



SECTION 221329 - SANITARY SEWERAGE PUMP STATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible effluent pumps.
2. Submersible sewage pumps.
3. Packaged engine-generator sets for standby power supply with the following features and accessories:
 - a. Diesel engine.
 - b. Unit-mounted cooling system.
 - c. Unit-mounted control and monitoring.
 - d. Outdoor enclosure.
 - e. Integrated sub-base fuel tank.

1.2 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- B. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include the following:
 1. Data on features, components, accessories ratings, and performance.
 2. Thermal damage curve for generator.
 3. Time-current characteristic curves for generator protective device.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 2. Wiring Diagrams: Power, signal, and control wiring schematic wiring diagrams and interconnection diagrams. Identify by terminal number each required interconnection between the generator set, automatic transfer switch, & other external interconnections.



- C. Provide one mark-up copy of this specification with notations clearly showing all deviations and / or exceptions to these Specifications.
- D. Voltage drop / motor starting capability curve.
- E. Calculations of sub-base fuel tank capacity requirements based on 48 hours runtime at full load.
- F. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
- G. Certified Summary of Performance Tests: Demonstrate compliance with specified requirement to meet performance criteria for sensitive loads.
- H. Test Reports:
 - 1. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 - 2. Report of sound generation.
 - 3. Report of exhaust emissions showing compliance with applicable regulations.
 - 4. Field quality-control test reports.
- I. Operation and Maintenance Data: For packaged engine-generators to include in emergency, operation, and maintenance manuals.
- J. Four sets of operating and maintenance instruction manuals shall be supplied for the engine, generator, governor, voltage regulator, and auxiliary system components as specified herein. Operation and maintenance manuals shall be prefaced with a complete bill of material that clearly identifies component descriptions and part numbers that are applicable to the specific unit supplied.
 - 1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- K. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
 - 2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Manufacturer Qualifications:
 - 1. A national firm that manufactures generator sets and controls and assembles them as a complete and coordinated unit.



2. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
 3. Service response shall be guaranteed to be eight hours or less upon receipt of service call notification.
 4. Provide one source responsibility for warranty, parts, and service through a local representative with factory trained service technicians.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use
- E. Comply with NFPA 37.
- F. Comply with NFPA 70.
- G. Comply with NFPA 99.
- H. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Retain shipping flange protective covers and protective coatings during storage.
 - B. Protect bearings and couplings against damage.
 - C. Comply with pump manufacturer's written rigging instructions for handling.
- 1.6 COORDINATION
- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- 1.7 WARRANTY
- A. Special Warranty: Manufacturer's standard form in which at no cost to the Owner the 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. Warranty Period: Two terms from date of Substantial Completion. Optional five year warranty shall be available upon request.
 - B. One-year minimum for all parts and labor for all equipment.



1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

At least:

1. Fuses: One for every type and one for each 10 of each type and rating, but not less than one of each.
2. Indicator Lamps: Two for every six of each type used, but not less than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Paint: Two spray cans of each color.
5. Pumps: One spare pump for duplex pump stations.
6. Relays: One for every type and one for each 10 of each type and rating, but not less than one of each.
7. One spare float.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE EFFLUENT PUMPS

- A. Submersible, Quick-Disconnect, Double-Seal Effluent Pumps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Myers.
 - b. Hydromatic.
2. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron, or better, closed or semiopen design for clear wastewater, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seals: Mechanical.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: Oil.
10. Controls:



- a. Enclosure: NEMA 250, Type 4X; pedestal-mounted.
- b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
- c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
- d. High-Water Alarm: NEMA 250, Type 6 enclosure with mechanical-float switch matching control and electric buzzer; 120-V ac, with transformer and contacts for remote alarm buzzer.
- e. Silence: Flashing red strobe light mounted at 6' minimum height.

11. Control-Interface Features:

- a. Remote Alarm Contacts: For remote alarm interface.
- b. SCADA Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.

