

**PART 1 GENERAL****1.1 WORK INCLUDED**

- A. This section covers work for installing a 350kW packaged engine generator set for Level 2 standby power supply, as shown on the Drawings for this project, complete. The packaged engine generator set shall include the following features:
1. Natural gas powered generator.
  2. Natural gas fuel system.
  3. Unit mounted cooling system.
  4. Unit mounted control and monitoring.
  5. Generator overcurrent and fault protection.
  6. Generator, exciter, and voltage regulator.
  7. Level 1 Enclosure
  8. Load Panel for ancillary generator loads.
  9. Vibration isolation devices.
  10. Finishes.
- B. See Section 26 36 00, TRANSFER SWITCHES for automatic transfer switches including sensors and relays to initiate automatic starting and stopping signals for the engine generator set.

**1.2 GENERAL REQUIREMENTS**

- A. Also see the GENERAL CONDITIONS, Division 01 00 00, GENERAL REQUIREMENTS, and Section 26 00 10, GENERAL ELECTRICAL REQUIREMENTS which contain information and requirements that apply to the work specified herein and are mandatory for this project.
- B. Like items of equipment or materials provided hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement, and shall include all necessary appurtenances for a complete and working system. The equipment or materials shall be the product of a manufacturer regularly engaged in the production of equipment or materials for the specified use. The

manufacturer shall have the sole responsibility for the proper functioning and coordination of the equipment or materials as furnished.

- C. The Contractor or their sub-contractors shall provide all required miscellaneous equipment and materials, as shown on the Drawings and in accordance with these Specifications. The Contractor or their sub-contractors shall furnish all equipment and material items, whether specified or not, as necessary to provide a complete, operable electrical system.

### 1.3 DEFINITIONS AND ABBREVIATIONS

- 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. NG: Natural gas.

### 1.4 SUBMITTALS

- A. Submittals shall be provided as specified in Section 01 33 00, SUBMITTALS and Section 26 00 10, GENERAL ELECTRICAL REQUIREMENTS.
- B. Provide all required operation and maintenance data for engine generators, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 77 00, CONTRACT CLOSEOUT, include the following:
  - 1. Routine maintenance requirements for engine generators and all installed components.
  - 1. Manufacturer's written instructions for testing and adjusting various devices.
  - 2. List of tools and replacement items recommended to be stored at the project site for ready access. Include part and drawing numbers, current unit prices, and source of supply.

### 1.5 QUALITY ASSURANCE

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

- B. Comply with ASME 15.1, Safety Standard for Mechanical Power Transmission Apparatus.
- C. Comply with NFPA 30, Flammable and Combustible Liquids Code; NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; and NFPA 110, Standard for Emergency and Standby Power Systems.
- D. Comply with NFPA 70, National Electrical Code.
- E. Comply with UL 2200, Stationary Engine Generator Assemblies.
- F. Engine Exhaust Emissions: Comply with 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 the generator set including engine, engine exhaust, engine cooling air intake and discharge, and other components of the installation.
- H. Source Limitations: Obtain packaged engine generator set and auxiliary components through one source from a single manufacturer.
- I. Manufacturer Qualifications: A qualified manufacturer that provides the type of equipment specified in this Section. Maintain, within 300 miles of the project site, a service center capable of providing training, parts, and emergency maintenance repairs.
  - 1. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints for engine generator skid mounts, including Shop Drawings, based on testing and engineering analysis of the manufacturer's standard units in assemblies similar to those indicated for this project.
- J. Installer Checking and Testing Qualifications: Manufacturer's authorized representative who is trained and approved for installation assistance, installation approval, and field testing of units required for this project.
  - 1. Maintenance Proximity: Not more than four hours normal travel time from Installer Representative's place of business to the project site.
- K. Testing Agency Qualifications: Member company of NETA or an NRTL.

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

## 1.6 FIELD CONDITIONS

### A. Environmental Conditions:

1. Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
  - a. Ambient Temperature: Between 32 degrees F to plus 110 degrees F.
  - b. Altitude: 5120 feet.

## 1.7 COORDINATION

- A. Coordinate size and location of concrete base for package engine generator set. Provide any required modifications to the existing concrete base and cast anchor bolts into base per templates provided by the manufacturer. Comply with the concrete, reinforcement, and formwork requirements as specified in Division 03 00 00, CONCRETE.

## 1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which the manufacturer agrees to repair or replace components of the package engine generator set, accessories, and associated auxiliary components that fail in materials or workmanship within the specified warranty period.
  1. Warranty Period: Two years from the date of Substantial Completion.

