line-to-line or line-to-neutral shall not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor determined according to NEMA MG1, "Motors and Generators," shall not exceed 50.
- H. Sustained Short-Circuit and Overload Current: For a 3-phase bolted short circuit at the system output terminals, the generator 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 any generator system component. The generator shall sustain 150% of continuous load current for 2 minutes with field set for rated load excitation.

- I. Temperature Rise of Generator: Within acceptable limits for insulation systems used according to NEMA MG1 when operating continuously at standby rating conditions.
- J. Nonlinear Load Performance: System performance shall not be degraded from that specified in this Article by operation with the non-linear loads specified hereinafter.
- K. Starting Time: Maximum total time period for a cold start, with ambient temperature at the low end of the specified range, shall be 8 seconds. Time period includes output voltage and frequency settlement within specified steady-state bands, and load acceptance.
- L. Generator Circuit Breakers: Ratings and features shall be as specified below in the generator load schedule, unless recommended otherwise by the generator manufacturer as a part of submittals and approved in writing by the Owner's Representative. All circuit breakers indicated to be provided with the generator set shall be enclosed within the generator housing, either group mounted or provided in a panelboard assembly. Mounting method shall isolate the control panel from generator set vibration.
 - 1. For each generator set provide a factory installed, 100% rated circuit breakers rated at 400 amperes that are UL489 listed. Circuit breakers shall be sized for the rated ampacity of the loads served by the breaker per the NEC. Circuit breakers shall be provided for:
 - a. Generator output line breaker (to ATS)
 - b. Generator output load bank breaker (for connection of a portable load bank)
 - c. Provide on all breakers key interlocks with keys as correct to prevent both line and load bank breakers to be closed at the same time
 - 2. The circuit breaker(s) shall incorporate an electronic trip device with the following characteristics:
 - a. Adjustable long time delay
 - b. Adjustable short time delay
 - c. Instantaneous
 - 6. Load side lugs shall be provided from the factory. The line circuit breaker shall include auxiliary contacts, shunt trip, undervoltage trip, alarm switch, and overcurrent switch functionality. Load side breaker connections made at the factory shall be separated from field connections.
 - 7. The shunt trip device shall be connected to trip the generator breaker when the generator-set is shut down by other protective devices.
 - 8. When GFI is required per the NEC, additional neutrals shall be factory installed, and the alarm indication shall be integrated with the generator-set alarms.
 - 9. Barriers to provide segregation of wiring from an emergency source to emergency loads from all other wiring and equipment, if required by the NEC, shall be provided.
- M. Load Schedule: As specified in paragraph "Submittals" in this section, submit computer calculations by the generator set manufacturer to verify compliance with the following ratings:
 - 1. Basis of Design: Kohler model 250REOZJE with a 4UA13 alternator
 - 2. KW, KVA, starting KVA, and voltage dip performance specified for the load schedule specified below.
 - 3. Engine-Generator ratings and generator reactance values shall be adequate to ensure satisfactory operation for the loads specified in the load schedule below, including motor loads and non-linear variable speed drive loads indicated in the load schedule below.

4. Starting of motor loads shall be based on the following conditions:
 - a. Motor windings to be at room temperature.
 - b. Generator to be driven by a synchronous driver.
 - c. Generator is to be hot, equivalent to the stabilized temperature band between the generator's 75% and 100% continuous load rating.

5. Minimum ratings – Refer to generator set load schedule below.
 - b. 130°C alternator temperature rise rating while operating in the ambient conditions specified hereinbefore for standby duty
 - c. Engine brake horsepower shall be sufficient to deliver full rated generator set kW/kVA when operated at rated rpm and equipped with all engine-mounted parasitic and external loads such as radiator fans and power generators.
 - d. Alternator pitch: 2/3 pitch, unless recommended otherwise by generator manufacturer and documented in equipment submittals.
 - e. The engine shall be EPA certified from the factory
 - f. Motor starting performance and voltage dip determinations shall be based on the complete generator set. The generator set shall be capable of supplying 980 locked rotor KVA minimum for starting motor loads with a maximum instantaneous voltage dip of 35%, as measured by a digital RMS transient recorder in accordance with IEEE Standard 115. Motor starting performance and voltage dip determination that does not account for all components affecting total voltage dip, i.e., engine, alternator, voltage regulator, and governor will not be acceptable. As such, the generator set shall be prototype tested to optimize and determine performance as a generator set system.
 - g. The generator set must accept rated load in one-step with a maximum instantaneous voltage dip of 35%, as measured by a digital RMS transient recorder in accordance with IEEE Standard 115.
 - h. Refer to the load schedule below as a basis for the computer calculations by generator manufacturer to verify proposed generator and engine ratings for compliance with specified/indicated ratings and applied loads indicated in the generator load schedule.

