TRUCKEE MEADOWS WATER AUTHORITY
Quality. Delivered.

Purchase Order

PO Accounting Date: 2/3/2017

THIS NUMBER MUST APPEAR ON ALL INVOICES, PACKAGES AND SHIPPING PAPERS.

Purchase Order # **PO-002719**

Delivery must be made within doors of specified destination.

BILL TO

Truckee Meadows Water Authority
Accounts Payable
PO Box 30013
Reno NV 89520-3013

VENDOR

Nevada Energy Systems Inc
PO Box 10083
Reno NV 89510

SHIP TO

Truckee Meadows Water Authority
1355 Capital Blvd
Reno NV 89502

Requester Contact Name	Requester Contact Phone Number	Vendor Number
		000240

Date Ordered	Date Requested	Freight Method/Terms
2/3/2017	5/31/2017	

Line #	Description/Part No.	Qty	UOM	Unit Price	Discount Amount	Extended Price
	Glendale 1.5MW Diesel Generator - NRS 332 Public Bid - TMWA Bid No. 2017-005 - awarded to lowest responsible and responsive bidder (Public Bid - NRS 332) 11-0013 - 1-7350-30-3010					
1	Contract Services	538660.00	usd	1.00		$538,660.00

Mark Foree
Mark Foree
General Manager

Truckee Meadows Water Authority's Terms and Conditions shall govern this and all related transactions, review them at http://tmwa.com/docs/po_terms_and_conditions.doc

This Purchase Order number must be indicated on all invoices, cartons and packing slips.

PO Total	$538,660.00

PURCHASE AGREEMENT
(NRS 332)

GLENDALE WTF 1.5 MW DIESEL GENERATOR PURCHASE
TMWA Bid No.: 2017-005
TMWA Capital Project No.: 11-0013

THIS EQUIPMENT/PRODUCT PURCHASE AGREEMENT (also herein referred to as "Contract"), made and entered into this 6th day of February, 20 17, by and between the Truckee Meadows Water Authority hereinafter called "TMWA" and **Nevada Energy Systems, Inc., P.O. Box 10083, Reno, Nevada 89510,** hereinafter called the "Supplier".

WITNESSETH, that TMWA and the Supplier, for the consideration hereinafter named, agree as follows:

Article 1 Scope of Work

The Supplier shall provide equipment/product for the 1,500 kW, 2,000 kVA at 4,160V 3-phase diesel medium voltage backup power generator set ("Generator") as provided in the specifications and provide all of the equipment and services described in the specification prepared by TMWA (Exhibit "A" attached hereto) and as amended by specific addenda, and shall do everything required by this Agreement in furnishing the Generator.

Delivery of the Generator shall be to TMWA's Glendale Water Treatment Facility located at 1205 S. 21st Street, Sparks, Nevada.

Article 2 Contract Time, Guaranteed Delivery Date, and Liquidated Damages

Supplier agrees to deliver the Generator, in a good and satisfactory condition, pursuant to the Specification to the TMWA Glendale Water Treatment Facility located at 1205 S. 21st Street, Sparks, Nevada, no later than **One Hundred Thirteen (113) calendar days** following the issuance of the Notice to Proceed, unless otherwise agreed to between the parties, which is the Guaranteed Delivery Time as defined in the Bid Package.

TMWA and Supplier recognize that time is of the essence of this Agreement.

Article 3 The Contract Sum

TMWA shall pay Supplier, as full compensation for furnishing the Generator, services, and other specified items in accordance with the Contract Documents and to the satisfaction of TMWA, the lump sum amount of: **Five Hundred Thirty-Eight Thousand Six Hundred ($538,600) Dollars.**

Article 4 Payment

Payment for the Generator item described on the Bid Schedule will be made within 30 days of the later of: i) inspection by TMWA and acceptance of delivery of such Generator; or ii) receipt of an invoice for the Generator item.

Article 5 Acceptance and Final Payment

Testing and acceptance of the Generator shall be as specified in the Specifications, Bid and Contract Documents. Acceptance of final payment by the Supplier shall constitute a full waiver and release by the Supplier of all claims against TMWA arising out of or relating to this Agreement.

Article 6 The Contract Documents

The following is an enumeration of the Contract Documents that are fully a part of the Contract as if herein repeated:

1. Bid Documents and Bid Form
2. Agreement
3. Specifications
4. Addenda

Article 7 Warranty

Supplier warrants that the Generator furnished under the Contract will be of good quality and new and that the Generator will be free from defects and will conform with the requirements of the Specifications, Bid and Contract Documents.

Article 8 Indemnification/Hold Harmless

Notwithstanding any provision to the contrary in the Contract Documents, TMWA waives any requirement that the Supplier on this bid provide insurance (other than property insurance insuring risk of loss until delivery and acceptance by TMWA) in connection with the delivery of the Generator.

Article 9 Performance Bond – NOT REQUIRED FOR THIS PROJECT

Article 10 Termination

In addition to other provisions of this Agreement, TMWA may terminate the Agreement in accordance with the procedures specified in the Bid Documents, Bid Form, Specifications and Contract upon giving Supplier seven (7) day notice in writing.

Article 11 Governing Law

This Agreement shall be governed by, interpreted under and construed and enforced in accordance with the laws of the State of Nevada, with venue in the County of Washoe. Each of the parties hereto acknowledge and agree that the laws of the State of Nevada and the selection of venue in the County of Washoe were freely chosen by the parties hereto.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement the day and year first above written.

TRUCKEE MEADOWS WATER AUTHORITY

Dated: FEB. 6, 2017 By: Mark Foree
General Manager

ATTEST: _____
TMWA Clerk

Dated: 1/30, 2017 Supplier: Nevada Energy Systems, Inc.

By: Sandy Todaro

Name: SANDY Todaro.

Title: Co Owner.

STATE OF NEVADA)
) ss:
COUNTY OF WASHOE)

On this 30th day of January, 2017, personally appeared before me, a Notary Public, Sandra M. Todaro, who acknowledged to me that he/she executed the foregoing Agreement for Equipment/Product as the authorized representative of the Supplier.

Melissa Kinsman
Notary Public

MELISSA R. KINSMAN
Notary Public - State of Nevada
Appointment Recorded in Washoe County
No: 16-1653-2 - Expires February 25, 2020

ATTACHMENT "A"

TECHNICAL SPECIFICATIONS

SECTION 263213

DIESEL MEDIUM VOLTAGE GENERATOR SET

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes details to cover work required to furnish, install, start-up, test, and document the packaged medium-voltage standby-power diesel engine generator set to include the following features:

1. Diesel engine.
2. Starting system.
3. Cooling system.
4. Diesel fuel-oil system with sub-base tank.
5. Engine exhaust & silencer.
6. Control and monitoring.
7. Battery and charger.
8. Generator over-current and fault protection.
9. Generator, exciter, and voltage regulator.
10. Vibration isolation devices.
11. Load bank and controller.

1.2 REFERENCES

A. In all cases, referenced specifications, codes and standards shall be the most recently published editions or the version currently adopted by the authority having jurisdiction.

B. National Electrical Manufacturers Association (NEMA)
1. NEMA MG 1 – Motors and Generators

C. International Electrical Testing Association (NETA):
1. NETA ATS – Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems

D. National Fire Protection Association (NFPA)
1. NFPA 30 – Flammable and Combustible Liquids Code
2. NFPA 37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
3. NFPA 70 – National Electrical Code (NEC)
4. NFPA 110 – Standard for Emergency and Standby Power Systems

1.3 SYSTEM DESCRIPTION

A. General: Standby engine generator set rated to serve continuously during interruption of prime electrical power and required auxiliaries, accessories, and controls to provide source of power, as specified herein, according to NFPA 110.

B. Capacity: Approximately 1500 kW, 2000 kVA at 4,160V 3-Phase. See performance and sizing calculation submittal requirements as well as electrical drawings for details.

1.4 ACTION SUBMITTALS

A. Bill of Materials: A listing shall include all of the panels, racks, instruments, components, and devices provided under this section.

B. Equipment tabulating all components furnished, followed by the manufacturer's name, manufacturer's model number, and a cross-reference to its location on the shop drawings.