## 1.2 MAINTENANCE SERVICE

- B. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of the manufacturer's designated service organization. Include exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by the manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of the original equipment. Provide first major maintenance within 10 months of substantial completion.

## **PART 2 PRODUCTS**

### 1.1 PERFORMANCE REQUIREMENTS

- A. Engine Exhaust Emissions: Comply with EPA Tier 3 requirements and applicable state and local government requirements.
- B. Noise Emission: Comply with applicable state and local government requirements due to sound emitted by the package engine generator including engine, engine exhaust, engine cooling air intake and discharge, and other components of the installation.

## 2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with these requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
  - 1. Onan/Cummins Power Generation.

## 2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory assembled and factory tested, liquid-cooled engine, with brushless generator and accessories.
- B. Power Rating: Industrial.
- C. Service Load: 350 kW/437.5 kVA de-rated for the specified elevation.
- D. Power Factor: 0.8, lagging.
- E. Frequency: 60 Hz.
- F. Voltage: 208-Volt ac.
- G. Phase: Three-phase, four wire, wye.
- H. Induction Method: Turbocharged.
- I. Governor: Adjustable isochronous, with speed sensing.
- J. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on the concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
- K. Capacities and Characteristics:
  - 1. Power Output Ratings: Nominal ratings as indicated excluding power required for the continued and repeated operation of the unit

and auxiliaries, with capacity as required to operate as a unit as evidenced by records of prototype testing.

2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

L. Engine Generator Set 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: 10 seconds.

## 2.4 ENGINE

- A. Fuel: Natural gas.

- B. Rated Engine Speed: 1800 rpm.
- C. Lubrication System: Engine or skid-mounted.
  - 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 shall be 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.
- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499. Provide a 208 Volt ac, 3-phase rated block heater.
- E. Governor: Adjustable isochronous, with speed sensing.
- F. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine driven coolant pump.
  - 1. Coolant: Solution of 50 percent ethylene glycol based antifreeze and 50 percent water, with anticorrosion additives as recommended by the engine manufacturer.
  - 2. Size of Radiator: Adequate to contain expansion of the total system coolant from cold start to 110 percent load condition.
  - 3. Temperature Control: Self-contained, thermostatic control valve shall modulate coolant flow automatically to maintain optimum constant coolant temperature as recommended by the engine manufacturer.
  - 4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging resistant, UV resistant, and abrasion resistant fabric.
    - a. Rating: 50-psig maximum working pressure with coolant at 180 degrees F, and non-collapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

- G. Muffler/Silencer: 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. Sound level measured at 25 feet from exhaust discharge after installation is complete shall be 75 dBA or less.
- H. Air Intake Filter: Heavy duty, engine mounted air cleaner with replaceable dry filter element and "blocked filter" indicator.
- I. Starting System: 24-Volt electric, with negative ground.
1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in the "Performance Requirements" article hereinbefore.
  2. Cranking Motor: Heavy-duty unit that automatically engages and releases from the engine flywheel without binding.
  3. Cranking Cycle: 60 seconds.
  4. Battery: Lead acid, with adequate capacity within the ambient temperature range specified in the "Performance Requirements" article hereinbefore to provide the specified cranking cycle at least three times without recharging.
  5. Battery Cable: Size as recommended by the engine manufacturer for the cable length indicated. Include required interconnecting conductors and connection accessories.
  6. 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.
  7. Battery Charging Alternator: Factory mounted on the engine with solid state voltage regulation and 35-A minimum continuous rating.
  8. 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:
    - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after the battery has lost charge until an adjustable equalizing voltage is achieved at the battery



terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until the battery is discharged again.

- b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to 140 degrees F 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.
- e. Safety Functions: Sense abnormally low battery voltage and close two contacts providing low battery voltage indication on the control and monitoring panel and to the Airfield Lighting Control & Management System (ALCMS). 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 the system control and monitoring panel and ALCMS.
- f. Enclosure and Mounting: NEMA 250, Type 1, wall mounted cabinet.

## 2.5 ENGINE FUEL SYSTEM

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

## 2.6 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: 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 shall initiate starting and stopping of the engine generator. When the mode-selector switch is switched to the On position, the engine generator shall start. The Off position of same switch shall initiate engine generator shutdown. When the engine generator is running, specified system or equipment failures or derangements shall automatically shut down the engine generator and initiate alarms. Operation of a remote Emergency Stop switch shall also shut down the engine generator set.
- B. Provide a minimum run time control set for 15 minutes adjustable to 30 minutes with an override only by operation of a remote Emergency Stop switch.