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GENERATOR SET LOAD SCHEDULE - TYPICAL FOR GENERATOR "A" & GENERATOR "B"					RUN			START			VOLT	FREQ	VOLT
STEP	DELAY	LOAD TYPE	LOAD DESCRIPTION	QTY	KW	KVA	PF	KW	KVA	PF	DIP %	DIP %	DIST %
1.1	0 SEC	UPS - 3 PH; IGBT;	1/2 LOAD 70KW/KVA UPS -18% BATT CHG	2	86.09	101.29	0.85	86.09	101.29	0.85			
1.2	0 SEC	LED LIGHTING	EVENLY DISTRIBUTED; FILTERED BALLAST	1	0.93	0.98	0.95	0.93	0.98	0.95			
1.3	0 SEC	LED LIGHTING	EVENLY DISTRIBUTED; FILTERED BALLAST	1	0.50	0.63	0.80	0.50	0.63	0.80			
1.4	0 SEC	OFFICE EQPT 3 PH	NON-LINEAR LOAD	1	4.50	5.27	0.85	4.50	5.27	0.85			
1.5	0 SEC	AIR COND 1 PH A-C	CU-5 UPS RMA/C COND; X-LINE; PH A-C	2	3.90	5.49	0.71	20.30	33.28	0.61			
1.6	0 SEC	NON-LINEAR LOAD	3 PH	1	2.00	2.22	0.90	2.00	2.22	0.90			
1.7	0 SEC	MISC. LINEAR LOAD	3 PH	1	3.00	3.00	1.00	3.00	3.00	1.00			
1	0 SEC	STEP TOTAL			100.92	118.24	0.85	117.32	144.36	0.81	8.46	7.21	3.51
1	0 SEC	CUM.TOTAL			100.92	118.24	0.85						
2.1	30 SEC	AIR CONDITIONING	AIR COOLED CONDENSER; X-LINE; 3 PH	3	19.11	24.69	0.77	76.32	149.64	0.51			
2.2	30 SEC	AIR CONDITIONING	IN-ROW A/C COMPRESSOR; VFD; 3 PH	3	35.88	46.00	0.78	41.40	46.00	0.90			
2	30 SEC	STEP TOTAL			54.99	70.69	0.78	117.72	189.71	0.62	10.70	7.24	7.38
2	30 SEC	CUM.TOTAL			155.91	188.55	0.83						
3.1	60 SEC	MISC. LINEAR LOAD	IN-ROW ELECTRIC HEAT; 3 PH	3	24.75	24.75	1.00	24.75	24.75	1.00			
3	60 SEC	STEP TOTAL			24.75	24.75	1.00	24.75	24.75	1.00	1.28	0.59	7.38
3	60 SEC	CUM.TOTAL			180.66	209.48	0.86						
-	-	GRAND TOTAL			180.66	209.48	0.86				10.70	7.24	7.38
GENERATOR PERFORMANCE SUMMARY													
ALTITUDE:	750 FEET	MAXIMUM ALLOWABLE VOLTAGE DIP:	10.70%		MINIMUM ALT. STARTING KVA AT 35% V DIP				980				
MAX TEMP	95 DEGREES F	MAXIMUM ALLOWABLE FREQUENCY DIP:	7.24%		MINIMUM REQUIRED KW/KVA RATING				255/318				
MIN BHP:	385 HP	MAXIMUM ALLOWABLE HARMONIC DIST:	7.38%		MINIMUM SITE RATED KW				252.45				
MIN DISPL:	548 CU IN	MAXIMUM ALLOWABLE GENSET % LOADED	71.56%		GENSET VOLTAGE				480/277				
GENERAL REQUIREMENTS:													
1. THE SCHEDULE ABOVE INDICATES THE CONFIGURATION AND TIMING OF STEP LOADING USED TO DETERMINE THE REQUIRED GENERATOR RATINGS FOR THE PROJECT.													
2. PROVIDE PROGRAMMING OF EQUIPMENT AND CONTROLS TO ACHIEVE THE TIME DELAYS INDICATED BELOW FOR RESTARTING EQUIPMENT AFTER LOSS OF POWER.													
3. COORDINATE PROGRAMMING OF RESTART TIME DELAYS AMONG THE EQUIPMENT AND RELATED CONTROL SYSTEMS THAT PERTAIN TO THE EQUIPMENT LISTED.													
4. TIME DELAYS INDICATED ARE FROM T=0 WHEN ALL GENERATORS ARE CONNECTED VIA ATS TO EQPT.													
5. VERIFY EQUIPMENT RATINGS AND LOADS DURING SUBMITTALS REVIEW AND ADJUST STEPS/TIME DELAYS WHERE NEEDED TO ACCOMMODATE PROPOSED EQUIPMENT RATINGS													
6. TIME DELAYS INDICATED FOR NON-CONTROLLED LOADS ARE ASSUMED TIME SEQUENCES FOR PURPOSES OF GENERATOR SIZING CALCULATIONS FOR LOAD PROFILE.													

2.5 S - ENGINE GENERATOR SET

- A. Power Output Rating: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
- B. Mounting Base: The engine-generator manufacturer shall assemble the engine and generator to a common base. The generator set base shall be designed and built by the engine-generator manufacturer to resist deflection, maintain alignment, and minimize resonant linear vibration. Mounting base shall have adequate strength and rigidity to maintain alignment of mounted components without dependence on a concrete foundation. The base shall be constructed of formed steel "C" channel members with a minimum thickness of 0.25 inches. The base arrangement shall incorporate a common interior width for furnishing dedicated stub up areas for mechanical and electrical connections. Steel cross members shall support genset and add rigidity to base with vibration isolators installed between generator set and supports. The base shall have provisions at each corner for overhead lifting. End caps shall be added to the base for the overhead lifting.
- C. Rigging Diagram: Inscribed on a metal plate permanently attached to the skid. Diagram indicates location and lifting capacity of each lifting attachment and location of the center of gravity.

2.6 S - ENGINE

- A. Comply with NFPA 37, "Stationary Combustion Engines and Gas Turbines."
- B. Fuel: Diesel fuel oil grade DF-2.
- C. Engine: 1800 rpm, 4 cycle.
- D. Lubrication System: Includes but not limited to the following:
 - 1. Oil Pump: The lubrication oil pump shall be a positive displacement type that is integral with the engine and driven from the engine crankshaft. The system shall incorporate full flow filtration with bypass valve to continue lubrication in the event of filter clogging.
 - 2. Bypass Valve: The bypass valve shall be integral with the engine filter base or receptacle. Systems where bypass valves are located in the replaceable oil filter are not acceptable. Pistons shall be oil cooled by continuous jet spray to the underside or inside of the crown and piston pin.
 - 5. Filter and Strainer: Rated to remove 90 percent of particles 5 microns and smaller while passing full flow.
 - 6. Oil Cooler: Maintains lubricating oil at the manufacturer's recommended optimum temperature.
 - 5. Thermostatic Control Valve: Controls flow in the system to maintain optimum oil temperature. Unit shall be capable of full flow and shall be designed to be fail-safe.
 - 6. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without the use of pumps or siphons or special tools or appliances.

