

SPECIAL SPECIFICATION

SECTION 16621S

PACKAGED ENGINE GENERATORS

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SPECIAL SPECIFICATION

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PACKAGED ENGINE GENERATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS.

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Section, apply to this Section.

1.02 SUMMARY

- A. This section includes packaged engine generator sets with the following features and accessories:
 - 1. Battery charger.
 - 2. Based-mounted fuel tank.
 - 3. Engine generator set.
 - 4. Muffler
 - 5. Outdoor enclosure
 - 6. Remote annunciator.
 - 7. Remote stop switch.
 - 8. Starting battery.
 - 9. Load bank.
 - 10. Load-bank remote-control panel.
- B. Related Sections include the following:
 - 1. **Division 13, Section 13085S “Seismic Protection”.**
 - 2. **Division 16 Section 16495S “Transfer Switches” for transfer switches, including sensors and relays to initiate automatic-starting and stopping signals for engine generator sets.**

1.03 DEFINITIONS

- A. Standby Rating: Power output equal to the power of the generator set delivers continuously under normally varying load factors for the duration of a power outage. Rating is at site conditions, as listed in Paragraph 2.02 of this specification section. Rating shall be at 0.8 power factor.
- B. Operational Bandwidth: The total variation from the lowest to the highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- C. Power Output Rating: Gross electrical power output of generator set minus total power requirements of electric motor-driven cooling fan and pump.
- D. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hz or cycles per second.

1.04 GENERATOR-SET PERFORMANCE, NOMINAL

- A. Stead-State Voltage Operational Bandwidth: 4 percent of rated output voltage from no load to full load.
- B. Steady-State Voltage Modulation Frequency: Less than one Hz.
- C. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage recovers to remain within the steady-state operating band within 2 seconds.
- D. Stead-State Frequency Operational Bandwidths: 0.5 percent of rated frequency from no load to full load.
- E. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there are no random speed variations outside the steady-state operational band and no hunting or surging of speed.
- F. Transient Frequency Performance: Less than 2-Hz variation for a 50 percent step-load increase or decrease. Frequency recovers to remain within the steady-state operating band within 3 seconds.
- G. Output Waveform: At no load, harmonic content measured line-to-line or line- to neutral does not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor, determined according to NEMA MG1, does not exceed 50.
- H. Sustained Short-Circuit Current: For a 3-Phase, bolted short circuit at the system output terminals, the system will supply a minimum of 250 percent of rated full-

load current for not less than 10 seconds and then clear the fault automatically, without damage to any generator system component.

- I. Temperature Rise of Generator: Within limits permitted by NEMA MG1 when operating continuously at full-rated load, including 2 hours per 24 hours at 110 percent of rated capacity.
- J. Starting Time: Maximum total time period for a cold start, with ambient temperature at the low end of the specified range, is 10 seconds. Time period includes output voltage and frequency settlement within specified steady-state bands.

1.05 SUBMITTALS

- A. Product Data: For each component. Include data on features, components, ratings, and performance. Include dimensioned outline plan and elevation drawings of engine generator set and other system components.
- B. Shop Drawings: Show detail of fabrication, piping, wiring, and installation of field-installed portions of system. Include general arrangement drawings showing locations of auxiliary components in relation to engine generator set and duct, piping, and wiring connections between generator sets and auxiliary equipment., Show connections, mounting and support provisions and access and workspace requirements.
 - 1. Wiring Diagrams: Show details of power and control connections and differentiating between factory-installed and field-installed wiring.
- C. Qualifications Data: For firms and persons specified in the “Quality Assurance” Article.
- D. Field Test and Observation Reports: Indicate and interpret test results for compliance with performance requirements.
- E. Certified summary of proto-type –unit test report.
- F. Certified Test Reports of Components and Accessories: For devices that are equivalent, but not identical, to those tested on prototype unit.
- G. Exhaust Emission Test Report: To show compliance with applicable regulations.
- H. Sound measurement test report.
- I. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.
- J. Field test report of tests specified in Part 3

- K. Maintenance data for system and components to include in the maintenance manuals. Include the following:
 - 1. List of tools and replacements items recommended to be stored at the site for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - 2. Detail operating instructions for both normal and abnormal conditions.
- L. Submit on the above per requirements of Section 01300S.