12. Guide-Rail Supports:

- a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
- b. Guide Rails: Vertical pipes or structural members, made of stainless steel, attached to baseplate and basin sidewall or cover.
- c. Baseplate: Stainless steel plate, attached to basin floor, supporting guide rails and stationary elbow.
- d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
- e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
- f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
- g. Lifting Chain: 3/8" stainless steel; attached to pump and cover at manhole.

B. Capacities and Characteristics:

- 1. Unit Capacity: _____.
- 2. Number of Pumps: _____.
- 3. Each Pump:
 - a. Capacity: _____.
 - b. Solids Handling Capability: 3 inches minimum.
 - c. Total Dynamic Head: _____.
 - d. Speed: _____.
 - e. Discharge Pipe Size: _____.
 - f. Motor Horsepower: _____.
 - g. Electrical Characteristics:
 - 1) Volts: 480.
 - 2) Phases: Three.
 - 3) Hertz: 60.



4. Unit Electrical Characteristics:
 - a. Full-Load Amperes: _____.
 - b. Minimum Circuit Ampacity: _____.
 - c. Maximum Overcurrent Protection: _____ A.

2.2 SUBMERSIBLE SEWAGE PUMPS

A. Submersible, Quick-Disconnect, Double-Seal Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Myers.
 - b. Hydromatic.
2. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
3. Pump type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
5. Impeller: Statically and dynamically balanced, cast bronze and stainless steel, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seals: Mechanical.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: Oil.
10. Controls:
 - a. Enclosure: NEMA 250, Type 4X; pedestal-mounted.
 - b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: NEMA 250, Type 6 enclosure with mechanical-float switch matching control and electric buzzer; 120-V ac, with transformer and contacts for remote alarm buzzer.
 - e. Silence: Flashing red strobe light mounted at 6' minimum height.
11. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. SCADA Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:



- 1) On-off status of pump.
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12. Guide-Rail Supports:

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- c. Baseplate: Stainless steel plate, attached to basin floor, supporting guide rails and stationary elbow.
- d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
- e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
- f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
- g. Lifting Chain: 3/8" stainless steel; attached to pump and cover at manhole.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Motors for submersible pumps shall be hermetically sealed.

2.4 ENGINE-GENERATOR MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cummins Power Generation; Industrial Business Group.
 2. Detroit Diesel.
 3. Clarke / Covington.
 4. Approved Equal.

2.5 ENGINE-GENERATOR SET

- A. Packaged engine-generator set shall be a coordinated assembly of compatible components.
- B. Power Output Ratings: Standby ratings as indicated, with capacity as required to operate as a unit for the duration of a power outage.
- C. Output Connections: Three phase, four wire.
- D. Safety Standard: Comply with ASME B15.1.



- E. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, and model and serial number of component.
- F. Fabricate engine-generator-set mounting frame and attachment of components to resist generator-set movement during a seismic event when generator-set mounting frame is anchored to building structure.
- G. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components.

2.6 GENERATOR-SET PERFORMANCE

- A. Steady-State Voltage Operational Bandwidth: 4 percent of rated output voltage from no load to full load.
- B. Steady-State Voltage Modulation Frequency: Less than 1 Hz.
- C. 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.
- D. Steady-State Frequency Operational Bandwidth: 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 shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
- F. Transient Frequency Performance: Less than 5 percent variation for a 50 percent stepload increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
- G. 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. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
- H. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, the 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.
- I. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.7 SERVICE CONDITIONS

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



1. Ambient Temperature: 5 to 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet.

2.8 ENGINE

- A. Fuel: Fuel oil, Grade DF-2
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
- D. Lubrication System: The following items are mounted on engine or skid:
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Positive displacement, full pressure lubrication oil pump.
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- F. Engine Fuel System:
 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions. Pump shall be capable of lifting fuel 5 feet.
 2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
 3. Fuel Filters: Provide filter & water separator.
- G. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- H. Governor: Adjustable isochronous, with speed sensing.

2.9 ENGINE COOLING SYSTEM

- A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
- B. Radiator: Rated for specified coolant.
- C. Coolant: Furnish solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
- D. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.