- E. Engine Fuel System: Comply with NFPA 30, "Flammable and Combustible Liquids." System includes:
1. Integral Injection Pumps: Driven by the engine camshaft. Pumps shall be adjustable for timing and cylinder pressure balancing.
 2. Main Fuel Pump: Mounted on the engine. Pump shall maintain adequate primary fuel flow under starting and load conditions.
 3. Fuel Oil Filter: Ahead of the injection pumps.
 4. Relief/Bypass Valve: Automatically regulates pressure in the fuel line and returns excess fuel to the source.
- F. Jacket Coolant Heater: Electric immersion type, factory-installed in the jacket coolant system, and rated for the voltage provided in the circuit indicated. Unit shall be rated and thermostatically controlled to maintain an engine temperature of 78 degrees F at the low end of the ambient temperature range specified under "Environmental Conditions" above. Provide manual shutoff valves to isolate the heater during servicing.
- G. Speed Governor: Adjustable isochronous electronic type, with speed sensing, providing 0.25% maximum steady-state frequency regulation.

2.7 S - ENGINE COOLING SYSTEM

- A. Description: Closed-loop, liquid-cooled, with radiator factory-mounted on engine generator set skid and integral engine-driven coolant pumping.
- B. Radiator: Factory-piped and -rated for specified coolant.
1. Radiator Core Tubes: Nonferrous metal construction other than aluminum.
 2. Size of Radiator: Adequate to contain expansion of total system coolant.
 3. Fan: Driven by multiple belts from engine shaft.
- C. Coolant: Solution of 50 percent ethylene glycol and 50 percent water.
- D. Temperature Control: Self-contained thermostatic control valve shall modulate coolant flow automatically to maintain optimum constant coolant temperature as recommended by the engine manufacturer. Features shall include:
1. Thermostatic Elements: Interchangeable and nonadjustable.
 2. Actuator Design: Normally-open valves to return to open position when actuator fails.
- E. Coolant Hose: Flexible assembly with nonporous rubber inside surface and aging, ultraviolet, and abrasion-resistant fabric outer covering.
1. Rating: 50 psi maximum working pressure with 180 deg F coolant, and noncollapsible under vacuum.

2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

2.8 S - FUEL SUPPLY SYSTEM

- A. System shall comply with NFPA 30, "Flammable and Combustible Liquids Code," and NFPA 37, "Standard for Stationary Combustion Engines and Gas Turbines."
- B. Sub-Base Tank: Factory-fabricated assembly of UL-listed double wall containment sub-base fuel tank located between or beneath the generator set skids inside the generator set housing, with fuel pump and the features described below.
 1. Tank capacity shall supply fuel to the engine for an uninterrupted period of 72 hours operation at 100 percent of rated power output of the engine generator system without being refilled, with a minimum capacity of 1270 gallons of diesel fuel.
 2. 3. The sub-base fuel system shall be listed under UL 142, subsection entitled Special Purpose Tanks EFVT category, and will bear their mark of UL Approval according to their particular classification.
 3. Provide a fuel filtration system with connections to both generator tanks. Fuel filtration system shall be "FUELTEC" model CF4.0-PLC or an approved equal. This system shall meet or exceed ISO cleanliness levels of 18/16/13 with a water content of less than 0.05%. Diesel fuel shall meet this ISO level after one pass through the fuel filtration system. System shall be complete with a one micron primary filter, micro-glass filter/coalescer, and Teflon coated stainless steel hydrophobic water separator. Provide with 36" X 42" X 14" aluminum enclosure, pumps, filters, etc. and mounting post with base.
 4. The above ground steel secondary containment rectangular tank for use as a sub base for diesel generators is manufactured and intended to be installed in accordance with the Flammable and Combustible Liquids Code-NFPA 30, the Standard for Installation and Use of Stationary Combustible Engine and Gas Turbines-NFPA 37, and Emergency and Standby Power Systems-NFPA 110.
 5. The primary tank shall be rectangular in shape and constructed in clam shell fashion to ensure maximum structural integrity and allow the use of a full throat fillet weld.
 6. Steel Channel Support System. Reinforced steel box channel for generator support, with a load rating of 5,000 lbs. per generator mounting hole location. Full height gussets at either end of channel and at generator mounting holes shall be utilized.
 7. Exterior Finish. The sub-base tank exterior finish shall be a polyurea-textured rubberized coating.
 8. Normal venting shall be sized in accordance with the American Petroleum Institute Standard No 2000, Venting Atmospheric and Low Pressure Storage Tanks not less than 1-1/4" (3 cm.) nominal inside diameter and at a height of no less than 11 feet above grade.
 9. The emergency vent opening shall be sized to accommodate the total capacity of both normal and emergency venting and shall be not less than that derived from NFPA 30, table 2-8, and based on the wetted surface area of the tank. The wetted area of the tank shall be calculated on the basis of 100 percent of the primary tank. The vent is to be spring-pressure operated: opening pressure is 0.5/psig and full opening pressure is 2.5 psig. The emergency relief vent is to be sized to accommodate the total venting capacity of both normal and emergency vents.
 10. A direct reading, UL listed, magnetic fuel level gauge with a hermetically sealed, vacuum tested dial, to eliminate fogging, with Fuel level read out at generator controller shall be provided .

11. A float switch for remote or local annunciation of a (50% standard) low fuel level condition shall be supplied.
12. High fuel level switch - A fuel level switch will be installed in the tank and the contacts will close when the fuel level reaches 90%.
13. Fuel fill option - The fuel fill is equipped with an OSHPD and IBC approved 5 gallon above ground fill/spill container with auto shut off feature that contains fuel overflow spills that may occur during fill-ups.

