SECTION 23 50 10
TURBINE/GENERATOR PACKAGE

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section specifies packaged turbine/generator with trim (accessories), natural gas fuel burner, fuel trains, sound enclosure, natural gas compressor, CO_2 system, combustion air cooling, controls, DC batteries and charger, portable engine cleaning cart and water injection system for NO_x control.

B. The turbine/generator manufacturer shall be responsible for providing the associated heat recovery steam generator, diverter, flues, silencers and expansions fitting. Reference Section 23 52 33.20.

1.2 RELATED WORK:

A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Section 01 60 00, PRODUCT REQUIREMENTS.

C. Section 09 91 00, PAINTING.

D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

E. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

F. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Valves for boiler trim, non-return stop-check valve, piping for fuel and feedwater trains.

G. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT: Burner controls, combustion control system, boiler water level control, pressure gages, thermometers.

H. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.

I. Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

J. Section 23 52 33.20 – HEAT RECOVERY STEAM GENERATOR.

1.3 QUALITY ASSURANCE:

A. Coordinate all new and existing equipment and conditions. This includes, but is not limited to: gas pressure regulators and available gas pressure, burner control system, combustion control system, economizer (if provided), breeching and stacks.

B. Provide written certification that the entire assembly has been coordinated to achieve the required performance and to provide the required features.

C. Manufacturer of package shall have a minimum of 5 years of previous experience in providing equipment for similar documented installations.

1.4 SUBMITTALS:

A. Before executing any work, submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Turbine/Generator Package:

1. Complete catalog information and outline drawing of package and accessories with dimensions.
2. Arrangement and description of construction of package and accessories.
3. Technical data including temperature ratings, emissions and arrangement of all components.
4. Weight of package.
5. Design pressures and temperatures.
6. Loading diagram of support frame. Evidence that turbine/generator package support requirements have been coordinated with foundation design.

10. Recommended anchorage of package support frame to foundation.

C. Manufacturer’s Instructions and Operation and Maintenance Documentation:

1. Safety precautions
2. Operator restart
3. Startup, shutdown, and post-shutdown procedures
4. Normal operations
5. Emergency operations
6. Environmental conditions
7. Preventive maintenance plan and schedule
8. Troubleshooting guides and diagnostic techniques
9. Wiring and control diagrams
10. Maintenance and repair procedures
11. Removal and replacement instructions
12. Spare parts and supply list
13. Parts identification
14. Testing equipment and special tool information
15. Warranty information
16. Testing and performance data
17. Contractor information

PART 2 - PRODUCTS

2.1 GAS TURBINE GENERATOR SET:

A. General Description: The gas turbine generator set shall be a completely integrated and fully operational package equipped with all accessories and auxiliary systems required for operation.

B. Package Description: The gas turbine generator set shall consist of an axial-flow gas turbine engine, generator, and reduction-drive gearbox. Components shall be installed in-line on a heavy-steel base frame referred to as the skid. The skid shall be a structural steel assembly with beam sections and cross members welded together to form a rigid foundation. Drip pans shall be included to collect any potential liquid leakage. Package connection points for fuel, lube oil, air, and water shall be located on the outer edge of the skid. Electrical connections shall be made in onskid junction boxes. Machined mounting surfaces on the skid facilitate component alignment. The gearbox shall be bolted directly to the engine and coupled by means of a splined interconnecting drive shaft that eliminates the need for field alignment. The gearbox and generator shall be connected by means of a flexible dry-disk, shear-type coupling enclosed in a spark-proof coupling guard. Jacking points are provided to facilitate alignment of the generator to the gearbox.

C. Major components and systems of the gas turbine generator set include:
   1. Gas turbine
   2. Reduction-drive gearbox
   3. Generator
   4. Start system
   5. Fuel system
   6. Lubricating oil system
   7. Control system
   8. Onskid electrical wiring
   9. Skid with drip pans
   10. Piping and manifolds

D. Package Electrical System
   1. The onskid package electrical system shall meet the following certification requirements:
      a. National Electrical Code (NEC)
   2. Three-Phase Motor Voltage: All three-phase motors and three-phase electrical components have the same voltage rating. Motor starters and contactors are not provided.

E. Service Connections: The generator set shall be supplied with self-contained systems for starting, fuel, lube oil, and control. All service connections shall be located on the outer edge of the skid.