- C. Comply with UL 508A.
- D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages 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.
- E. Control and Monitoring Panel:
  - 1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup. Controller to provide fault/alarm historian.
  - 2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
  - 3. Instruments: Located on the control and monitoring panel and viewable during operation.
    - a. Engine lubricating oil pressure gage.
    - b. Engine coolant temperature gauge.
    - c. DC voltmeter (alternator battery charging).
    - d. Running time meter.
    - e. AC voltmeter, for each phase.
    - f. AC ammeter, for each phase.
    - g. AC frequency meter.
    - h. Generator voltage adjusting rheostat.
  - 4. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:
    - a. Cranking control equipment.
    - b. Run-Off-Auto switch.
    - c. Control switch not in automatic position alarm.
    - d. Overcrank alarm.
    - e. Overcrank shutdown device.
    - f. Low-water temperature alarm.
    - g. High engine temperature pre-alarm.
    - h. High engine temperature.
    - i. High engine temperature shutdown device.
    - j. Overspeed alarm.
    - k. Overspeed shutdown device.
    - l. Coolant low level alarm.
    - m. Coolant low level shutdown device.

- n. Coolant high temperature pre-alarm.
  - o. Coolant high temperature alarm.
  - p. Coolant low temperature alarm.
  - q. Coolant high temperature shutdown device.
  - r. Battery high voltage alarm.
  - s. Low cranking voltage alarm.
  - t. Battery charger malfunction alarm.
  - u. Battery low voltage alarm.
  - v. Lamp test.
  - w. Contacts for local and remote common alarm.
  - x. Low starting air pressure alarm.
  - y. Low starting hydraulic pressure alarm.
  - z. Remote manual stop shutdown device.
  - aa. Air shutdown damper alarm when used.
  - bb. Air shutdown damper shutdown device when used.
  - cc. Generator overcurrent protective device not-closed alarm.
  - dd. Hours of operation.
  - ee. Engine generator metering, including voltage, current, hertz, kilowatt, kilowatt hours, kilovolt ampere, and power factor.
- F. 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.
1. One Normally Open “Generator Run” contact is required for the ALCMS.
  2. One Normally Open “Generator Fail” contact is required for the ALCMS.
  3. One Normally Open “Battery Low” contact is required for the ALCMS.
  4. One Normally Closed “Generator Run” contact is required for the operation of the intake louver actuator in the Generator Room.
- G. Common Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of the initiating condition will reactivate the alarm until the silencing switch is reset.
1. Engine high temperature shutdown.
  2. Lube oil, low pressure shutdown.

3. Overspeed shutdown.
4. Remote emergency stop shutdown.
5. Engine high temperature pre-alarm.
6. Lube-oil, low pressure pre-alarm.
7. Low coolant level.

## 2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.
- B. 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: Selected to coordinate with generator thermal damage curve.
  3. Shunt Trip: Connected to trip breaker when the engine generator is shut down by other protective devices.
  4. Mounting: Adjacent to, or integrated with, control and monitoring panel.
- C. Generator Protector: Microprocessor based unit shall continuously monitor the current level in each phase of the generator output, integrate generator heating effect over time, and predict when thermal damage of the alternator will occur. When signaled by the 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 shall perform the following functions:
  1. Initiates a generator overload alarm when the generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm shall be integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
  2. Under single phase or three phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.

3. As overcurrent 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 overcurrent devices and controls recovery of rated voltage to avoid overshoot.

## 2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to the engine shaft. Exciter shall be rotated integrally with the generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Dripproof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. 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.
  2. Maintain voltage within 20 percent on one step, full load.
  3. Provide anti-hunt provision to stabilize voltage.
  4. Maintain frequency within 10 percent and stabilize at rated frequency within 5 seconds.
- I. Sub-transient Reactance: 12 percent, maximum.

## 2.9 VIBRATION ISOLATION DEVICES

- A. ¼-inch thick, elastomeric isolator pad attached to baseplate underside.

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

### 1.1 OUTDOOR GENERATOR-SET ENCLOSURE

- B. Description: Vandal-resistant, weatherproof steel, sound attenuated housing, wind resistant up to **120 mph**. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure. Sound pressure levels measured at 7 meters will be 75 dB(A) or less. Air discharge to be vertical.
- C. Engine Cooling Airflow through Enclosure: 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 top of range specified in system service conditions.
  - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
  - 2. Automatic Motorized Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
  - 3. Enclosure Space Heater: Factory supplied enclosure space heater.
- D. Enclosure Load Panel: Manufacturer installed load panel to power enclosure equipment. All enclosure equipment will be pre-wired with conduit and conductors.
- E. Interior Lights with Switch: Factory-wired, vapor proof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
  - 1. AC lighting system and connection point for operation when remote source is available.
  - 2. DC lighting system for operation when remote source and generator are both unavailable.
  - 3. Convenience Outlets: Factory wired GFCI to enclosure load panel

### 2.10 FINISHES

- A. Indoor and Outdoor Enclosure and Components: Manufacturer's standard corrosion resistant, abrasion resistant, and heat resistant finish over corrosion resistant pretreatment and compatible primer system.