2.9 S - ENGINE EXHAUST SYSTEM

- A. Muffler: Horizontal aluminized critical-type, sized as recommended by the engine manufacturer.
- B. Connections from Engine to Exhaust System: Flexible section of corrugated stainless steel pipe.
- C. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liners.
- D. Supports for Muffler and Exhaust Piping: Vibration isolating-type.
- E. Discharge: Provide elbow and vertical riser, with hinged rain cap. Supports and bracing as recommended by the manufacturer.

2.10 S - COMBUSTION AIR-INTAKE SYSTEM

- A. Air-Intake Silencer: Filter-type providing filtration as recommended by the engine manufacturer.
 1. Mounting: Factory-installed on engine generator set at a location readily accessible for servicing.
- B. Supports for Air-Intake Piping and Filter-Silencer: Vibration isolation-type as recommended by manufacturer.

2.11 S - STARTING SYSTEM

- A. Description: 24 V electric starting system with negative ground, and including the following items:
 1. Components: Rated so they will not be damaged during a full engine-cranking cycle with the ambient temperature at the maximum specified in paragraph "Environmental Conditions."
 2. Cranking Motor: Heavy-duty 24-volt positive-engagement solenoid shift-starting motor that automatically engages and releases from the engine flywheel without binding.
 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 4. Battery shall comply with SAE J537, "Storage Batteries," and shall have adequate capacity within the ambient temperature range specified in paragraph "Environmental Conditions" to provide the specified cranking cycle series at least three times without recharging. Provide BCI group 31 batteries for all each generator which must meet the

engine manufactures' specifications for the ambient conditions specified in "Project Conditions" and shall comply with the NFPA requirements for engine cranking cycles. Each battery shall be rated according to SAE Standards J-537 with a minimum cold cranking amp of 950 amps and a minimum reserve capacity of 185 Minutes at 80 degrees F. The battery plates shall be constructed of a calcium-lead alloy to provide long waterless operation and extended battery life. The battery elements must be anchor-locked with full-frame grids and tight-packed commercial plates to resist the effects of vibration. The battery must contain a handle to aid in lifting and the case must be constructed of polypropylene to resist breakage and extend service life. Removable cell covers shall be provided to allow for checking of electrolyte specific gravity

5. Battery Cable: Size as recommended by the generator set manufacturer for the required cable length. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory-fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall maintain battery above 50 degrees F within range specified under "Environmental Conditions;" and shall shut off automatically when battery temperature reaches 70 degrees F. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory-mounted on engine with solid-state voltage-regulation and 35 ampere minimum continuous rating.
8. Battery Charger: Current limiting, automatic equalizing and float charging-type designed for operation from a 120 V 60 Hz supply source. Unit shall comply with UL 508, "Electrical Industrial Control Equipment," UL 1012, and shall include the following features:
 - a. Operation: Equalizing charging rate of 10 amperes shall be initiated automatically after the battery has lost charge until an adjustable equalizing voltage is achieved at the battery terminals. The unit shall then automatically implement an automatic 3-stage float to equalization charge mode to switch to a lower float-charging mode, and shall continue operating in that mode until the battery is discharged again.
 - b. Automatic Temperature Compensation: Adjusts the float and equalizes voltages for variations in the ambient temperature from minus 40 degrees F to 140 degrees F to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Voltage regulation of 1% from no to full load over 10% AC input line voltage variations.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing "low battery voltage" indication on control and monitoring panel. Also provide sensing of high battery voltage and loss of a.c. input or d.c. output of battery charger. Either of these conditions shall close contacts that provide "battery charger malfunction" indication at system control and monitoring panel. Provide alarm circuit board with alarm contacts for low battery voltage, high battery voltage, and battery charger malfunction.
 - f. Enclosure and Mounting: NEMA Class 1, mounted within generator set enclosures.

2.12 S - CONTROL AND MONITORING

- A. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped on a common control and monitoring panel mounted on the generator set.
- B. Controller
1. Refer to paragraph "MANUFACTURERS" for controller basis of design specification.
 - a. The generator set controller shall be a microprocessor based control system that will provide automatic starting, system monitoring, and protection. The controller system shall also provide local monitoring and remote monitoring. The control system shall be capable of PC based updating of all necessary parameters, firmware, and software. .
 - b. The controller shall be mounted on the generator set and shall have integral vibration isolation. The controller shall be prototype and reliability tested to ensure operation in the conditions encountered.
 2. Codes and Standards
 - a. The generator set controller shall meet NFPA 110 Level 1 requirements and shall include an integral alarm horn as required by NFPA.
 - b. The controller shall meet NFPA 99 and NEC requirements.
 - c. The controller shall be UL 508 listed.
 3. Applicability
 - a. The controller shall be a standard offering in the manufacturer's controller product line.
 - b. The controller shall support 12-volt and 24volt starting systems.
 - c. The controller's environmental specification shall be: -40°C to 70°C operating temperature range and 5-95% humidity, non-condensing.
 - d. The controller shall mount on the generator
 4. Hardware Requirements
 - a. Control Panel shall include:
 1. The control shall have a run-off/reset-auto three-position selector switch
 2. Emergency Stop Switch. The controller mounted, latch type remote stop switch shall be red in color with a "mushroom" type head. Depressing the stop button will immediately stop the generator set and lockout the generator set for any automatic remote starting.
 3. Five indicating lights (LED):
 - a. System Ready - green
 - b. Not in Auto - yellow
 - c. Programming Mode - yellow
 - d. System Warning – yellow
 - e. System Shutdown – red
 4. Digital Display. The digital display shall be a vacuum fluorescent display with two lines of alphanumeric, with 2 lines of data and 20 characters. The display shall be viewable in all light conditions. The display shall display status of all faults and warnings. The display shall also display any engine faults. The 16-button keypad gives the user information access and local programming capability.
 5. Sixteen-position snap action environmentally sealed tactile-feel membrane keypad for menu selection and data entry.
 6. For ease of use, an operating guide shall be printed on the