C. Product Data: For each type of product. Drawings and descriptive (catalog) data and brochures of each item of equipment including technical data sheets for the engine and generator.
   1. Diesel engine data.
      a. Manufacturer
      b. Model
      c. Revolutions per minute (rpm)
      d. Rated capacity brake horsepower (bhp)
      e. Make and model of governor
      f. Piston displacement (cubic inches)
      g. Guaranteed fuel consumption rate in gallons per hour at:
         1) Full Load
         2) 3/4 Load
         3) 1/2 Load
   2. Generator Data
      a. Manufacturer
      b. Model
      c. Rated kVA
      d. Rated kW
      e. Voltage
      f. Temperature rise above 40°C ambient at rated output with 80% power factor
      g. Generator efficiency including excitation losses at
         1) Full Load
         2) 3/4 Load
         3) 1/2 Load
      h. Voltage dip calculations with specified loading (see electrical drawings).
   3. Engine-generator unit and accessories to include:
      a. Enclosure
      b. Accessory sub-panel & transformer
      c. Control panels
      d. Voltage Regulator
      e. Fuel System
      f. Exhaust System
      g. Batteries

h. Battery Charger
i. Water Jacket Heater
j. Load Bank Unit
k. Load Bank Controller
l. other accessories not listed here
m. Manufacturer
n. Model
o. Catalog data/cutsheets
p. Weight of skid-mounted unit
q. Overall length
r. Overall width
s. Overall height
t. Exhaust pipe size
u. Cubic feet per minute (cfm) of air required for combustion and also for ventilation.
v. Heat rejected to enclosure by engine and generator in Btu/hr.
w. Cooling air volume required
x. Total efficiency of the unit
y. Emissions certification
z. Sound data (enclosure performance data)

4. Generator Circuit Breaker
   a. Catalog data
   b. Recommended trip settings for all adjustable settings
   c. Short-circuit interrupting ratings

D. Shop Drawings:
   1. Identify electrical connection requirements and characteristics.
   2. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   4. Identify fluid drain ports and clearance requirements for proper fluid drain.
   5. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
   7. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for equipment and functional relationship between all electrical components. Generator winding data and connection diagrams. Include battery charger and water jacket power requirements.

E. Certified foundation and anchor bolt plans for all floor/concrete–mounted equipment. Include sizing and structural calculations for required anchoring and seismic bracing equipment for seismic considerations stamped by a Professional Engineer licensed in the State of Nevada.

F. Departure from Drawings: Submit to the Engineer, in writing for review, details of any necessary proposed departures from these contract documents, and the reasons therefore, as soon as practicable and within 30-days after the award of the contract. Make no such departures without the prior written approval of the engineer.

G. Description of operation.

H. Test procedures, syllabus of training and a schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Sizing Calculation: Generator supplier to submit a project specific sizing calculation for engineering review and approval. Loading as shown on the electrical drawings. Submitted generator set equipment shall not to exceed 80% of de-rated capacity. De-rated capacity shall take into consideration project elevation and temperature at the proposed installation site.

B. Seismic Qualification Data: Certificates for engine generator, accessories, and components, from manufacturer.

C. Source quality-control reports.

D. Certified test reports: Indicate results of performance testing.

E. Field quality-control reports: Inspections, findings, and recommendations.

F. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data: Include six (6) copies of the instructions and service manuals for normal operation, routine maintenance, oil sampling, analysis for engine wear, and emergency maintenance procedures. The manual shall be bound in a 9-inch by 12-inch size binder. Include a table of contents with all pages neatly assembled and fit within the manual cover.

B. For each section provide the following information as applicable:
1. Itemized list for all data provided.
2. Name and location of the manufacturer and the manufacturer's local representative, nearest suppliers, and spare parts warehouse.
3. Recommended installation, adjustment, start-up, calibration, and trouble-shooting procedures.
4. Recommended lubrication, lubrication intervals, and estimate of yearly quantity needed.
5. Recommended step-by-step procedures for all modes of operation.
6. Complete internal and connection wiring diagrams.
7. Recommended preventative maintenance procedures for all modes of operation.
8. Complete parts lists, by generic title and identification number.
9. Recommended spare parts and special tools.
10. Disassembly, overhaul, and reassembly instructions.
11. All approved shop drawing information pertinent to facility operation and maintenance.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, with service facilities within 50 miles of this project. Manufacturer shall be ISO 9001 or 9002 certified. The generator set shall be certified

by the engine manufacturer to be suitable for use at the installed location and rating and shall meet all applicable exhaust emission requirements at the time of commissioning at the location installed for standby power. Provide certification that the engine-generator complies with the requirements of Federal, State, and Local Agencies.

B. Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience. Supplier shall take unit responsibility for the entire medium voltage standby diesel engine generator system, to provide a complete and operable system that meets all the requirements of these contract documents. The medium voltage standby diesel engine generator supplier shall be responsible for the selection, design, manufacture, installation, and testing of the equipment specified herein to ensure complete compatibility of the elements of the standby generator system with other equipment installed, new and existing, at the facility. The generator-set supplier shall coordinate with all associated system suppliers and installers to ensure the installation dimensions, connections, and requirements are compatible.

C. Installer: An authorized representative who is trained and approved by manufacturer.

D. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA for on-site testing.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at the time of shipment.

B. Equipment shall withstand the mechanical stresses caused by rough handling during shipment in addition to the electrical and mechanical stresses, which occur during operation of the system. Protect radiator core with wood sheet.

C. Store in a location as agreeable with the engineer, secure from weather or accidental damage. If stored outdoors, indoor gear shall be covered and heated, and outdoor gear shall be heated.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Furnish written manufacturer warranty for on-site parts and labor.

2. Warranty Period: 2 years from date of successful generator startup, not to exceed 90-days from date of delivery.

1.10 MAINTENANCE SERVICE

1. Furnish service and maintenance of engine generator for one year from date of successful generator startup, not to exceed 90-days from date of delivery.

1.11 MAINTENANCE MATERIALS

1. Furnish two of each: fuel, oil, and air filter elements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide first-quality new materials, free from defects and suitable for the intended use and the space provided. Provide equipment compliant with requirements set forth in the contact documents and standards which have been locally established. As a minimum, provide equipment which meets the requirements of:
   1. UL 508 (Electric Industrial Controls)
   2. UL 142 (Sub Base Fuel Tanks)
   3. UL 1236 (Battery Chargers)
   4. UL 2200 (Generator Sets)
   5. UL 499 (Heaters)

B. Furnish and install all incidental items not specifically shown or specified which are required by good practice to provide the complete system specified herein.

2.2 MANUFACTURERS

A. Cummins/ONAN

B. Caterpillar Inc.

C. MTU Onsite Energy

D. Generac Power Systems

E. Kohler Industrial Power

F. Katolight

G. Taylor Power Systems

H. Gillette Manufacturing

I. Substitutions: TMWA approved alternate only.

J. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.3 PERFORMANCE REQUIREMENTS

A. As a minimum, the standby generator shall have a continuous rating for stepped loads as specified on the electrical drawings. The contractor is responsible for coordinating functional

requirements with various equipment suppliers to furnish a complete, fully-integrated and operational system.

B. Seismic Performance: Engine generator housing, day tank, engine generator, batteries, battery racks, silencers, sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels. Water shall be substituted for diesel fuel in fuel tank during test
3. Component Importance Factor: 1.5.

C. B11 Compliance: Comply with B11.19.

D. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 EPSS.

E. UL Compliance: Comply with UL 2200.

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

G. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

H. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: -20 to 115 deg F (-29 to 46 deg C).
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 4500 feet (1372 m).

I. The generator set shall be provided with a sound-absorbing housing with interior lighting. It shall have sufficient clearances for routine maintenance and shall have code required clearances.

J. Sufficient capacity to operate under 110% of nameplate rating for one hour in specified ambient environmental conditions.

2.4 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled, four-stroke cycle, compression ignition diesel internal combustion engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. EPSS Class: Engine generator shall be classified as a Class 2 according to NFPA 110.