- E. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- F. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, 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.

2.10 FUEL SUPPLY SYSTEM

- A. Comply with NFPA 30, NFPA 54, and applicable state and local codes.
- B. Sub-base double wall fuel tank, capacity as indicated on the drawings, UL listed; fill and vent package; fuel gauge; low fuel and high fuel float switches; overflow alarm float switch.
- C. Piping Connections: Field-installed fuel supply and return lines, fittings, and connections from tank to engine. Flexible fuel lines shall be rated 300 degrees F & 100 psi, ending in pipe threads. All fuel piping shall be pressure tested for minimum 2 hours.
- D. Provide thermostatically controlled fuel tank heater.
- E. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.11 ENGINE EXHAUST SYSTEM

- A. Muffler / Silencer:
 - 1. Critical type, sized as recommended by engine manufacturer.
 - 2. Sound level measured at a distance of 23 feet from exhaust discharge shall be 75 dBA or less.
 - 3. Coated to be temperature & rust resistant.
 - 4. Mounted internal to the enclosure.
- B. Condensate Drain for Muffler: Schedule 40, black steel pipe connected to muffler drain outlet through a petcock.
- C. Connection from Engine to Exhaust System: Flexible section of gas-proof, corrugated stainless-steel pipe.
- D. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liner.
- E. Exhaust Piping External to Engine: ASTM A 53/A 53M, Schedule 40, welded, black steel, with welded joints and fittings, and screened openings to prevent rodent entry.



2.12 COMBUSTION-AIR INTAKE

- A. Description: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

2.13 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 in "Service Conditions" Article.
 2. Cranking Motor: Heavy-duty, positive engagement, solenoid shift-starting motor that automatically engages and releases from engine flywheel without binding.
 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 4. Battery: Adequate capacity within ambient temperature range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article to provide specified cranking cycle at least three times without recharging.
 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 6. Battery Tray: Plastic coated metal tray treated for electrolyte resistance, constructed to contain spillage of electrolyte. Include accessories required to support and fasten batteries in place.
 7. Battery Heater: 120V, thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article.
 8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging 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.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates with 5% accuracy.
 - e. 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.
 - f. Enclosure and Mounting: NEMA 250, Type 4X, wall-mounted cabinet.



2.14 CONTROL AND MONITORING / CONTROLLER

- A. Standards: The controller shall meet the following industry standards:
1. NFPA-110 Level 1 requirements with an integral alarm horn as required by NFPA.
 2. NFPA-99 and NFPA-70 (NEC).
 3. Set control must be listed under UL 508.
- B. The controller must operate between -40°C to +70°C and 5-95% humidity, non-condensing.
- C. It shall be possible to mount the control on the generator set. The control must be able to be mounted in any of 4 orientations for ease of viewing.
- D. Hardware Requirements:
1. The control shall have a run-off/reset-auto three-position selector switch. If specified herein, a version of the control shall have a key operated selector switch.
 2. A controller mounted latch type emergency stop push button shall be supplied.
 3. It shall be possible to adjust alternator output voltage at the controller.
 4. The controller must provide five indicating lights:
 - a. System ready - green.
 - b. Not in auto - yellow.
 - c. Programming mode - yellow.
 - d. System warning - yellow.
 - e. System shutdown - red
 5. The controller shall include a lighted display with two lines of 20 alphanumeric characters for messages. Panel lights must be supplied as standard.
 6. The controller shall include a sixteen-position snap action sealed keypad for menu selection and data entry.
 7. For ease of use, an operating guide must be placed on the controller faceplate.
 8. The controller shall include an audible alarm.
- E. Functional Requirements
1. Field programmable time delay for engine start. Adjustment range, 0 to 5 minutes in 1 second increments.
 2. Field programmable time delay engine cool down. Adjustment range, 0 to 10 minutes in 1 second increments.
 3. It shall be possible to start the generator and run it at an idle speed during warmup. The idle time must be user adjustable. Engine cool down at idle must also be available.
 4. Real time clock and calendar for time stamping of events.
 5. Output with adjustable timer for an ether injection starting system. Adjustment range, 0-10 seconds.
 6. Programmable cyclic cranking that allows up to six crank cycles and up to 45 seconds of crank time per crank cycle.
 7. The controller vacuum fluorescent display should automatically be turned off after 5 minutes of no controller activity.
 8. The controller firmware must provide alternator protection for overload and short circuit matched to each individual alternator and duty cycle.