- controller faceplate.
7. Alarm Horn. The controller shall provide an alarm horn that sounds when any faults or warnings are present. The horn shall also sound when the controller is not in the AUTO mode.
 8. Lamp Test Button. When this button is depressed, it shall test all controller lamps.
 9. Alarm Off. This button will silence the alarm horn when the unit is AUTO.
 10. Panel lights shall be supplied as standard.
5. Control Functional Requirements
- a. The generator controller shall display and monitor the following engine and alternator functions and allow adjustments of certain parameters at the controller:
 1. Field-programmable time delay for engine start. Adjustment range 0-5 minutes in 1 second increments.
 2. Field-programmable time delay engine cool down. Adjustment range 0-10 minutes in 1 second increments.
 3. Capability to start and run at user-adjustable idle speed during warm-up for a selectable time period (0-10 minutes), until engine reaches preprogrammed temperature, or as supported by ECM-equipped engine.
 4. The idle function including engine cooldown at idle speed.
 5. Real-time clock and calendar for time stamping of events.
 6. Output with adjustable timer for an ether injection starting system. Adjustment range, 0-10 seconds
 7. Output for shedding of loads if the generator set reaches a user programmable percentage of its kW rating. Load shed shall also be enabled if the generator set output frequency falls below 59 Hz.
 8. Programmable cyclic cranking that provides up to 30 seconds of programmable cyclic cranking and up to 60 seconds rest with up to 6 cycles.
 9. The capability to reduce controller current battery draw, for applications where no continuous battery charging is available. The controller vacuum fluorescent display should turn off automatically after the controller is inactive for 5 minutes.
 10. Control logic with alternator protection for overload and short circuit matched to each individual alternator and duty cycle.
 11. Control logic with RMS digital voltage regulation. The system shall have integral microprocessor based voltage regulator system that provides +/- 0.25% voltage regulation no-load to full load with three phase sensing. A separate voltage regulator is not acceptable. The digital voltage regulator shall be applicable to single- or three-phase systems. The system shall be prototype tested and control variation of voltage to frequency. The voltage regulator shall be adjustable at the controller with maximum +/- 20% adjustable of nominal voltage.
 12. The capability to exercise the generator set by programming a running time into the controller. This feature shall also be programmable through the PC software.
 13. Alternator thermal overload protection. The system shall have integral alternator overload and short circuit protection matched to each alternator for the particular voltage and phase configuration.

14. Control function shall include output voltage adjustment.
15. Battle switch function selection to override normal fault shutdowns, except emergency stop and over speed shutdowns.
16. The control shall detect the following conditions and display on control panel:
 - a. Customer programmed digital auxiliary input ON (any of the 21 inputs available)
 - b. Customer programmed analog auxiliary input out of bounds for any of 7 inputs for ECM equipped engines:
 - c. Emergency stop
 - d. High coolant temperature
 - e. High oil temperature
 - f. Controller internal fault
 - g. Locked rotor - fail to rotate
 - h. Low coolant level
 - i. Low oil pressure
 - j. Master switch error
 - k. NFPA common alarm
 - l. Overcrank
 - m. Overspeed with user-adjustable level, range 60-70 Hz.
 - n. Overvoltage with user adjustable level, range 105% to 135%
 - o. Overfrequency with user adjustable level, range 102% to 140%
 - p. Underfrequency with user adjustable level, range 80% to 90%
 - q. Undervoltage with user adjustable level, range 70% to 95%
 - r. Coolant temperature signal loss
 - s. Oil pressure gauge signal loss
17. Conditions resulting in generator warning (generator will continue to operate):
 - a. Battery charger failure
 - b. Customer programmed digital auxiliary input on (any of the 21 inputs available)
 - c. Customer programmed analog auxiliary input on any of the 7 inputs available on ECM engines
 - d. Power system supplying load
 - e. Ground fault detected - detection by others
 - f. High battery voltage - Level shall be user adjustable. (Range 29-33 volts for 24-volt systems.)
 - g. High coolant temperature
 - h. Load shed
 - i. Loss of AC sensing
 - j. Underfrequency
 - k. Low battery voltage - level shall be user adjustable (Range 20-25 volts for 24-volt systems.)
 - l. Low coolant temperature
 - m. Low fuel level or pressure
 - n. Low oil pressure
 - o. NFPA common alarms

- p. Overcurrent
 - q. Speed sensor fault
 - r. Weak battery
 - s. Alternator protection activated
6. Control Monitoring Requirements
- a. The generator set shall have alarms and status indication lamps that show non-automatic status and warning and shutdown conditions. The controller shall indicate with a warning lamp and or alarm and on the digital display screen any shutdown, warning or engine fault condition that exists in the generator set system. The following alarms and shutdowns shall exist as a minimum:
 - 1. All monitored functions must be viewable on the control panel display.
 - 2. The following generator set functions shall be monitored:
 - a. All output voltages - single phase, three phase, line to line, and line to neutral, 0.25% accuracy
 - b. All single phase and three phase currents, 0.25% accuracy
 - c. Output frequency, 0.25% accuracy
 - d. Power factor by phase with leading/lagging indication
 - e. Total instantaneous kilowatt loading and kilowatts per phase, 0.5% accuracy
 - f. kVARS total and per phase, 0.5% accuracy
 - g. kVA total and per phase, 0.5% accuracy
 - h. kW hours
 - i. A display of percent generator set duty level (actual kW loading divided by the kW rating)
 - 3. Engine parameters listed below shall be monitored, as available with ECM equipped engines
 - a. Coolant temperature both in English and metric units
 - b. Oil pressure in English and metric units
 - c. Battery voltage
 - d. RPM
 - e. Lube oil temperature
 - f. Lube oil level
 - g. Crankcase pressure
 - h. Coolant level
 - i. Coolant pressure
 - j. Fuel pressure
 - k. Fuel temperature
 - l. Fuel rate
 - m. Fuel used during the last run
 - n. Ambient temperature
 - 4. Operational records shall be stored in the control beginning at system startup.
 - a. Run time hours
 - b. Run time loaded hours
 - c. Run time unloaded hours
 - d. Number of starts
 - e. Factory test date