D. Service Load: shown on Electrical Sheets.

E. Power Factor: 0.8, lagging.

F. Frequency: 60 Hz.

G. Voltage: 4160 Vac.

H. Phase: Three-phase, four-wire wye.

I. Induction Method: Turbocharged.

J. Governor: Electronic, adjustable isochronous, with speed sensing. Shall maintain engine speed at precise rated frequency with operation within 0.25 percent steady-state, 5 percent no-load to full-load, and recovery to steady-state within 2 seconds following load changes. Governor shall not permit frequency modulation to exceed ¼ cycle per second. Governor shall be a stand-alone unit and not integrated into the generator control panel.

K. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

L. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

M. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage, from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency, from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10 system requirements.

2.5 DIESEL ENGINE

A. Fuel: ASTM D 975 diesel fuel oil, Grade 2-D S15.

B. Rated Engine Speed: 1800 rpm (maximum nominal).

C. The complete engine block shall be machined from one casting. Designs incorporating multiple blocks bolted together are not acceptable.

D. The engine shall receive a prime coat, and two coats of industrial paint suitable for the intended use. Contractor to supply owner a selection of finish coat color from manufacturer's standard colors.

E. All exposed rotating parts of the engine shall be provided with guards for protection of personnel per OSHA requirements.

F. Lubrication System: Engine or skid mounted.

1. Shall incorporate a gear type lube oil pump to furnish oil pressure to moving parts.
2. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow. Shall incorporate a bypass valve that will allow circulation in case of filtration system failure.
3. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe and shall incorporate a oil cooler system.
4. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
5. Lubrication oil as recommended by the engine manufacturer for job conditions.

G. Batteries: Four 8D heavy-duty 24VDC, diesel starting type lead-acid storage batteries mounted on a acid resistant material battery rack. Furnish battery cables of adequate size and length, minimum #4/0 AWG DLO.

H. Engine Jacket Heater: Two 240V thermal-circulation, electric-immersion type heaters, factory installed in coolant jacket system with integral thermostatic control, sized to maintain engine jacket coolant between 120°F and 140°F in an ambient temperature of -20°F. Heater mechanical connections shall have isolation valves. Heaters shall be hard-wired, no plugs.

I. Muffler/Silencer: Heavy-duty, welded construction, critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Include a seamless stainless-steel flexible exhaust connector.
3. Shall be supported independently to prevent transmission of vibration and allow for expansion. Use long radius, low restriction fittings.

J. Sound-attenuated, weather-proof enclosure: baffled, sound-attenuating insulation.

1. Sound level measured at a distance of 23 feet (7 m) from exhaust discharge after installation is complete shall be 85 dBA or less.
2. Be vandal resistant and lockable with three point handle operated latches. It shall not be possible to access or operate equipment without a key.
3. The roof shall have a positive camber for water runoff. The exhaust outlet(s) shall be supplied with rain guard(s) at least 1-inch above the enclosure to prevent moisture from entering the enclosure.
4. The base of the enclosure shall be designed for skid base installation and shall include a means for fastening to the concrete slab. Anchor points, isolators and anchors shall be designed for the site specific seismic zone.
5. Air openings shall include fixed louvers sized to allow proper air flow. Frames shall be manufactured from 14-gauge steel. The blades and the fronts shall be covered with 14-guage expanded screen.
6. Single doors shall be a minimum of 30-inches wide. Double doors shall be 60-inches wide. All doors shall have stainless steel hinges and be fully weather stripped. Doors shall be removable.
7. Doors and walls shall be insulated with sound attenuating material.
8. Mufflers and silencers shall be furnished for roof mounting to the enclosure. Fully insulated mufflers and silencers may be internally mounted if thermal performance is not compromised.
9. All seams shall be caulked with body sealer. The enclosure shall be prepped, primed with self-etching primer suitable for the material used in the construction of the enclosure. Final coating shall be powder coat. Supply the owner with a color selection fan-deck (180 colors, minimum) that shall include standard and premium industrial colors. Include color sample chips for final selection as requested by owner. Final enclosure exterior color selection shall be by owner.
10. A 100A 1-phase 240S/120V 12-circuit sub-panel with 100A main circuit breaker, 20amp branch breakers, and an associated approximate 30kVA 480x240S/120V transformer.
11. A 120V LED lighting system shall be incorporated into the enclosure which will produce 40-50 foot-candles on the floor as well as associated 3-way switches at each door.
12. Four GFCI receptacles shall be located within the enclosure where likely to be needed during maintenance.

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

2.6 STARTING SYSTEM

A. Starting shall be initiated by a 24VDC electric system with negative ground.

B. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.

C. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

D. Cranking Cycle: As required by NFPA 110 for system level specified.

E. Cranking Duration: Sufficient capacity to crank the engine at starting speed for one minute without overheating.

F. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.

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

H. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.

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

J. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
   1. Operation: Automatic, two-rate, equalizing-charger with maximum rate of 10A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   2. Construction: An SCR-controlled, replaceable printed circuit board installed in an enclosure with high/low rate potentiometers, ammeter, and charger status (power) light. Include a status control relay to allow three function options:
      a. Disconnect during cranking only.
      b. Disconnect during generator set operation.
      c. Continuous battery monitoring.
   3. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F (minus 40 deg C) to 140 deg F (plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
   4. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   5. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
   6. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage

and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

7. Protection: Fused input and output suitable for installation.
8. Enclosure and Mounting: NEMA-12 wall-mounted cabinet within generator enclosure.

K. NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.

2.7 COOLING SYSTEM

A. The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction. The cooling system shall be sized to maintain safe operation at 50°C maximum ambient temperature at 5,000ft above sea level.

B. Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine/gear-driven coolant pump with blower type fan and a radiator duct adapter to allow for direct exhausting of used cooling air.

C. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

D. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.

E. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant-system pressure for engine used. Equip with gauge glass and petcock.

F. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

G. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
   1. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
   2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. Radiator system shall be capable of maintaining a safe engine temperature in ambient temperature of 115°F.

I. Radiator air-flow restriction of 0.5 inches of water maximum.

2.8 DIESEL FUEL-OIL SYSTEM

A. UL approved and comply with NFPA 30.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel. Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

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

D. Shall include a fuel priming pump.

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

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

G. Sub-base Fuel Tank: Factory-fabricated fuel tank assembly of a 12-gauge steel construction complete with baffles, drain, fuel inlet, vent, fill cap fuel level gauge, fuel level light, and the following features:

1. Containment: Double-wall.

    a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of tank leak. Shall be wired into the common alarm signal.

2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of twenty-four hours' operation at 100 percent of rated power output of engine generator system without being refilled.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel-supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. Piping Connections: Factory-installed fuel-supply and return lines, from tank to engine; local fuel fill; vent line; overflow line; and tank drain line with shutoff valve.
6. Shall incorporate conduit entry openings.

2.9 CONTROL AND MONITORING

A. Functional Requirement: The generator is to operate in a close-transition fashion. The generator set shall include control equipment and programming, as well as voltage matching and breaker operation components, to incorporate the functional requirements listed herein. Generator breakers shall rest in the open position until closed by command. Utility breakers will rest in the closed position until actuated by the control system.

B. Comply with UL 508A.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

D. Control and Monitoring Panel:

1. Generator-mounted, NEMA-12 enclosure on vibration isolators, completely wired with a provision for padlocking.
2. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
3. Instruments: Located on the control and monitoring panel, digital sensors with inputs to a digital control panel, and viewable during operation:

    a. Engine lubricating-oil temperature gauge.
    b. Engine lubricating-oil pressure gauge.
    c. Engine-coolant temperature gauge.
    d. DC voltmeter (alternator battery charging).
    e. Battery charging indicator.
    f. Engine running-time meter (hours).
    g. Phase selector switch.
    h. AC voltmeter, for each phase.
    i. AC ammeter, for each phase.
    j. AC frequency meter.
    k. Generator-voltage-adjusting rheostat.
    l. Oil Pressure Engine Fault Indicator.
    m. Coolant Temperature Engine Fault Indicator.
    n. Overspeed Engine Fault Indicator.
    o. Run indication light.
    p. Not in Auto indication.

4. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:

    a. Cranking control equipment.
    b. Three-position Run-Off-Auto switch.
    c. Alarm Reset pushbutton.
    d. Control switch not in automatic position alarm.
    e. Adjustable reset timers.
    f. Overcrank alarm.
    g. Overcrank shutdown device.
    h. Low water temperature alarm.
    i. High engine temperature pre-alarm.
    j. High engine temperature.
    k. High engine temperature shutdown device.
    l. Overspeed alarm.
    m. Overspeed shutdown device.
    n. Low-fuel main tank.

        1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for the duration required for the indicated EPSS class.

    o. Coolant low-level alarm.
    p. Coolant high-temperature prealarm.
    q. Coolant high-temperature alarm.
    r. Coolant low-temperature alarm.
    s. Coolant high-temperature shutdown device.
    t. EPS load indicator.

u. Battery high-voltage alarm.
v. Low-cranking voltage alarm.
w. Battery-charger malfunction alarm.
x. Battery low-voltage alarm.
y. Lamp test.
z. Contacts for local and remote common alarm.
aa. Low-starting air pressure alarm.
bb. Low-starting hydraulic pressure alarm.
cc. Remote manual-stop shutdown device.
dd. Air shutdown damper alarm when used.
ee. Air shutdown damper shutdown device when used.
ff. Alarm horn and silence switch.
gg. Panel illumination lights ON/OFF switch.
hh. Lamp push to test switch.
ii. Auxiliary Run relays.

E. Contactor based alarm terminal board for signals shall include:
1. Engine failure. (common alarm)
2. Low fuel level.
3. Switch not-in-auto.
4. Low battery voltage. (common alarm)
5. Generator run.
6. Transfer-switch indication.
7. Generator breaker open/tripped. (common alarm)
8. Auto hand switch.

F. Control Interface Terminal board shall include:
1. Start/Stop Control
2. Generator Run-Off-Auto (dry-contacts)
3. Common Alarm (dry-contacts)
4. Low Fuel Alarm (dry-contacts)
5. Generator Running (dry-contacts)

G. All alarm and status contacts shall be brought out to terminal strips and numbered and identified.

H. All engine contacts shall be capable of 10A, 120VAC Form-C type.

I. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

J. All relays shall be of the plug-in enclosed type.

K. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

L. Provide connection terminals for a series switch to be connected to the Emergency Stop Switch for Fire Department use. This shall be a normally closed switch. The terminals shall be jumpered if not required for this purpose. Opening this circuit shall halt and prevent generator operation.

M. Adjustable overall cranking cycle of 60 to 120 seconds with reset periods adjustable from 10 to 30 seconds. The control system shall provide for three cranking cycles of approximately 20 seconds duration each. The starting circuit shall be automatically disconnected when the engine starts. If the engine fails to start, a cranking limiter shall disconnect the starting circuit and shall lock out the control, and the FAIL TO START alarm shall be initiated.

N. Generator mode of operation shall be determined by a 4-position selector switch with functions labeled as HAND-OFF-AUTOMATIC-TEST (HOAT).

O. When the generator HOAT switch is in HAND position, generator and transfer control shall be as follows:
   1. The call to start the MV generator will be initiated.
   2. Transfer control shall ensure the utility breaker is closed.
   3. Transfer control shall ensure the generator breaker is open.
   4. Generator shall run until there is a change in mode of operation by the selector switch.

P. When the HOAT switch is in the OFF position:
   1. It shall not be possible to start the generator set.
   2. If the generator set is running, it shall immediately shut-down with no cool-down sequence.
   3. In either case, the generator breaker shall be reset to the open position.

Q. When the generator HOAT switch is in AUTOMATIC position, generator and transfer control shall be as follows:
   1. Upon loss of utility (normal) voltage, the transfer control program, after an adjustable delay, shall start the MV generator. Upon generator power quality being acceptable, the transfer control shall open the utility breaker and then shall close the generator breaker to power the MV bus.
   2. Upon return of power, the generator control system shall initiate a voltage magnitude, phase angle, and frequency synchronizing algorithm with the incoming utility voltage signal. Once the generator has achieved a matching voltage signal, the utility breaker shall be closed, with electrical power and operation uninterrupted – for a complete closed-transition. After a programmable delay, the generator breaker will be opened and after an adjustable cooling delay, the generator will turn off.
   3. The utility and generator breaker controls shall be electrically coordinated, utilizing mechanically actuated auxiliary contacts, to allow for open-transition from utility to generator and closed-transition from generator to utility. Transfer controls shall incorporate fail-safe mechanisms which will account for normal or abnormal conditions including component failures and operator errors.
   4. Cooling cycle: When the generator is released, begin the cool-down period, adjustable from 0 to 30 minutes. This time delay shall be set in accordance with the recommendations of the standby generator supplier.

R. When the generator HOAT switch is in TEST position, generator and transfer control shall be as follows:
   1. The call to start the MV generator will be initiated.
   2. The generator control system shall initiate a voltage magnitude, phase angle, and frequency synchronizing algorithm with the incoming utility voltage signal. Once the generator has achieved a matching voltage signal, the generator breaker shall be closed, with electrical power and operation uninterrupted - for a complete closed-transition. After a programmable delay, the utility breaker will be opened.

3. Switching the HOAT switch to the AUTOMATIC position shall terminate the TEST mode. Upon switching the HOAT switch to the AUTOMATIC position, the generator control system shall initiate a voltage magnitude, phase angle, and frequency synchronizing algorithm with the incoming utility voltage signal. Once the generator has achieved a matching voltage signal, the utility breaker shall be closed, with electrical power and operation uninterrupted - for a complete closed-transition. After a programmable delay, the generator breaker will be opened and the cooling cycle shall commence.
4. Cooling cycle: When the generator is released, begin the cool-down period, adjustable from 0 to 30 minutes. This time delay shall be set in accordance with the recommendations of the standby generator supplier.

S. Generator unit shall incorporate a lockable DC-switch which shall remove the battery connections to the run circuit.

T. The control system shall include a programmable delay of 0-30 seconds delay between any HOAT switch position changes.

U. The protective functions shall be active, regardless of the position of the HAND-OFF-AUTO-TEST switch or other selector switches.

2.10 GENERATOR OVER-CURRENT AND FAULT PROTECTION

A. Over-current protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

1. Over-current protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Protective Relay: GE489, Beckwith M-3410A, Beckwith M-3425A (or pre-approved equal).

C. Generator Main Line Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Type: 400A frame, 350A trip LSIG
2. Tripping Characteristics: Adjustable long-time and short-time delay, instantaneous, and ground-fault sensing.
3. Trip Settings: Selected to coordinate with generator thermal damage curve.
4. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices through generator set 24VDC battery supply.
5. Mounting: On generator output, adjacent to or integrated with control and monitoring panel, within NEMA-12 enclosure.
6. Generator Main Line Circuit Breaker shall include lockout capability.

D. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open

the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As over-current heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other over-current devices and controls recovery of rated voltage to avoid overshoot.

E. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Trip generator protective device on ground fault.

2.11 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

B. Shall be of a salient pole synchronous type generator with a temperature rise not to exceed 130°C.

C. Single bearing flange mounted design. Bearing to be laminated, steel, semi-flexible, piloting device. The couplings shall be properly guarded to prevent injury to personnel.

D. Excitation through a permanent magnet generator (PMG)

E. Comply with NEMA MG 1.

F. Electrical Insulation: Class H.

G. Range: Provide limited range of output voltage by adjusting the excitation level.

H. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over-speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

I. Enclosure: Drip-proof.

J. Instrument Transformers: Mounted within generator enclosure.

K. Voltage Regulator: Solid-state, volts-per-hertz type, separate from exciter, providing performance as specified and as required by NFPA 110. Voltage Regulation shall be a stand-alone unit and not integrated into the generator control panel.

1. Adjusting Rheostats on Control and Monitoring Panel: Provide manual control for plus or minus 5 percent adjustment of output-voltage operating band, voltage-drop, and voltage-gain.
2. Maintain voltage within 30 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 15 percent and stabilize at rated frequency within five seconds.
5. Printed circuit board and power control diodes shall be hermetically sealed for moisture protection.

L. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

M. Subtransient Reactance: 12 percent, maximum.

N. Skid-mounted design.

O. Incorporate a power terminal cabinet with adequate size for connection of load conductors.

2.12 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene separated by steel shims.
2. Shore A Scale Durometer Rating: 50.
3. Number of Layers: Two.
4. Minimum Deflection: 1 inch (25 mm).

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint mounted to structure steel base tank.

1. Housing: Steel with resilient, vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 1 inch (25 mm).

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

2.13 LOAD BANK AND CONTROLLER

A. Radiator-mounted, manually-controlled load bank installed within the generator enclosure. Load bank to be 50% generator capacity in two equal steps. Include all accessories such as cables, connections, control power transformers, and disconnect circuit breaker, ventilation fans, enclosure, and indication/control panel.

2.14 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Comply with NECA 1 and NECA 404.

C. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

D. Equipment Mounting:

1. Install packaged engine generators with sub-base fuel tanks on cast-in-place concrete equipment bases.
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

E. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

F. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

G. Fuel Piping:
1. Copper and galvanized steel shall not be used in the fuel-oil piping system.

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

3.2 CONNECTIONS

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

B. Connect cooling-system water piping to engine generator and heat exchanger with flexible connectors.

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

D. Connect fuel piping to engines with a gate valve and union and flexible connector.

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

F. Connect wiring according to applicable electrical power conductor and cable sections of this specification. Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

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

3.3 IDENTIFICATION

A. Identify system components as necessary for HVAC piping and equipment and according to "Identification for Electrical Systems."

3.4 FACTORY TEST WITNESS PROVISION

A. Generator supplier shall provide the owner with a full-load test to witness at the factory.

B. Factory tests shall be made in a testing cell designed for full-load testing.

C. Factory tests shall require owner approval prior to shipping the final product for installation at the project site.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a NETA certified, qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Perform tests recommended by manufacturer and in "Visual and Mechanical Inspection" and "Electrical and Mechanical Tests" subparagraphs below, as specified in the NETA ATS. Certify compliance with test parameters.

    a. Visual and Mechanical Inspection:

        1) Compare equipment nameplate data with Drawings and the Specifications.
        2) Inspect physical and mechanical condition.
        3) Inspect anchorage, alignment, and grounding.
        4) Verify that the unit is clean.

    b. Electrical and Mechanical Tests:

        1) Perform insulation-resistance tests according to IEEE 43.

            a) Machines Larger Than 200 hp (150 kW): Test duration shall be 10 minutes. Calculate polarization index.
            b) Machines 200 hp (150 kW) or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

        2) Test protective relay devices.
        3) Verify phase rotation, phasing, and synchronized operation as required by the application.
        4) Functionally test engine shutdown for low oil pressure, over-temperature, over-speed, and other protection features as applicable.
        5) Conduct performance test according to NFPA 110.
        6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. 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.
6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
7. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.

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

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

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

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

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

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

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

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component, indicating satisfactory completion of tests.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative for 2-hours of two persons each to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators, at the project site.

B. Simulate power outage by interrupting normal source; demonstrate that the system operates to provide standby power.

END OF SECTION 263213

SECTION 263213

DIESEL MEDIUM VOLTAGE GENERATOR SET

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes details to cover work required to furnish, install, start-up, test, and document the packaged medium-voltage standby-power diesel engine generator set to include the following features:

1. Diesel engine.
2. Starting system.
3. Cooling system.
4. Diesel fuel-oil system with sub-base tank.
5. Engine exhaust & silencer.
6. Control and monitoring.
7. Battery and charger.
8. Generator over-current and fault protection.
9. Generator, exciter, and voltage regulator.
10. Vibration isolation devices.
11. Load bank and controller.

1.2 REFERENCES

A. In all cases, referenced specifications, codes and standards shall be the most recently published editions or the version currently adopted by the authority having jurisdiction.

B. National Electrical Manufacturers Association (NEMA)
1. NEMA MG 1 – Motors and Generators

C. International Electrical Testing Association (NETA):
1. NETA ATS – Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems

D. National Fire Protection Association (NFPA)
1. NFPA 30 – Flammable and Combustible Liquids Code
2. NFPA 37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
3. NFPA 70 – National Electrical Code (NEC)
4. NFPA 110 – Standard for Emergency and Standby Power Systems

1.3 SYSTEM DESCRIPTION

A. General: Standby engine generator set rated to serve continuously during interruption of prime electrical power and required auxiliaries, accessories, and controls to provide source of power, as specified herein, according to NFPA 110.

B. Capacity: Approximately 1500 kW, 2000 kVA at 4,160V 3-Phase. See performance and sizing calculation submittal requirements as well as electrical drawings for details.

1.4 ACTION SUBMITTALS

A. Bill of Materials: A listing shall include all of the panels, racks, instruments, components, and devices provided under this section.

B. Equipment tabulating all components furnished, followed by the manufacturer's name, manufacturer's model number, and a cross-reference to its location on the shop drawings.

C. Product Data: For each type of product. Drawings and descriptive (catalog) data and brochures of each item of equipment including technical data sheets for the engine and generator.
   1. Diesel engine data.
      a. Manufacturer
      b. Model
      c. Revolutions per minute (rpm)
      d. Rated capacity brake horsepower (bhp)
      e. Make and model of governor
      f. Piston displacement (cubic inches)
      g. Guaranteed fuel consumption rate in gallons per hour at:
         1) Full Load
         2) 3/4 Load
         3) 1/2 Load
   2. Generator Data
      a. Manufacturer
      b. Model
      c. Rated kVA
      d. Rated kW
      e. Voltage
      f. Temperature rise above 40°C ambient at rated output with 80% power factor
      g. Generator efficiency including excitation losses at
         1) Full Load
         2) 3/4 Load
         3) 1/2 Load
      h. Voltage dip calculations with specified loading (see electrical drawings).
   3. Engine-generator unit and accessories to include:
      a. Enclosure
      b. Accessory sub-panel & transformer
      c. Control panels
      d. Voltage Regulator
      e. Fuel System
      f. Exhaust System
      g. Batteries

h. Battery Charger
i. Water Jacket Heater
j. Load Bank Unit
k. Load Bank Controller
l. other accessories not listed here
m. Manufacturer
n. Model
o. Catalog data/cutsheets
p. Weight of skid-mounted unit
q. Overall length
r. Overall width
s. Overall height
t. Exhaust pipe size
u. Cubic feet per minute (cfm) of air required for combustion and also for ventilation.
v. Heat rejected to enclosure by engine and generator in Btu/hr.
w. Cooling air volume required
x. Total efficiency of the unit
y. Emissions certification
z. Sound data (enclosure performance data)

4. Generator Circuit Breaker
   a. Catalog data
   b. Recommended trip settings for all adjustable settings
   c. Short-circuit interrupting ratings

D. Shop Drawings:
   1. Identify electrical connection requirements and characteristics.
   2. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   4. Identify fluid drain ports and clearance requirements for proper fluid drain.
   5. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
   7. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for equipment and functional relationship between all electrical components. Generator winding data and connection diagrams. Include battery charger and water jacket power requirements.

E. Certified foundation and anchor bolt plans for all floor/concrete–mounted equipment. Include sizing and structural calculations for required anchoring and seismic bracing equipment for seismic considerations stamped by a Professional Engineer licensed in the State of Nevada.

F. Departure from Drawings: Submit to the Engineer, in writing for review, details of any necessary proposed departures from these contract documents, and the reasons therefore, as soon as practicable and within 30-days after the award of the contract. Make no such departures without the prior written approval of the engineer.

G. Description of operation.

H. Test procedures, syllabus of training and a schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Sizing Calculation: Generator supplier to submit a project specific sizing calculation for engineering review and approval. Loading as shown on the electrical drawings. Submitted generator set equipment shall not to exceed 80% of de-rated capacity. De-rated capacity shall take into consideration project elevation and temperature at the proposed installation site.