9. A $\pm 0.25\%$ digital voltage regulator must be incorporated into the controller software. No separate voltage regulator is acceptable.
10. It shall be possible to exercise the generator by programming a running time into the controller.

F. Generator System Monitoring Requirements

1. All monitored functions shall be viewable on the digital display.
2. The following generator functions shall be monitored:
 - a. Output voltages - line to line and line to neutral, 0.25% accuracy.
 - b. Output currents, 0.25% accuracy.
 - c. Output frequency, 0.25% accuracy.
 - d. Power factor by phase with leading/lagging indication.
 - e. Total instantaneous kilowatt loading and kilowatts per phase, 0.5% accuracy.
 - f. kVARs, total and per phase, 0.5% accuracy.
 - g. kVA, total and per phase, 0.5% accuracy.
 - h. kW hours.
 - i. Display of percent generator duty level - actual kW loading divided by the kW rating.
3. The following engine parameters shall be monitored:
 - a. Coolant temperature.
 - b. Battery voltage.
 - c. RPM.
 - d. Lube oil temperature.
 - e. Lube oil level.
 - f. Crankcase pressure.
 - g. Coolant level.
 - h. Fuel pressure.
 - i. Fuel rate.
 - j. Fuel used during the last run.
 - k. Ambient temperature.
4. The following operational records since system start up shall be stored in the controller:
 - a. Run time hours.
 - b. Run time loaded.
 - c. Run time unloaded.
 - d. Number of starts.
 - e. Factory test date.
 - f. Last run data including date, duration, and whether loaded or unloaded.
 - g. kW hours.
 - h. Event history.
5. The following operational records shall be stored in a resettable form for maintenance use:
 - 1) Run time hours.
 - 2) Run time loaded.



- 3) Run time unloaded.
 - 4) Number of starts.
 - 5) Days of operation.
 - 6) Start date after reset.
 - 7) kW hours.
 - 8) Event history.
6. The controller shall store the last one hundred generator system events with date and time of the event.
 7. The following information shall be stored in the controller and displayed on demand:
 - a. Manufacturer's model and serial number.
 - b. Battery voltage.
 - c. Generator set kilowatt rating.
 - d. Rated current.
 - e. System voltage.
 - f. System frequency.
 - g. Number of phases.
 8. The controller shall be capable of detecting the following conditions and indicating if the condition will shutdown the generator and annunciate the situation, using words and phrases, on the digital display:
 - a. Customer programmed digital auxiliary input ON.
 - b. Customer programmed analog auxiliary input out of bounds.
 - c. Emergency stop.
 - d. High coolant temperature.
 - e. High oil temperature.
 - f. Controller internal fault.
 - g. Locked rotor - fail to rotate.
 - h. Low coolant level.
 - i. Low oil pressure.
 - j. Master switch error.
 - k. NFPA common alarms.
 - l. Over crank.
 - m. Over speed with user adjustable level, range 65-70 Hz on 60 Hz systems.
 - n. Generator over voltage with user adjustable level, range 105% to 135%.
 - o. Over frequency with user adjustable level, range 102% to 140%.
 - p. Under frequency with user adjustable level, range 80% to 90%.
 - q. Generator under voltage with user adjustable level, range 70% to 95%.
 - r. Coolant temperature signal loss.
 - s. Oil pressure gauge signal loss.
 - t. Fuel level sensor loss.
 9. The controller shall be capable of detecting the following conditions and indicating if the condition will provide a warning, and annunciate the situation, using words and phrases, on the digital display:
 - a. Battery charger failure.
 - b. Customer programmed digital auxiliary input ON.