2.2 GAS TURBINE:

A. General Description: The single-shaft gas turbine shall be a completely integrated and self-contained prime mover.

B. Principles of Operation: Pre-cooled combustion process air shall be drawn into the gas turbine air inlet and compressed by the multi-stage,

axial-flow engine compressor. The compressed air shall be directed into the annular combustion chamber at a steady flow. Fuel shall be injected and mixed with the compressed air and ignited during the start cycle. Continuous combustion shall be maintained as long as there is an adequate flow of pressurized air and fuel. Hot pressurized gas from the combustor expands through and drives the turbine, dropping in pressure and temperature as it exits the turbine. The excess air shall be mixed with the combustion products to reduce the gas temperature at the turbine first stage-inlet.

2.3 REDUCTION-DRIVE GEARBOX:

A. General Description: The reduction-drive gearbox shall be an industrial, epicyclic, star-gear design selected specifically for generator set applications. The reduction gearbox shall be designed for continuous-duty operation and reduces the output speed of the turbine to the required operating speed of the generator. The gearbox shall be coupled to the gas turbine through a balanced high-speed shaft, splined at both ends. The output shaft shall be coupled to the generator through a flexible disk-type dry coupling enclosed in a spark-proof coupling guard. The design of the gearbox shall facilitate straight-through shafting. Gear lubrication shall be provided by the package lube oil system.

2.4 GENERATOR AND ASSOCIATED EQUIPMENT:

A. General Description: The gas turbine package shall be provided with a generator, exciter and control system integrated to the package.

1. Standard Features: Generator shall include the following standard features:
   a. Sleeve bearings with pressure fed sumps
   b. Terminal box
   c. Form wound stator windings
   d. Amortisseur windings
   e. Rotor balance to 125% rated speed
   f. Anti-condensation space heaters
   g. Permanent magnet generator (PMG)
   h. Rotating armature-type VAC exciter
   i. Full-wave rectifier assembly
2. Rotor: The salient, four-pole, laminated rotor is dynamically balanced to minimize vibration. Motor fans shall move cooling air through the generator and around the rotor. The rotors shall have layer-wound field windings cemented with a high-strength resin and are baked to cure the resin. The rotor shall be in electrical and mechanical balance at all speeds up to 125 percent of rated speed.

3. Stator: High-grade silicon steel laminations, which are precision-punched and individually insulated. Windings shall be form-wound and treated with thermosetting synthetic varnish or vacuum pressure impregnated (VPI) epoxy for maximum moisture resistance, high dielectric strength, and high bonding qualities. The windings shall be braced to withstand shock loads such as motor starting and short circuits. Space heaters shall be supplied to minimize condensation during shutdowns.
4. Shaft: Shaft diameter shall provide the necessary stiffness to avoid torsional vibration. The turbine-driven generator set shall be given a complete torsional analysis.
5. Frame: Heavy-duty steel and fabricated with deep welds and internal reinforcing for extra rigidity and strength. The frame shall also include lifting lugs.
6. Exciter: Excitation current for the generator field coils shall be provided by a brush less rotating exciter with a permanent magnet generator (PMG) pilot exciter. The exciter shall be mounted directly on the generator rotor shaft. The exciter shall consist of two basic parts, a small three-phase, AC generator with rotating armature and a three-phase, full-wave, diode-type bridge rectifier that rotates with the armature. The pilot exciter shall be a PMG that rotates with the main generator rotor shaft. It feeds the exciter field windings with excitation current and is controlled by the combined generator control module (CGCM).
7. Bearing Lubrication System: The generator shall be supplied with a force-fed bearing lubrication system consisting of onskid piping and a filter strainer. Oil shall be supplied from the package lube oil system.

2.5 START SYSTEM:

A. General Description: The start system shall include a direct-drive AC starter motor driven by a solid-state variable frequency drive (VFD). The start system shall provide torque to initiate engine rotation and to assist the engine in reaching a self-sustaining speed.

B. Starter Motor: The starter motor shall provide high breakaway starting torque and acceleration from standstill to starter dropout speed. The motor shall be a standard frame size and constructed to be explosion proof and flameproof. The motor shall include an integral over-temperature protection thermostat connected to the control system for hazardous area motor certification and protection. Separate cable/conduit entry points shall be provided for power connections, thermal protection wiring, and the space heater wiring. Starting power

shall be transferred to the gas turbine via the reduction-drive gearbox and over-running clutch and shaft assemblies.

D. Variable Frequency Drive: The variable frequency drive (VFD) shall be a motor speed controller that provides pulse-width modulated power with variable frequency and voltage to the starter motor. Controlled by the control system, the VFD shall regulate voltage and frequency to the starter motor to control engine speed from standstill to starter dropout speed. The system shall be capable of three consecutive starts with a four-minute purge time on each start. The VFD cabinet shall be designed for installation in the location indicated on the Drawings.