1.06 QUALITY ASSURANCE

- A. **Manufacturer Qualifications:** Engage a firm experienced in manufacturing equipment of types and capacities similar to those indicated for this Project and with a service center maintained by engine generator set manufacturer capable of providing training, parts, and emergency maintenance and repairs at the Project site with 4 hours maximum response time.
- B. **Testing Agency Qualifications:** An independent testing agency with the experience and capability to conduct testing indicated without delaying the Work as evaluated according to criteria contained in ASTM E699.
- C. **Source Limitations:** Obtain engine generator set and auxiliary components from a single manufacturer with responsibility for entire system. Furnish a representative product built from components that have proved reliable and compatible with each other and are coordinated to operate as a unit as evidence by records of prototype testing.
- D. **Listing and Labeling:** Provide system components of types and ratings for which listing or labeling service is established and components specified in this Section that are listed and labeled.
 - 1. The Terms “Listed” and “Labeled”’: As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” as defined in OSHA Regulation 1910.7.
- E. Comply with NFPA 70.
- F. Comply with NFPA 99.
- G. Comply with NFPA 110 requirements for Level 1 emergency power supply systems.
- H. **Engine Exhaust Emissions:** Comply with applicable state and local government requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. **Provide all labor, material and equipment, including crane, to offload engine generator set from delivery truck and set in final location.**
- B. **Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.**

1.08 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Submit a written warranty signed by Contractor and manufacturer, with single – source responsibility for engine generator and auxiliary components, agreeing to repair or replace items that do not meet requirements or that deteriorate as defined in this Section within the specified warranty period.
- C. Warranty Period: 2 years from date of Substantial Completion.

1.09 MAINTENANCE SERVICE

- A. Maintenance: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of the manufacturer's designated service organization. Include quarterly exercising to check for proper, starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies as used in the manufacture and installation of original equipment.

1.10 EXTRA MATERIALS

- A. Furnish extra material described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents. Deliver extra material to Owner.
 - 1. Fuses: 1 for every 10 of each type and rating, but not less than 1 of each.
 - 2. Indicator Lamps: 2 for every 6 of each type used, but not less than 2 of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion air filters.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work are the following:
1. Caterpillar, Inc.: Engine Division
 2. Detroit Diesel
 3. Generac Corporation
 4. Kohler Company: Generator Division
 5. Onan Corporation: Industrial Business Group.

2.02 SERVICE CONDITIONS

- A. Environmental Conditions: Engine generator systems withstands the following environmental conditions without mechanical or electrical damage or degradation of performance capability.
1. Ambient Temperature: Minus 15 degree Celsius to plus 40 degrees Celsius.
 2. Relative Humidity: 0 to 95 percent.
 3. Altitude: Sea Level to 6000 feet (1800 m).
- B. Unusual Service Conditions: Engine generator equipment and installation is required to operate in the following conditions.
1. Seismic Design per IBC 2000: Seismic Design Category D; Use Group 3; Site Class D.

2.03 ENGINE- GENERATOR

- A. Furnish a coordinated assembly of compatible components.
- B. Ratings : 480Y/277V, 60Hz, and power output ratings of systems are as indicated on the drawings.
- C. Loads: Refer to One-line diagram.
- D. Output Connections: 3 phase, 4 wire.
- E. Safety Standard: Comply with ASME B15.1.

- F. Nameplates: Each major system component is equipped with a conspicuous nameplate of component manufacturer. Nameplate identified manufacturer of origin and address, and model and serial number of item.
- G. Resistance to Seismic Forces: Supports for internal and external components, and fastenings for batteries, wiring, and piping are designed to withstand static or anticipated seismic forces, or both, in any direction. For each item, use a minimum force equal to weight of item.
- H. Limiting dimensions indicated for system components are not exceeded.
- I. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
- J. Skid: Adequate strength and rigidity to maintain alignment of mounted components without dependence on a concrete foundation. Skid is free from sharp edges and corners. Lifting attachments are arranged to facilitate lifting with slings without damaging any components. Refer to Section 2.7.B “Base Mounted Fuel Oil Tank”.
- K. Rigging Diagram: Inscribed on a metal plate permanently attached to skid. Diagram indicates location and lifting capacity of each lifting attachment and location of center of gravity.