- c. Customer programmed analog auxiliary input ON.
- d. Power system supplying load.
- e. High battery voltage (level shall be user adjustable, 29-33 volts).
- f. High coolant temperature.
- g. Loss of AC sensing.
- h. Under frequency.
- i. Low battery voltage (level shall be user adjustable, 20-25 volts).
- j. Low coolant temperature.
- k. Low fuel level or pressure.
- l. Low oil pressure.
- m. NFPA common alarms.
- n. Over current.
- o. Speed sensor fault.
- p. Weak battery.
- q. Alternator protection activated.

G. Inputs

- 1. There shall be 21 dry contact inputs that can be user configured to shutdown the generator or provide a warning.
- 2. There shall be 5 user programmable analog inputs for monitoring and control.
- 3. Each analog input can accept 0 to 5 volt analog signals.
- 4. It shall be possible to define each user configured input using words or phrases that will be viewable on the digital display.
- 5. Additional standard inputs:
 - a. Reset of system faults.
 - b. Remote two wire start.
 - c. Remote emergency stop.
 - d. Idle mode enable.

H. Outputs

- 1. NFPA 110 Level 1 outputs shall be available.
- 2. There shall be thirty outputs available for interfacing to other equipment.
- 3. Any of these outputs shall be able to be user configured from a list of over 25 functions and faults.
- 4. These outputs shall drive optional dry contacts.
- 5. A programmable user defined common fault output with over 40 selections shall be available.

I. System Programming

- 1. It shall be possible to program the controller with the controller keypad or using a Windows operating system compatible personal computer.
- 2. Programming access is to be enabled only at the controller and must be password protected.
- 3. It shall be possible to disable programming so the system can only be monitored.
- 4. The following shall be programmable from the controller keypad.
 - a. Time delay settings:



- 1) Generator run time (0 to 72 hours) - exercise.
- 2) Engine start.
- 3) Engine cool down.
- 4) Over voltage and under voltage delays.
- 5) Starting aid.
- 6) Crank on and crank pause time.
- 7) Idle time.
- b. Trip point settings:
 - 1) High battery voltage.
 - 2) Low battery voltage.
 - 3) Over speed.
 - 4) Under frequency.
 - 5) Over frequency.
 - 6) Under voltage.
 - 7) Over voltage.

J. Programmable relays shall not be allowed be allowed on any pump station.

2.15 GENERATOR OVERCURRENT AND FAULT PROTECTION

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

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Matched to generator thermal damage curve as closely as possible.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Protector:

1. A resettable line current sensing circuit breaker with inverse time versus current response shall be furnished which protects the generator from damage due to its own high current capability. This breaker shall not trip within the 10 seconds specified above to allow selective tripping of down-stream fuses 01' circuit breakers under a fault condition. This breaker shall not automatically reset, preventing restoration of voltage if maintenance is being performed. Field current-sensing breaker will not be acceptable.
2. Microprocessor-based unit that continuously monitors current level in each phase of generator output, integrates generator heating effect over time, and predicts when thermal damage of the alternator will occur. When signaled by the protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from the load circuits. Protector shall perform the following functions:
 - a. Initiates a generator overload alarm when the generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds.
 - b. Indication for this alarm is integrated with other generator-set malfunction alarms.
 - c. Under single or three-phase fault conditions, regulates the generator to 300 percent of rated full-load current for up to 10 seconds. As the overcurrent heating effect on the generator approaches the thermal damage point of the unit, the protector



switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.