B. Seismic Qualification Data: Certificates for engine generator, accessories, and components, from manufacturer.

C. Source quality-control reports.

D. Certified test reports: Indicate results of performance testing.

E. Field quality-control reports: Inspections, findings, and recommendations.

F. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data: Include six (6) copies of the instructions and service manuals for normal operation, routine maintenance, oil sampling, analysis for engine wear, and emergency maintenance procedures. The manual shall be bound in a 9-inch by 12-inch size binder. Include a table of contents with all pages neatly assembled and fit within the manual cover.

B. For each section provide the following information as applicable:
1. Itemized list for all data provided.
2. Name and location of the manufacturer and the manufacturer's local representative, nearest suppliers, and spare parts warehouse.
3. Recommended installation, adjustment, start-up, calibration, and trouble-shooting procedures.
4. Recommended lubrication, lubrication intervals, and estimate of yearly quantity needed.
5. Recommended step-by-step procedures for all modes of operation.
6. Complete internal and connection wiring diagrams.
7. Recommended preventative maintenance procedures for all modes of operation.
8. Complete parts lists, by generic title and identification number.
9. Recommended spare parts and special tools.
10. Disassembly, overhaul, and reassembly instructions.
11. All approved shop drawing information pertinent to facility operation and maintenance.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, with service facilities within 50 miles of this project. Manufacturer shall be ISO 9001 or 9002 certified. The generator set shall be certified

by the engine manufacturer to be suitable for use at the installed location and rating and shall meet all applicable exhaust emission requirements at the time of commissioning at the location installed for standby power. Provide certification that the engine-generator complies with the requirements of Federal, State, and Local Agencies.

B. Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience. Supplier shall take unit responsibility for the entire medium voltage standby diesel engine generator system, to provide a complete and operable system that meets all the requirements of these contract documents. The medium voltage standby diesel engine generator supplier shall be responsible for the selection, design, manufacture, installation, and testing of the equipment specified herein to ensure complete compatibility of the elements of the standby generator system with other equipment installed, new and existing, at the facility. The generator-set supplier shall coordinate with all associated system suppliers and installers to ensure the installation dimensions, connections, and requirements are compatible.

C. Installer: An authorized representative who is trained and approved by manufacturer.

D. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA for on-site testing.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at the time of shipment.

B. Equipment shall withstand the mechanical stresses caused by rough handling during shipment in addition to the electrical and mechanical stresses, which occur during operation of the system. Protect radiator core with wood sheet.

C. Store in a location as agreeable with the engineer, secure from weather or accidental damage. If stored outdoors, indoor gear shall be covered and heated, and outdoor gear shall be heated.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Furnish written manufacturer warranty for on-site parts and labor.

2. Warranty Period: 2 years from date of successful generator startup, not to exceed 90-days from date of delivery.

1.10 MAINTENANCE SERVICE

1. Furnish service and maintenance of engine generator for one year from date of successful generator startup, not to exceed 90-days from date of delivery.

1.11 MAINTENANCE MATERIALS

1. Furnish two of each: fuel, oil, and air filter elements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide first-quality new materials, free from defects and suitable for the intended use and the space provided. Provide equipment compliant with requirements set forth in the contact documents and standards which have been locally established. As a minimum, provide equipment which meets the requirements of:
   1. UL 508 (Electric Industrial Controls)
   2. UL 142 (Sub Base Fuel Tanks)
   3. UL 1236 (Battery Chargers)
   4. UL 2200 (Generator Sets)
   5. UL 499 (Heaters)

B. Furnish and install all incidental items not specifically shown or specified which are required by good practice to provide the complete system specified herein.

2.2 MANUFACTURERS

A. Cummins/ONAN

B. Caterpillar Inc.

C. MTU Onsite Energy

D. Generac Power Systems

E. Kohler Industrial Power

F. Katolight

G. Taylor Power Systems

H. Gillette Manufacturing

I. Substitutions: TMWA approved alternate only.

J. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.3 PERFORMANCE REQUIREMENTS

A. As a minimum, the standby generator shall have a continuous rating for stepped loads as specified on the electrical drawings. The contractor is responsible for coordinating functional

requirements with various equipment suppliers to furnish a complete, fully-integrated and operational system.

B. Seismic Performance: Engine generator housing, day tank, engine generator, batteries, battery racks, silencers, sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels. Water shall be substituted for diesel fuel in fuel tank during test
3. Component Importance Factor: 1.5.

C. B11 Compliance: Comply with B11.19.

D. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 EPSS.

E. UL Compliance: Comply with UL 2200.

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

G. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

H. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: -20 to 115 deg F (-29 to 46 deg C).
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 4500 feet (1372 m).

I. The generator set shall be provided with a sound-absorbing housing with interior lighting. It shall have sufficient clearances for routine maintenance and shall have code required clearances.

J. Sufficient capacity to operate under 110% of nameplate rating for one hour in specified ambient environmental conditions.

2.4 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled, four-stroke cycle, compression ignition diesel internal combustion engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. EPSS Class: Engine generator shall be classified as a Class 2 according to NFPA 110.

D. Service Load: shown on Electrical Sheets.

E. Power Factor: 0.8, lagging.

F. Frequency: 60 Hz.

G. Voltage: 4160 Vac.

H. Phase: Three-phase, four-wire wye.

I. Induction Method: Turbocharged.

J. Governor: Electronic, adjustable isochronous, with speed sensing. Shall maintain engine speed at precise rated frequency with operation within 0.25 percent steady-state, 5 percent no-load to full-load, and recovery to steady-state within 2 seconds following load changes. Governor shall not permit frequency modulation to exceed ¼ cycle per second. Governor shall be a stand-alone unit and not integrated into the generator control panel.

K. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

L. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

M. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage, from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency, from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10 system requirements.

2.5 DIESEL ENGINE

A. Fuel: ASTM D 975 diesel fuel oil, Grade 2-D S15.

B. Rated Engine Speed: 1800 rpm (maximum nominal).

C. The complete engine block shall be machined from one casting. Designs incorporating multiple blocks bolted together are not acceptable.

D. The engine shall receive a prime coat, and two coats of industrial paint suitable for the intended use. Contractor to supply owner a selection of finish coat color from manufacturer's standard colors.

E. All exposed rotating parts of the engine shall be provided with guards for protection of personnel per OSHA requirements.

F. Lubrication System: Engine or skid mounted.

1. Shall incorporate a gear type lube oil pump to furnish oil pressure to moving parts.
2. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow. Shall incorporate a bypass valve that will allow circulation in case of filtration system failure.
3. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe and shall incorporate a oil cooler system.
4. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
5. Lubrication oil as recommended by the engine manufacturer for job conditions.

G. Batteries: Four 8D heavy-duty 24VDC, diesel starting type lead-acid storage batteries mounted on a acid resistant material battery rack. Furnish battery cables of adequate size and length, minimum #4/0 AWG DLO.

H. Engine Jacket Heater: Two 240V thermal-circulation, electric-immersion type heaters, factory installed in coolant jacket system with integral thermostatic control, sized to maintain engine jacket coolant between 120°F and 140°F in an ambient temperature of -20°F. Heater mechanical connections shall have isolation valves. Heaters shall be hard-wired, no plugs.

I. Muffler/Silencer: Heavy-duty, welded construction, critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Include a seamless stainless-steel flexible exhaust connector.
3. Shall be supported independently to prevent transmission of vibration and allow for expansion. Use long radius, low restriction fittings.