2.04 ENGINE

- A. Comply with NFPA 37.
- B. Fuel: Diesel fuel oil grade DF-2.
- C. Maximum Engine Speed: 1800rpm.
- D. Maximum Piston Speed for 2-Cycle Engines : 1725 fpm (8.8 m/s)
- E. Maximum Piston Speed for 4-Cycle Engines: 2250 fpm (11.4m/s)
- F. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft. The following items are mounted on the engine or skid:
 - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 microns and smaller while passing full flow.
 - 2. Oil Cooler: Maintains lubricating oil at manufacturer’s recommended optimum temperature throughout 2 hours of operation of generator set at 110 percent of system power output rating.
 - 3. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Unit is capable of full flow and is designed to be fail-safe.

4. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without the use of pumps or siphons or special tools or appliances.
- G. Engine Fuel System: Comply with NFPA 30. System includes the following:
1. Integral Injection Pumps: Driven by engine camshaft. Pumps are adjustable for timing and cylinder pressure balancing.
 2. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 3. Parallel Fuel Oil Filters: Ahead of injection pumps. Changeover valves allow independent use of either filter.
 4. Relief/Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- H. Jacket Coolant Heater: Electric- immersion type, factory installed in jacket coolant system. Unit is rated and thermostatically controlled to maintain and engine temperature of 25 degrees Celsius at the low end of the ambient temperature range specified in "Service Conditions" Paragraph above.

2.05 GOVERNOR

- A. Type: Electric isochronous with droop adjustment (0-10%) that controls an engine driven hydraulic activator, **suitable for use on UPS and other non-sinusoidal type loads.**
- B. Governor shall be similar to a Woodward 2301 A Speed Control Governor.

2.06 ENGINE COOLING SYSTEM

- A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine generator – set skid and integral engine-driven coolant pumping.
- B. Radiator: Rated for specified coolant.
- C. Coolant: Solution of 50 percent ethylene glycol and 50 percent water.
- D. Expansion Tank: Constructed of welded steel plate and equipped with gage glass and petcock. Capacity is as indicated.
- E. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer. Features include the following:
1. Thermostatic Elements: Interchangeable and nonadjustable.

2. Actuator Design: Normally open valves to return to open position when actuator fails.
- F. Coolant Hose: Flexible assembly with nonporous rubber inside surface and aging, ultraviolet, and abrasion-resistant fabric outer covering.
1. Rating: 50-psig (345-kPa) maximum working pressure with 180 degrees fahrenheit (82 degrees Celsius) coolant, and non-collapsible under vacuum.
 2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

2.07 FUEL SUPPLY SYSTEM

- A. Comply with NFPA 30 and NFPA 37.
- B. **Base-Mounted Fuel Oil Tank:** Factory-installed and –piped, listed and labeled fuel oil tank. Features include the following:
1. Tank fuel level indicator.
 2. Capacity: 10 hour minimum
 3. Double –contained.
 4. Leak detection on secondary containment.
 5. Vandal-resistant fill cap.

2.08 ENGINE EXHAUST SYSTEM

- A. Connections from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe.
- B. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liners.

2.09 COMBUSTION AIR-INTAKE SYSTEM

- A. Air-Intake Silencer: Filter type providing filtration as recommended by engine manufacturer.
1. Sound level emanating from air intake measured as specified in the Diesel Engine Manufacturers Association’s “DEMA Test Code for the Measurement of Sound from Heavy-Duty Reciprocating Engines” at a distance of 25 feet (8 m) is 54 dBA or less in the 1200-to4800- Hz frequency band and 56 dBA or less in the 4800-to 10,000-Hz band.

2. Mounting: Factory installed on engine generator set at a location readily accessible for servicing.

2.10 STARTING SYSTEM

- A. Description 24-V electric, with negative ground and including the following items:
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in “Environmental Conditions” paragraph above.
 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 4. Battery complies with SAW 1537 and has adequate capacity within ambient temperature range specified in “Service Conditions” Paragraph above to provide specified cranking cycle at least twice without recharging.
 5. Battery Cable: Size as recommended by generator set manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater is arranged to maintain battery above 10 degrees Celsius regardless of external ambient temperature within range specified in “Service Conditions” Paragraph above. Include accessories required to support and fasten batteries in place.
 7. Battery – Charging Alternator: Factory mounted on engine with solid-state voltage-regulation and 35-A minimum continuous rating.
 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit Complies with UL 508 and includes the following features:
 - a. Operation: Equalizing – charging rate of 10A is initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit then automatically switches to a lower float-charging mode and continues operating in that mode until batter is discharged again.
 - b. Automatic Temperature Compensation: Adjusts float and equalize voltage for variations in ambient temperature from minus 40 degrees Celsius to plus 60 degrees Celsius to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintains output voltage constant regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters indicated charging rates.