- d. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.16 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1 and specified performance requirements.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H, synthetic, non-hygroscopic. Temperature rise of the rotor and stator shall be limited to 105°C at the specified kW rating.
- D. Stator-Winding Leads: four bars brought out to terminal.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Excitation shall use no slip or collector rings, or brushes, and shall be arranged to sustain generator output under short-circuit conditions as specified.
- G. Enclosure: Dripproof.
- 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 shall provide plus or minus 5 percent adjustment of output-voltage operating band.
 - 2. The voltage regulator must be capable of maintaining voltage within +/- 1% at any constant load from 0 to 100% of rating. The regulator must be isolated to prevent tracking when connected to SCR loads, and provide individual adjustments for voltage range, stability, and volts-per-hertz operation, and be protected from the environment by conformal coating.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: The alternator shall be salient-pole, brushless, of 2/3 pitch to eliminate the third harmonic, self-ventilated of drip-proof construction with amortisseur rotor windings and skewed for smooth voltage waveform.
- L. Subtransient Reactance: 12 percent, maximum.
- M. Performance:



1. The generator shall be capable of sustaining at least 250% of rated current for at least 10 seconds under a 3-phase symmetrical short by inherent design or by the addition of an optional current boost system.
2. Upon 1-step application of any load up to 100% of the rated load at 0.8 power factor, the voltage dip shall not exceed 20% and shall recover to +/- 2% of rated voltage within 1 second.
3. The generator shall be capable of starting motor loads of 3200 kVA inrush, with a maximum voltage dip of 30%.

2.17 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof prepainted 14-gauge Aluminum alloy housing, wind resistant up to 90 mph. Enclosure shall feature a peaked roof to direct water run-off. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be hinged and removable by one person without tools. Door locks shall be stainless steel and keyed alike. Hardware and fasteners shall be stainless steel. Instruments and control shall be mounted within enclosure. Enclosure shall meet any and and/or all applicable building code.
- B. Engine Cooling Airflow through Enclosure: The generator set shall be capable of operating at full load in an ambient of 40°C with no derating of the electrical output.

2.18 FUEL SYSTEM

- A. Sub-base double wall fuel tank, capacity as indicated on the drawings, UL listed; fill and vent package; fuel gauge; low fuel and high fuel float switches; overflow alarm float switch.
- B. Piping Connections: Field-installed fuel supply and return lines, fittings, and connections from tank to engine. Flexible fuel lines shall be rated 300 degrees F & 100 psi, ending in pipe threads. All fuel piping shall be pressure tested for minimum 2 hours.

2.19 FINISHES

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

2.20 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set 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 in Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2.
 2. Generator Tests: Comply with IEEE 115.
 3. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype shall have been factory tested to demonstrate compatibility and reliability.



- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Full load run.
 - 2. Maximum power.
 - 3. Voltage regulation.
 - 4. Transient and steady-state governing.
 - 5. Single-step load pickup.
 - 6. Safety shutdown device testing.
 - 7. Observation of Factory Tests: Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

- C. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

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

- C. Examine roughing-in of electrical connections. Verify actual locations of connections before packaged engine-generator installation.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

3.3 INSTALLATION

- A. Pump Installation Standards:
 - 1. Comply with HI 1.4 for installation of centrifugal pumps.

- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

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



- D. Install packaged engine generators level on concrete base.
 - 1. Vibration Isolation: Mount packaged engine generators on restrained spring isolators with a minimum deflection as recommended by the manufacturer.
- E. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- G. Furnish lubricating oil to fill the crank case as recommended by the manufacturer.
- H. Provide full fuel tank for start-up and refill.

3.4 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Perform each electrical test and visual and mechanical inspection as required by the manufacturer's installation criteria. Certify compliance with test parameters.
 - 3. Perform tests recommended by manufacturer.
 - 4. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 5. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:
 - 6. Single-step full-load pickup test with an external load bank.
 - 7. Engine coolant temperature, oil pressure, and battery charge level along with generator voltage, amperes, and frequency shall be monitored & recorded throughout the test.



8. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
9. 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.
10. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
11. Verify acceptance of charge for each element of the battery after discharge.
12. Verify that measurements are within manufacturer's specifications.
13. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
14. 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.
15. Coordinate tests with tests for transfer switches and run them concurrently.
16. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
17. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
18. Remove and replace malfunctioning units and retest as specified above.
19. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
20. 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.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.



3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train] Owner's maintenance personnel to adjust, operate, and maintain controls, pumps, and packaged engine-generators.
 - 1. Coordinate this training with that for transfer switches.

END OF SECTION 221329