- f. Last run data including date, duration, and whether loaded or unloaded
 - g. Run time kilowatt hours
 - 5. The following operational records shall be a resettable for maintenance purposes:
 - a. Run time hours
 - b. Run time loaded hours
 - c. Run time unloaded hours
 - d. Run time kilowatt hours
 - e. Days of operation
 - f. Number of starts
 - g. Start date after reset
 - 6. The controller shall store the last one hundred generator set system events with date and time of the event.
 - 7. For maintenance and service purposes, the controller shall store and display on demand the following information:
 - a. Manufacturer's model and serial number
 - b. Battery voltage
 - c. Generator set kilowatt rating
 - d. Rated current
 - e. System voltage
 - f. System frequency
 - g. Number of phases
- 7. Inputs and Outputs
 - a. Inputs
 - 1. There shall be 21 dry contact inputs that can be user-configured to shut down the generator set or provide a warning.
 - 2. There shall be 7 user-programmable analog inputs for ECM-equipped engines for monitoring and control.
 - 3. Each analog input can accept 0-5 volt analog signals
 - 4. Resolution shall be 1:10,000
 - 5. Each input shall include range settings for 2 warnings and 2 shutdowns.
 - 6. All values shall be on the control panel display.
 - 7. Shall be user-assigned.
 - 8. Additional standard inputs required:
 - a. Input for an external ground fault detector. Digital display shall show "ground fault" upon detection of a ground fault.
 - b. Reset of system faults.
 - c. Remote two-wire start.
 - d. Remote emergency stop.
 - 9. Idle mode enable.
 - b. Outputs
 - 1. All NFPA 110 Level 1 outputs shall be available.
 - 2. Thirty outputs shall be available for interfacing to other equipment
 - a. All outputs shall be user-configurable from a list of 25 functions and faults
 - b. These outputs shall drive optional dry contacts.
 - 3. A programmable user-defined common fault output with over 40

selections shall be available.

8. Communications (Modbus protocol)
 - a. If the generator set engine is equipped with an ECM (engine control module), the controller shall communicate with the ECM for control, monitoring, diagnosis, and meet SAE J1939 standards.
 - b. Industry standard Modbus communication shall be provided..
 - c. A Modbus master shall monitor and alter parameters, and start or stop a generator.
 - d. The controller shall have the capability to communicate to a personal computer (IBM or compatible) running Windows 7 or later.
 - e. Communications shall be available for serial, CAN, and Ethernet bus networks.
 - f. A variety of connections shall be available based on requirements:
 1. A single control connection to a PC.
 2. Multiple controls on an intranet network connected to a PC.
 3. A single control connection to a PC via phone line.
 4. Multiple controls to a PC via phone line.
 - g. Generator and transfer switch controls shall be equipped with communications modules capable of connecting to the same communication network.
 - h. The capability to connect up to 128 controls (any combination of generator sets and transfer switches) on a single network shall be supported.
 - i. Cabling shall not be limited to the controller location.
 - j. Network shall be self-powered.
 9. Communications accessories
 - a. Supply a Modbus to Ethernet Converter that provides one RJ45 jack for standard Ethernet 10/100 connection, and a terminal block for RS-485 connection, and is powered by 12 VDC. The Baud rate on the Modbus RTU side shall be selectable 9600 or 19200. The converter shall support Simple Network Management Protocol (SNMP) users to poll or issue trap commands.
 10. Remote annunciator panel - The remote annunciator shall meet NFPA 110, Level 1 requirements and enable remote viewing of the generator status. The panel shall be connected to the generator controller via either network communication wires or via hard wired connections. Remote annunciator shall also indicate ATS source availability, contactor position, and loaded or unloaded test for up to four transfer switches. The panel shall have the capability to be either flush- mounted or surface-mounted. The annunciator shall meet UL508 requirements
- C. Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items on engine, generator, or elsewhere as indicated. Where not indicated, locate to suit manufacturer's standard.
- G. Wiring: Provide types and number of conductors required in conduit to provide the functions specified.

- A. Comply with NEMA MG 1, "Motors and Generators," and specified performance requirements.
- B. Drive: Generator shaft shall be directly connected to the engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: NEMA Class H. Temperature rise of rotor and stator shall be limited to the temperature rise indicated on the generator set schedule.
- D. Stator Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at rated capacity.
- F. Excitation system shall be brushless, permanent magnet type, and shall derive excitation current from a pilot exciter mounted on the rotor shaft. Exciter shall enable the generator to provide the short circuit current specified hereinafter in paragraph "System Performance."
- G. Pitch: Generator pitch shall be as indicated on the engine-generator set schedule.
- H. Enclosure: Dripproof.
- I. Instrument Transformers: Mounted within generator enclosure.
- J. Voltage Regulator: Three phase sensing, digital solid-state-type, environmentally sealed, separate from exciter, providing performance as specified. Provide the following performance, features and accessories:
 - 1. Adjusting rheostat on control and monitoring panel provides plus or minus 10 percent adjustment of output voltage operating band.
 - 2. Voltage regulator shall be suitable for use with non-linear and silicon-controlled rectifier (SCR) loads, and shall be designed to maintain voltage control with at least 20% total harmonic current distortion. Provide additional circuitry and filtering as required for the application and to comply with all specifications.
- K. Surge Protection: Conform to UL 1449, "Transient Voltage Surge Suppressors." Mount suppressors in generator enclosure and connect to load terminals.
- L. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above the dew point.
- M. Alternator:
 - 1. The alternator shall be salient-pole, brushless, pitch as indicated on the generator load schedule, with 4 bus bar provision for external connections, self-ventilated, with drip-proof construction and amortisseur rotor windings, and skewed for smooth voltage waveform. The ratings shall meet the NEMA standard (MG1-32.40) temperature rise limits. The insulation shall be class H per UL1446 and the varnish shall be a vacuum pressure impregnated, fungus resistant epoxy. Temperature rise of the rotor and stator shall be limited to 130°C Standby. The PMG based excitation system shall be of brushless