J. Sound-attenuated, weather-proof enclosure: baffled, sound-attenuating insulation.

1. Sound level measured at a distance of 23 feet (7 m) from exhaust discharge after installation is complete shall be 85 dBA or less.
2. Be vandal resistant and lockable with three point handle operated latches. It shall not be possible to access or operate equipment without a key.
3. The roof shall have a positive camber for water runoff. The exhaust outlet(s) shall be supplied with rain guard(s) at least 1-inch above the enclosure to prevent moisture from entering the enclosure.
4. The base of the enclosure shall be designed for skid base installation and shall include a means for fastening to the concrete slab. Anchor points, isolators and anchors shall be designed for the site specific seismic zone.
5. Air openings shall include fixed louvers sized to allow proper air flow. Frames shall be manufactured from 14-gauge steel. The blades and the fronts shall be covered with 14-guage expanded screen.
6. Single doors shall be a minimum of 30-inches wide. Double doors shall be 60-inches wide. All doors shall have stainless steel hinges and be fully weather stripped. Doors shall be removable.
7. Doors and walls shall be insulated with sound attenuating material.
8. Mufflers and silencers shall be furnished for roof mounting to the enclosure. Fully insulated mufflers and silencers may be internally mounted if thermal performance is not compromised.
9. All seams shall be caulked with body sealer. The enclosure shall be prepped, primed with self-etching primer suitable for the material used in the construction of the enclosure. Final coating shall be powder coat. Supply the owner with a color selection fan-deck (180 colors, minimum) that shall include standard and premium industrial colors. Include color sample chips for final selection as requested by owner. Final enclosure exterior color selection shall be by owner.
10. A 100A 1-phase 240S/120V 12-circuit sub-panel with 100A main circuit breaker, 20amp branch breakers, and an associated approximate 30kVA 480x240S/120V transformer.
11. A 120V LED lighting system shall be incorporated into the enclosure which will produce 40-50 foot-candles on the floor as well as associated 3-way switches at each door.
12. Four GFCI receptacles shall be located within the enclosure where likely to be needed during maintenance.

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

2.6 STARTING SYSTEM

A. Starting shall be initiated by a 24VDC electric system with negative ground.

B. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.

C. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

D. Cranking Cycle: As required by NFPA 110 for system level specified.

E. Cranking Duration: Sufficient capacity to crank the engine at starting speed for one minute without overheating.

F. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.

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

H. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.

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

J. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
   1. Operation: Automatic, two-rate, equalizing-charger with maximum rate of 10A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   2. Construction: An SCR-controlled, replaceable printed circuit board installed in an enclosure with high/low rate potentiometers, ammeter, and charger status (power) light. Include a status control relay to allow three function options:
      a. Disconnect during cranking only.
      b. Disconnect during generator set operation.
      c. Continuous battery monitoring.
   3. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F (minus 40 deg C) to 140 deg F (plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
   4. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   5. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
   6. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage

and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

7. Protection: Fused input and output suitable for installation.
8. Enclosure and Mounting: NEMA-12 wall-mounted cabinet within generator enclosure.

K. NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.

2.7 COOLING SYSTEM

A. The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction. The cooling system shall be sized to maintain safe operation at 50°C maximum ambient temperature at 5,000ft above sea level.

B. Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine/gear-driven coolant pump with blower type fan and a radiator duct adapter to allow for direct exhausting of used cooling air.

C. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

D. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.

E. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant-system pressure for engine used. Equip with gauge glass and petcock.

F. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

G. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
   1. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
   2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. Radiator system shall be capable of maintaining a safe engine temperature in ambient temperature of 115°F.

I. Radiator air-flow restriction of 0.5 inches of water maximum.

2.8 DIESEL FUEL-OIL SYSTEM

A. UL approved and comply with NFPA 30.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel. Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

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

D. Shall include a fuel priming pump.

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

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

G. Sub-base Fuel Tank: Factory-fabricated fuel tank assembly of a 12-gauge steel construction complete with baffles, drain, fuel inlet, vent, fill cap fuel level gauge, fuel level light, and the following features:

1. Containment: Double-wall.

    a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of tank leak. Shall be wired into the common alarm signal.

2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of twenty-four hours' operation at 100 percent of rated power output of engine generator system without being refilled.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel-supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. Piping Connections: Factory-installed fuel-supply and return lines, from tank to engine; local fuel fill; vent line; overflow line; and tank drain line with shutoff valve.
6. Shall incorporate conduit entry openings.

2.9 CONTROL AND MONITORING

A. Functional Requirement: The generator is to operate in a close-transition fashion. The generator set shall include control equipment and programming, as well as voltage matching and breaker operation components, to incorporate the functional requirements listed herein. Generator breakers shall rest in the open position until closed by command. Utility breakers will rest in the closed position until actuated by the control system.

B. Comply with UL 508A.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

D. Control and Monitoring Panel:

1. Generator-mounted, NEMA-12 enclosure on vibration isolators, completely wired with a provision for padlocking.
2. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
3. Instruments: Located on the control and monitoring panel, digital sensors with inputs to a digital control panel, and viewable during operation:

    a. Engine lubricating-oil temperature gauge.
    b. Engine lubricating-oil pressure gauge.
    c. Engine-coolant temperature gauge.
    d. DC voltmeter (alternator battery charging).
    e. Battery charging indicator.
    f. Engine running-time meter (hours).
    g. Phase selector switch.
    h. AC voltmeter, for each phase.
    i. AC ammeter, for each phase.
    j. AC frequency meter.
    k. Generator-voltage-adjusting rheostat.
    l. Oil Pressure Engine Fault Indicator.
    m. Coolant Temperature Engine Fault Indicator.
    n. Overspeed Engine Fault Indicator.
    o. Run indication light.
    p. Not in Auto indication.

4. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:

    a. Cranking control equipment.
    b. Three-position Run-Off-Auto switch.
    c. Alarm Reset pushbutton.
    d. Control switch not in automatic position alarm.
    e. Adjustable reset timers.
    f. Overcrank alarm.
    g. Overcrank shutdown device.
    h. Low water temperature alarm.
    i. High engine temperature pre-alarm.
    j. High engine temperature.
    k. High engine temperature shutdown device.
    l. Overspeed alarm.
    m. Overspeed shutdown device.
    n. Low-fuel main tank.

        1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for the duration required for the indicated EPSS class.

    o. Coolant low-level alarm.
    p. Coolant high-temperature prealarm.
    q. Coolant high-temperature alarm.
    r. Coolant low-temperature alarm.
    s. Coolant high-temperature shutdown device.
    t. EPS load indicator.

u. Battery high-voltage alarm.
v. Low-cranking voltage alarm.
w. Battery-charger malfunction alarm.
x. Battery low-voltage alarm.
y. Lamp test.
z. Contacts for local and remote common alarm.
aa. Low-starting air pressure alarm.
bb. Low-starting hydraulic pressure alarm.
cc. Remote manual-stop shutdown device.
dd. Air shutdown damper alarm when used.
ee. Air shutdown damper shutdown device when used.
ff. Alarm horn and silence switch.
gg. Panel illumination lights ON/OFF switch.
hh. Lamp push to test switch.
ii. Auxiliary Run relays.

E. Contactor based alarm terminal board for signals shall include:
1. Engine failure. (common alarm)
2. Low fuel level.
3. Switch not-in-auto.
4. Low battery voltage. (common alarm)
5. Generator run.
6. Transfer-switch indication.
7. Generator breaker open/tripped. (common alarm)
8. Auto hand switch.

F. Control Interface Terminal board shall include:
1. Start/Stop Control
2. Generator Run-Off-Auto (dry-contacts)
3. Common Alarm (dry-contacts)
4. Low Fuel Alarm (dry-contacts)
5. Generator Running (dry-contacts)

G. All alarm and status contacts shall be brought out to terminal strips and numbered and identified.

H. All engine contacts shall be capable of 10A, 120VAC Form-C type.

I. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

J. All relays shall be of the plug-in enclosed type.

K. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

L. Provide connection terminals for a series switch to be connected to the Emergency Stop Switch for Fire Department use. This shall be a normally closed switch. The terminals shall be jumpered if not required for this purpose. Opening this circuit shall halt and prevent generator operation.

M. Adjustable overall cranking cycle of 60 to 120 seconds with reset periods adjustable from 10 to 30 seconds. The control system shall provide for three cranking cycles of approximately 20 seconds duration each. The starting circuit shall be automatically disconnected when the engine starts. If the engine fails to start, a cranking limiter shall disconnect the starting circuit and shall lock out the control, and the FAIL TO START alarm shall be initiated.

N. Generator mode of operation shall be determined by a 4-position selector switch with functions labeled as HAND-OFF-AUTOMATIC-TEST (HOAT).