- e. Safety Functions: Include sensing of abnormally low battery voltage arranged to close contracts providing low battery voltage indication on control and monitoring panel. Also include sensing of high battery voltage and loss of ac input or dc output of battery charger. Either of these conditions closes contracts that provide a battery charger malfunction indication at systems control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.11 CONTROL AND MONITORING

- A. Functional Description: When the mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic-transfer switches initiate starting and stopping of the generator set. When the mode-selector switch is switched on the on position, the generator set manually starts. The off position of the same switch initiates generator –set shutdown. When the generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.
- B. Configuration: Operating and safety indications, protective devices, basic system controls and engine gages are grouped on a common control and monitoring panel mounted on the generator set. Mounting method isolates the control panel from generator-set vibration.
- C. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator circuit breaker, and other indicated components are grouped in a combination control and power panel. Control and monitoring section of panel is isolated from power sections by steel barriers.

The factory mounted engine generator control panel shall be unit mounted on suitable rubber vibration isolators. The generator set shall be supplied with two each 100% rated circuit breakers, ampere ratings as shown in the drawings, equipped with adjustable ground fault protection and shunt trips wired to the control panel emergency shutdowns.

- D. Indicating and Protective Devices, and Controls: Include those required by NFPA 110 for a Level 1 system, plus the following:
 - 1. Ac Voltmeter
 - 2. Ac ammeter
 - 3. Ac frequency meter
 - 4. Dc voltmeter (alternator battery charging)

5. Engine-coolant temperature gage
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter
 8. Ammeter- voltmeter, phase-selector switch or switches
 9. Generator-voltage adjusting rheostat
 10. Start-stop switch
 11. Over-speed shutdown device
 12. Coolant high-temperature shutdown device
 13. Coolant low-level shut down device
 14. Oil low-pressure shutdown device
 15. Fuel tank derangement alarm
 16. Fuel tank high- level shutdown of fuel supply alarm
- E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items on engine, generator, or elsewhere to suit manufacturer's standard.
- F. Connection to Data Link: A separate terminal block, factory wired to Form C dry contracts, for each alarm and status indication is reserved for connections for data link transmission of indications to remote data terminals. Data system connections to terminal are covered in another Section.
- G. Common Remote Audible Alarm: Signal the occurrence of any of the events listed below without differentiating between different event types. Locate audible device and silencing means where indicated. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
1. Engine high-temperature shutdown
 2. Lube-oil low-pressure shutdown
 3. Over-speed shutdown
 4. Remote emergency-stop shutdown
 5. Engine high-temperature pre-alarm
 6. Lube-oil low-pressure pre-alarm
 7. Fuel tank low level

8. Overcrank shutdown
 9. Coolant low-temperature alarm
 10. Control switch not in auto position
 11. Battery-charger malfunction alarm
 12. Battery low-voltage alarm
- H. Remote Emergency-Stop Switch: Surface wall-mounted, unless otherwise indicated and prominently labeled. Push button is protected from accidental operation.

2.12 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG1 and specified performance requirements.
- B. Drive: Generator shaft is directly connected to engine shaft. Exciter is rotates integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction prevents 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.
- F. Excitation uses no slip or collector rings, or brushes, and is arranged to sustain generator output under short-circuit conditions as specified.
- G. Enclosure: Drip proof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 1. Adjusting rheostat on control and monitoring panel provide plus or minus 5 percent adjustment of output voltage operating band.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.13 LOAD BANK

- A. Description: Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, resistive/reactive unit capable of providing a balanced 3-phase, delta-connected load to generator set at system capacity as shown on drawings, at 80 percent power factor (lagging). Unit is capable of selective control of load in 25 percent steps with minimum step changes of approximately 5 and 10 percent available.
- B. Resistive Load Elements: Corrosion – resistant chromium alloy with ceramic and steel supports. Elements are double insulated and designed for repetitive on-off cycling. Elements are mounted in removable aluminized-steel heater cases.
- C. Load- Bank Heat Dissipation: Integral fan with totally enclosed motor provides uniform cooling airflow through load elements. Airflow and coil operating current are such that, at maximum load, with ambient temperature at the upper end of the specified range, load-bank elements operate at not more than 50 percent of maximum continuous rating of the resistance wire.
- D. Load Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120V. Contactors are located in a separate NEMA 250, Type 3R enclosure within the load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.
- E. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.
- F. Load-Bank Enclosures: NEMA 250, Type 3R, conforming with NEMA ICS6. Louvers at cooling air intake and discharge openings prevent entry of rain and snow. Openings for airflow are screened with ½-inch (13-mm) square galvanized steel mesh.
- G. Protective Devices: Power input circuit to load bank is protected by circuit breaker. Cooling airflow and over temperature sensors automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors disconnect load power, control, and heater circuits. Fan motor is separately protected by overload and short-circuit devices. Short-circuit devices are non-interchangeable fuses with 200,000-A interrupting capacity.
- H. Remote-Control Panel: Separate from load bank in a NEMA 250, Type 3R, enclosure. Includes a control power switch and pilot light, and switches controlling groups of load elements. Locate in generator cabinet with generator controls.