construction controlled by a digital, three phase sensing, solid- state, voltage regulator. The AVR shall be capable of proper operation under severe nonlinear loads and provide individual adjustments for voltage range, stability and volts-per-hertz operations. The AVR shall be protected from the environment by conformal coating. The waveform harmonic distortion shall not exceed 5% total RMS measured line-to-line at full rated load. The TIF factor shall not exceed 50.

2. The alternator shall have a maintenance-free bearing, designed for 40000 hour B10 life. The alternator shall be directly connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.
3. The generator shall be inherently capable of sustaining at least 300% of rated current for at least 10 seconds under a 3-phase symmetrical short circuit without the addition of separate current-support devices.

2.14 S/C - SEISMIC REQUIREMENTS

- A. Internal and external supports for components, supports, and fastenings for equipment, piping, and wiring shall be designed to withstand static or anticipated seismic forces, or both, in all directions. The generator set shall be IBC Certified as meeting the required maximum seismic design acceleration level per the International Building Code in effect at the time of issuance of this specification for the specific location of the generator installation site. The generator shall be analyzed or shake tested by a third party, accompanied by a Certificate of Compliance, and include a seismic label on the generator set (per Section 1702 of the IBC Code). Seismic certified generators shall be installed per the specific seismic instructions provided by the manufacturer.

2.15 S - OUTDOOR GENERATOR SET ENCLOSURE

- A. Enclosure: Level 1 Sound Attenuated Enclosure.
 1. The generator set shall be supplied with a Sound Attenuated Enclosure, providing a sound pressure of 75 dB(A) while the generator is operating at 100% load at 7 meters (23 feet) - free field - using acoustic insulation and acoustic-lined inlet hoods, constructed from high strength, low alloy 14 gauge galvanized steel. The acoustic insulation used shall meet UL 94 HF1 flammability classification. The enclosure shall be manufactured from bolted panels to facilitate service, future modifications, or field replacement. The enclosure shall use external vertical air inlet and outlet hoods with 90 degree angles to discharge air up and reduce noise. The enclosure shall have an integral rodent guard and skid end caps and shall have bracing to meet 241 kph (150 mph) wind loading.
 2. The enclosure components and skid shall be cleaned with a two-stage alkaline cleaning process to remove grease, grit, and grime from parts. Components shall then be subjected to a zirconium-based conversion coating process to prepare the metal for electrocoat adhesion. All enclosure parts shall receive an 100% epoxy primer electrocoat with high-edge protection. Following the electrocoat process, the parts shall be finish coated with powder baked paint for corrosion-resistance.
 3. The enclosure must surpass a 3,000 hour salt spray corrosion test per ASTM B-1117.
 4. Enclosures will be finished in the manufacturer's standard color.
 5. The enclosures shall allow the generator set to operate at full load in an ambient temperature of 50°C with no additional derating of the electrical output of the generator set.
 6. Enclosures shall be equipped with sufficient side and end doors to allow access for operation, inspection, and service of the unit and all options. Minimum requirements are two doors per side. When the generator set controller faces the rear of the generator set,

an additional rear facing door is required. Access to the controller and main line circuit breaker shall meet the requirements of the National Electric Code.

7. Doors shall be fitted with hinges, hardware, and the doors shall be removable.
8. Doors shall be equipped with lockable latches. Locks shall be keyed alike. Door locks shall be recessed to minimize potential of damage to door/enclosure.
9. A duct between the radiator and air outlet shall be provided to prevent re-circulation of hot air.
10. The complete exhaust system shall be internal to the enclosure.
11. The critical silencer shall be fitted with a tailpipe and rain cap.

- B. Space Heater: Provide a space heater where determined necessary by the manufacturer in order to comply with specification requirements for cranking capacity and environmental conditions. If required, provide complete with all required accessories and wiring, including field wiring.

2.16 S - FINISHES

- A. Indoor Enclosures and Components: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.
- B. Outdoor Enclosures: Refer to enclosure specifications above.

2.17 S - SOURCE QUALITY CONTROL

- A. Factory Tests: Include prototype testing and Project-specific equipment tests (equipment manufactured specifically for this Project).
- B. Prototype Testing: Performed on a separate engine generator set using the same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Conform to those required for Level 1 energy converters in paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2 of NFPA 110. In addition, provide the following testing:
 - a. Maximum power (kw).
 - b. Maximum kilovolt amperes (kva).
 - c. Alternator temperature rise by embedded thermocouple and by resistance method per NEMA MG1-32.6
 - d. Governor speed regulation under steady-state and transient conditions.
 - e. Voltage regulation and generator transient response.
 - f. Fuel consumption at 1/4, 1/2, 3/4, and full load.
 - g. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
 - h. Three-phase line-to-line short circuit test.
 - i. Alternator cooling air flow.
 - j. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.
 - k. Maximum motor starting (kVA) at 35% instantaneous voltage dip
 - l. Endurance testing
2. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype have been acceptably tested to demonstrate compatibility and reliability.