## 2.11 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.
  - 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
  - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
  - 3. Filters: One set each of lubricating oil, fuel, and combustion air filters.

## PART 3 EXECUTION

### 1.1 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. Comply with IEEE 115.
- B. Project Specific Equipment Tests: Before shipment, factory test the 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. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
  - 2. Full load run.
  - 3. Maximum power.
  - 4. Voltage regulation.
  - 5. Transient and steady state governing.
  - 6. Single-step load pickup.

7. Safety shutdown.
8. Report factory test results within 10 days of completion of test.

### 3.2 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with the manufacturer's representative present, for compliance with requirements for installation and other conditions affecting the packaged engine generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 INSTALLATION

- A. Comply with the manufacturer's written installation and alignment instructions, NFPA 110, NECA 1, NECA 404, and NFPA 70.
- B. Equipment Mounting:
  1. Install packaged engine generators on cast-in-place concrete equipment bases complying with the details shown on the Drawings.
  2. Coordinate the size and location of concrete bases and anchor bolts for packaged engine generators. Cast anchor bolt inserts into bases per templates provided by the manufacturer.
  3. Install packaged engine generator with elastomeric isolator pads on the concrete base. Secure sets to anchor bolts installed in concrete bases.
  4. Concrete, reinforcement, and formwork requirements are specified in Division 03 00 00, CONCRETE. In addition, concrete bases for seismic isolators are specified in Section 26 05 29, HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEM. Anchor bolts are specified in Section 05 50 00, MISCELLANEOUS METAL ITEMS.
- C. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.



- D. Install Schedule 40, black steel piping with welded joints and make connections to the fuel supply, engine muffler, and other components as required using stainless steel flexible connectors. Install wall and/or roof thimbles and boots as shown and as specified in Division 07 00 00, THERMAL AND MOISTURE PROTECTION. Piping size shall be as shown or the same size as the connecting component's inlet or outlet.
  - 1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless steel flexible connector, and Schedule 40, black steel pipe with welded joints.
- E. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

### 3.4 CONNECTIONS

- A. Piping installation requirements are specified in other sections included in Division 22 00 00, PLUMBING, Division 23 00 00, HEATING, VENTILATING, AND AIR CONDITIONING (HVAC), and Division 40 00 00, PROCESS INTERCONNECTIONS. The Drawings indicate the general arrangement of piping and specialties.
- B. Connect fuel, cooling system, and exhaust system piping adjacent to the packaged engine generator to allow service and maintenance.
- 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 Section 26 05 26, GROUNDING AND BONDING.
- F. Connect wiring according to Section 26 05 19, LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Provide a minimum of one 90-degree bend in flexible conduits 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.

### 3.5 IDENTIFICATION

- A. Identify field installed conductors, interconnecting wiring, and components; provide warning signs for components complying with the requirements for

identification specified in Section 26 05 53, IDENTIFICATION FOR ELECTRICAL SYSTEMS.

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: The Contractor shall engage a factory authorized service representative to test and inspect components, assemblies, and equipment installations including all connections.
- B. Perform the following tests and inspections with the assistance of a factory authorized service representative:
  - 1. Perform tests recommended by the manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.
    - a. Visual and Mechanical Inspection:
      - 1) Compare equipment nameplate data with the 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) Test protective relay devices.
      - 2) Verify phase rotation, phasing, and synchronized operation as required by the application.
      - 3) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
  - 2. Battery Tests: Equalize charging of battery cells according to the 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 the 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 element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
  5. 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.
  6. Harmonic Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
  - D. 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.
  - E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
  - F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
  - G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - H. Remove and replace malfunctioning units and retest as specified above.
  - I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.
  - J. 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.

**3.7 DEMONSTRATION**

- A. Engage a factory authorized service representative to train the Owner's maintenance personnel:
  - 1. How to adjust, operate, and maintain packaged engine generator set and all components.
- B. Also see Section 01 66 40, MANUFACTURERS' SERVICES. Provide a minimum of one person-day(s) of training separate from the inspection and testing procedures time.

END OF SECTION 26 32 13