- I. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

2.14 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels are lockable and provide adequate access to components requiring maintenance. Panels are removable by one person without tools. Instruments and control are mounted within enclosure.
- B. Muffle Location: External to enclosure.
- C. Engine Cooling Airflow through Enclosure: Adequate to maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at the top of the range specified in system service conditions.
- D. Louvers: Fixed-engine cooling air inlet and discharge. Louvers prevent entry of rain and snow. Bird Screen as required.
- E. Panel board: 208Y/120V, three phase, main circuit breaker sized for required loads, NEMA 1 panel board with branch circuit breakers for all AC auxiliary power inside enclosure. Breakers sized accordingly for heaters, battery charger, day tank, interior lights, receptacle, miscellaneous, and spare. Provide transformer 480 V-208Y/120V to supply panel board. Size as required for loads. Panel board and transformer located in enclosure.
- F. Automatic Dampers: At engine cooling air inlet and discharge . Dampers are closed to reduce enclosure heat loss in cold weather when unit is not operating.
- G. Interior Lights: With switch at each door. Factory –wired vapor proof-type fixtures within housing, arranged to illuminate controls and accessible interior.
- H. Convenience Outlets: GFI, two minimum, factory wired.

2.15 FINISHES

- A. Outdoor Enclosures: Manufacturer’s standard enamel over corrosion-resistant pretreatment and compatible standard primer.

2.16 SOURCE QUALITY CONTROL

- A. Factory Tests: Include prototype testing and Project –specific equipment testing (testing of equipment manufactured specifically for this Project).

- B. Prototype Testing: Performed on a separate engine generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Conform to those required for Level 1 energy converters in paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2 of NFPA 110.
 - 2. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype have been tested to demonstrate compatibility and reliability.
- C. Supply the manufacturer's certified test report, with all testing at 0.8 power factor.

PART 3 - EXECUTION

3.01 INSTALLATIONS

- A. Anchor generator set and other system components on concrete housekeeping bases conforming to Division 3 Section "Cast-in-Place Concrete" and as indicated. Provide anchorage according to manufacturer's written instruction, unless otherwise indicated.
- B. Maintain minimum workspace around components according to manufacturer's Shop Drawings and National Electrical Code.

3.02 IDENTIFICATION

- A. Identify systems components according to Division 15 Section "Mechanical Identification" and Division 16 Section "Electrical Identification".

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise installation and connection of unit and to report results in writing.
- B. Supervised Adjusting and Pre-testing: Under supervision of factory-authorized service representative, pre-test all system functions, operations, and protective features. Provide all instruments and equipment required for tests. Adjust to ensure operation is according to Specifications. Load system using the supplied and installed 0.8 power factor load bank.
 - 1. InterNational Electrical Testing Association Tests: Perform each visual and mechanical inspection and electrical and mechanical test stated in InterNational Electrical Testing Association's NETA ATS for emergency engine generator sets. Certify compliance with test parameters.

2. Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.
 3. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 4. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each elements of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 5. Exhaust System Back-Pressure Test: Use a manometer with a scale exceeding 40 inches (1000mm) of water. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
 6. Exhaust Emissions Test: Conform to applicable government test criteria.
 7. Voltage and Frequency Transient Stability Test: 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.
 8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- C. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.04 CLEANING

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

3.05 DEMONSTRATION

- A. Training: Engage a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of system and to train Owner's maintenance personnel as specified below.
1. Schedule training with at least 7 days' advance notice.

3.06 COMMISSIONING

- A. Battery Equalization: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltage.

- B. The contract shall perform all commissioning and testing work as shown in Section 01710S.**

END OF SECTION