- C. Project-Specific Equipment Tests: Test engine generator set and other system components and accessories prior to shipment. Test items individually and assembled and connected as a complete system at the factory in a manner equivalent to that required at the Project site. Record and report test data. Conform to SAE 8528, "Engine Power Test Code-Spark Ignition and Diesel," and the following:
1. Test Equipment: Use instruments calibrated within the previous 12 months and with accuracy directly traceable to the National Institute of Standards and Technology (NIST).
 2. Hydrostatic Test: Perform on radiator, heat exchanger, and engine water jacket.
 3. Generator Tests: Conform to IEEE 115, "Test Procedures for Synchronous Machines."
 4. Complete System Continuous Operation Test: Includes nonstop operation for a minimum of 4 hours, including at least 1 hour each at 1/4, 1/2, 3/4, and full load. If unit stops during the 4-hour test, repeat the complete test. Record the following minimum data at the start and end of each load run, at 15-minute intervals between those times, and at 15-minute intervals during the balance of the test:
 - a. Fuel consumption.
 - b. Exhaust temperature.
 - c. Jacket water temperature.
 - d. Lubricating oil temperature and pressure.
 - e. Generator load current and voltage, each phase.
 - f. Generator system gross and net output kW.
 5. Complete System Performance Tests: Include the following to demonstrate conformance to specified performance requirements:
 - a. Single-step load pickup.
 - b. Transient and steady-state governing.
 - c. Transient and steady-state voltage performance.
 - d. Safety shutdown devices
 - e. Rated Power @ 0.8 PF
 - f. Maximum power
 6. Observation of Test: Provide 2-week advance notice of tests and opportunity for observation of test by Owner's representatives.
 7. Report test results within 10 days of completion of test and issue a certified test record to Owner's Representative prior to shipment.

2.18 S - WARRANTY

1. Warranty and Service: The generator set shall include a standard warranty covering one (1) year or 2000 hours, whichever occurs first, to guarantee against defective material and workmanship in accordance with the manufacturer's published warranty from the date of initial startup. The generator set manufacturer and its distributor shall maintain a 24-hour parts and service organization. This organization shall regularly engage in maintenance contract programs to perform preventive maintenance and service on equipment similar to that specified. A service agreement shall be available and shall include system operation under simulated operating conditions; adjustment to the

generator set, transfer switch, and switchgear controls as required, and certification in the owner's maintenance log of repairs made and functional tests performed on all systems.

PART 3 - EXECUTION

3.1 C - INSTALLATION

- A. Anchor generator set and other system components on concrete bases conforming to specified requirements and as indicated. Provide anchorage according to manufacturer's recommendations.
- B. Exhaust Piping Installation: In accordance with manufacturer's recommendations.
- C. Maintain minimum working space around components according to manufacturer's recommendations and NEC.
- D. Manufacturer's Field Services: Arrange and pay for the services of a factory-authorized service representative to supervise the installing, connecting, testing, and adjusting of the unit.
- E. Grounding: Provide grounding of the engine-generator set as indicated or specified. Additional grounding requirements are specified in Section 16310.

3.2 S/C - IDENTIFICATION

- A. Identify system components with labeling in accordance with manufacturer recommendations.

3.3 S/C - FIELD QUALITY CONTROL

- A. Supervised Adjusting and Pretesting: Under supervision of factory-authorized service representative, Contractor shall pretest all system functions, operations, and protective features. Provide all instruments and equipment required for tests. Adjust to ensure operation is according to Specifications.
- B. Tests: Under supervision of factory-authorized service representative, Contractor shall perform the tests listed below according to manufacturer's recommendations upon completion of installation of system. Use instruments bearing records of calibration within the last 12 months, traceable to NIST standards, and adequate for making positive observation of test results. Include the following tests:
 - 1. Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.
 - 2. Battery Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 - 3. 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.

4. Simulation of malfunctions to verify proper operation of local and remote protective, alarm, and monitoring devices.
 5. Load Test: Provide a temporary variable resistive load bank capable of simulating kW of load for which unit is rated. Run unit at 25, 50, and 75 percent of rated capacity for 30 minutes each, and at 100 percent for 3 hours. Record voltage, frequency, load current, battery-charging current, power output, oil pressure, and coolant temperature periodically during the test.
 6. Exhaust Emissions Test: Not required.
 7. Voltage and Frequency Transient Stability Tests: Not required.
 8. Operational Tests: The manufacturer's factory-trained distributor service representative shall perform an installation check, startup, and building load test. The engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. Set all generator and transfer switch controls in compliance with drawings and specifications. Perform two (2) complete operational tests by simulating loss of commercial power. Verify engine-generator start-up, load transfer, operation, for one-hour minimum, sequencing of loads, and voltage drop. Reapply commercial power, and verify load re-transfer and engine-generator cool down and shut down. The tests shall include but not be limited to:
 - a. Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present and expected.
 - b. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. These shall include: block heaters, battery chargers, alternator strip heaters, remote annunciators, etc.
 - c. Generator set startup under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during operation, normal and emergency line-to-line voltage and frequency, and phase rotation.
 - d. Automatic start by means of a simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator set voltage, amperes, and frequency shall be monitored throughout the test
- C. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- D. Commissioning: The Owner will be retaining the services of an independent commissioning agent to participate in additional commissioning documentation and testing. The Supplier shall provide the services of the manufacturer's factory-trained distributor service representative for two 8 hour days for commissioning testing. The Contractor shall provide the services of licensed electrician for two 8 hour days for commissioning testing. Commissioning testing procedures will be provided to the Supplier and Contractor after review and approval of project submittals.
- E. Coordinate testing and training with testing/training of automatic transfer switches and run them concurrently.

3.4 C - CLEANING

- A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5 S/C - DEMONSTRATION

- A. Training: Supplier shall provide the services of a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of the system and to train Owner's personnel for a minimum of 8 hours total.
- D. Schedule training at Owner's convenience with at least 14-day advance written notice.

END OF SECTION