O. When the generator HOAT switch is in HAND position, generator and transfer control shall be as follows:
   1. The call to start the MV generator will be initiated.
   2. Transfer control shall ensure the utility breaker is closed.
   3. Transfer control shall ensure the generator breaker is open.
   4. Generator shall run until there is a change in mode of operation by the selector switch.

P. When the HOAT switch is in the OFF position:
   1. It shall not be possible to start the generator set.
   2. If the generator set is running, it shall immediately shut-down with no cool-down sequence.
   3. In either case, the generator breaker shall be reset to the open position.

Q. When the generator HOAT switch is in AUTOMATIC position, generator and transfer control shall be as follows:
   1. Upon loss of utility (normal) voltage, the transfer control program, after an adjustable delay, shall start the MV generator. Upon generator power quality being acceptable, the transfer control shall open the utility breaker and then shall close the generator breaker to power the MV bus.
   2. Upon return of power, the generator control system shall initiate a voltage magnitude, phase angle, and frequency synchronizing algorithm with the incoming utility voltage signal. Once the generator has achieved a matching voltage signal, the utility breaker shall be closed, with electrical power and operation uninterrupted – for a complete closed-transition. After a programmable delay, the generator breaker will be opened and after an adjustable cooling delay, the generator will turn off.
   3. The utility and generator breaker controls shall be electrically coordinated, utilizing mechanically actuated auxiliary contacts, to allow for open-transition from utility to generator and closed-transition from generator to utility. Transfer controls shall incorporate fail-safe mechanisms which will account for normal or abnormal conditions including component failures and operator errors.
   4. Cooling cycle: When the generator is released, begin the cool-down period, adjustable from 0 to 30 minutes. This time delay shall be set in accordance with the recommendations of the standby generator supplier.

R. When the generator HOAT switch is in TEST position, generator and transfer control shall be as follows:
   1. The call to start the MV generator will be initiated.
   2. The generator control system shall initiate a voltage magnitude, phase angle, and frequency synchronizing algorithm with the incoming utility voltage signal. Once the generator has achieved a matching voltage signal, the generator breaker shall be closed, with electrical power and operation uninterrupted - for a complete closed-transition. After a programmable delay, the utility breaker will be opened.

3. Switching the HOAT switch to the AUTOMATIC position shall terminate the TEST mode. Upon switching the HOAT switch to the AUTOMATIC position, the generator control system shall initiate a voltage magnitude, phase angle, and frequency synchronizing algorithm with the incoming utility voltage signal. Once the generator has achieved a matching voltage signal, the utility breaker shall be closed, with electrical power and operation uninterrupted - for a complete closed-transition. After a programmable delay, the generator breaker will be opened and the cooling cycle shall commence.
4. Cooling cycle: When the generator is released, begin the cool-down period, adjustable from 0 to 30 minutes. This time delay shall be set in accordance with the recommendations of the standby generator supplier.

S. Generator unit shall incorporate a lockable DC-switch which shall remove the battery connections to the run circuit.

T. The control system shall include a programmable delay of 0-30 seconds delay between any HOAT switch position changes.

U. The protective functions shall be active, regardless of the position of the HAND-OFF-AUTO-TEST switch or other selector switches.

2.10 GENERATOR OVER-CURRENT AND FAULT PROTECTION

A. Over-current protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

1. Over-current protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Protective Relay: GE489, Beckwith M-3410A, Beckwith M-3425A (or pre-approved equal).

C. Generator Main Line Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Type: 400A frame, 350A trip LSIG
2. Tripping Characteristics: Adjustable long-time and short-time delay, instantaneous, and ground-fault sensing.
3. Trip Settings: Selected to coordinate with generator thermal damage curve.
4. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices through generator set 24VDC battery supply.
5. Mounting: On generator output, adjacent to or integrated with control and monitoring panel, within NEMA-12 enclosure.
6. Generator Main Line Circuit Breaker shall include lockout capability.

D. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open

the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As over-current heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other over-current devices and controls recovery of rated voltage to avoid overshoot.

E. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Trip generator protective device on ground fault.

2.11 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

B. Shall be of a salient pole synchronous type generator with a temperature rise not to exceed 130°C.

C. Single bearing flange mounted design. Bearing to be laminated, steel, semi-flexible, piloting device. The couplings shall be properly guarded to prevent injury to personnel.

D. Excitation through a permanent magnet generator (PMG)

E. Comply with NEMA MG 1.

F. Electrical Insulation: Class H.

G. Range: Provide limited range of output voltage by adjusting the excitation level.

H. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over-speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

I. Enclosure: Drip-proof.

J. Instrument Transformers: Mounted within generator enclosure.

K. Voltage Regulator: Solid-state, volts-per-hertz type, separate from exciter, providing performance as specified and as required by NFPA 110. Voltage Regulation shall be a stand-alone unit and not integrated into the generator control panel.

1. Adjusting Rheostats on Control and Monitoring Panel: Provide manual control for plus or minus 5 percent adjustment of output-voltage operating band, voltage-drop, and voltage-gain.
2. Maintain voltage within 30 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 15 percent and stabilize at rated frequency within five seconds.
5. Printed circuit board and power control diodes shall be hermetically sealed for moisture protection.

L. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

M. Subtransient Reactance: 12 percent, maximum.

N. Skid-mounted design.

O. Incorporate a power terminal cabinet with adequate size for connection of load conductors.

2.12 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene separated by steel shims.
2. Shore A Scale Durometer Rating: 50.
3. Number of Layers: Two.
4. Minimum Deflection: 1 inch (25 mm).

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint mounted to structure steel base tank.

1. Housing: Steel with resilient, vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 1 inch (25 mm).

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

2.13 LOAD BANK AND CONTROLLER

A. Radiator-mounted, manually-controlled load bank installed within the generator enclosure. Load bank to be 50% generator capacity in two equal steps. Include all accessories such as cables, connections, control power transformers, and disconnect circuit breaker, ventilation fans, enclosure, and indication/control panel.

2.14 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Comply with NECA 1 and NECA 404.

C. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

D. Equipment Mounting:

1. Install packaged engine generators with sub-base fuel tanks on cast-in-place concrete equipment bases.
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

E. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

F. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

G. Fuel Piping:
1. Copper and galvanized steel shall not be used in the fuel-oil piping system.

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

3.2 CONNECTIONS

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

B. Connect cooling-system water piping to engine generator and heat exchanger with flexible connectors.

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

D. Connect fuel piping to engines with a gate valve and union and flexible connector.

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

F. Connect wiring according to applicable electrical power conductor and cable sections of this specification. Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

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

3.3 IDENTIFICATION

A. Identify system components as necessary for HVAC piping and equipment and according to "Identification for Electrical Systems."

3.4 FACTORY TEST WITNESS PROVISION

A. Generator supplier shall provide the owner with a full-load test to witness at the factory.

B. Factory tests shall be made in a testing cell designed for full-load testing.

C. Factory tests shall require owner approval prior to shipping the final product for installation at the project site.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a NETA certified, qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Perform tests recommended by manufacturer and in "Visual and Mechanical Inspection" and "Electrical and Mechanical Tests" subparagraphs below, as specified in the NETA ATS. Certify compliance with test parameters.

    a. Visual and Mechanical Inspection:

        1) Compare equipment nameplate data with Drawings and the Specifications.
        2) Inspect physical and mechanical condition.
        3) Inspect anchorage, alignment, and grounding.
        4) Verify that the unit is clean.

    b. Electrical and Mechanical Tests:

        1) Perform insulation-resistance tests according to IEEE 43.

            a) Machines Larger Than 200 hp (150 kW): Test duration shall be 10 minutes. Calculate polarization index.
            b) Machines 200 hp (150 kW) or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

        2) Test protective relay devices.
        3) Verify phase rotation, phasing, and synchronized operation as required by the application.
        4) Functionally test engine shutdown for low oil pressure, over-temperature, over-speed, and other protection features as applicable.
        5) Conduct performance test according to NFPA 110.
        6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. 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.
6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
7. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.

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

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

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

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

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

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

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

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component, indicating satisfactory completion of tests.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative for 2-hours of two persons each to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators, at the project site.

B. Simulate power outage by interrupting normal source; demonstrate that the system operates to provide standby power.

END OF SECTION 263213