2.6 FUEL SYSTEM:

A. General Description: The conventional combustion, fuel system, in conjunction with the control system, shall include all necessary components to control ignition and fuel flow during all modes of operation.

1. Conventional Combustion System: Fuel injectors shall be equally spaced around the combustor to inject fuel into the combustion chamber. The fuel injected into the combustion chamber shall be controlled during starting and steady-state operation to maintain stable combustion.

B. Gas Fuel System:

1. The gas fuel system shall include:
   a. Skid edge gas fuel filter
   b. Supply pressure transmitter
   c. Pilot air operated primary gas fuel shutoff valve
   d. Pilot air operated secondary gas fuel shutoff valve
   e. Pilot air operated gas vent valve
   f. Electrically operated fuel control valve
   g. Torch with shutoff valve and pressure regulators
   h. Main fuel manifold
   i. Fuel injectors

2.7 LUBRICATION SYSTEM:

A. The lubrication system shall circulate oil under pressure to the gas turbine and driven equipment. Lube oil shall be supplied from the lube oil tank located in the driver frame. Oil temperature shall be maintained at optimal levels by a thermostatic control valve, oil tank heater, and oil cooler. The lubrication system shall incorporate the following components:

1. Oil tank
2. Oil tank heater
3. Lube oil (supplied by Contractor to manufacturer’s specification)

4. Gas turbine driven main lube oil pump
5. AC motor-driven pre/post lube oil pump
6. DC motor-driven backup lube oil pump
7. Duplex lube oil filter system with replaceable elements
8. Oil level, pressure, and temperature indications
9. Pressure and temperature regulators
10. Strainers
11. Oil tank vent separator
12. Oil tank vent flame trap

B. Lube Oil: Lube oil shall be Contractor furnished. Petroleum base or synthetic oil with a viscosity grade of C32 or C46 may be used. Synthesized hydrocarbon oils are recommended due to lower pour point, higher viscosity index, better heat transfer, and lower oxidation rate. Lube oil must conform to turbine manufacturer’s Engineering Specification.

C. Gas Turbine-Driven Main Lube Oil Pump: The main lube oil pump shall be mounted on the reduction-drive gearbox. This positive-displacement pump shall provide lube oil pressure for normal operation.

D. AC Motor-Driven Pre/Post Lube Oil Pump: The pre/post lube oil pump shall provide oil pressure during the package start sequence and after package shutdown to protect the gas turbine and driven equipment bearings. The pre/post lube oil pump shall provide lube oil pressure during a gas turbine roll down in the event the main lube oil pump has failed.

E. DC Motor-Driven Backup Lube Oil Pump: The backup lube oil pump shall provide lube oil pressure for post lube cooling of the gas turbine and driven equipment bearings in the event the pre/post lube oil pump fails. The backup lube oil pump shall provide lube oil pressure during a gas turbine roll down in the event the main lube oil pump and pre/post lube oil pump have both failed. The backup lube oil pump shall also provide lube oil pressure during an emergency condition such as a fire, control system failure, emergency stop, or if a turbine over speed is detected by the backup system.

F. Duplex Lube Oil Filter System: The duplex lube oil filter system shall be supplied with a filter transfer valve and filter differential pressure indication with alarm. The transfer valve shall allow a filter transfer to be performed while the gas turbine is running. The lube oil filter system shall be contained completely within the skid.

G. Lube Oil Vent Coalescer: An offskid lube oil vent separator shall be provided to remove oil vapor from the lube oil tank vent airflow. The separator shall drain trapped oil vapor back to the lube oil tank and allows the remaining vent airflow to exhaust to the atmosphere. A tank

overpressure alarm and shutdown shall be included. The lube oil vent separator shall be loose shipped for offskid installation by the Contractor.

H. Lube Oil Vent Flame Arrestor: The lube oil vent flame arrestor shall prevent an ignition source from entering the lube oil tank. The flame arrestor shall be loose shipped for offskid installation by the Contractor.

I. Lube Oil System Components

1. Lube Oil Cooler: Air-to-oil type cooler shall be provided for oil cooling for the gas turbine and the driven equipment. The cooler shall be sized for specified heat loads and ambient temperatures and shall be designed for either a -3.8 degrees C or +4.4 degrees C (25 degrees F or 40 degrees F) approach temperature. The cooler shall be loose shipped for installation by the Contractor. The cooler shall be supplied for installation on the package enclosure with the interconnect piping provided.
2. Lube Oil Immersion Tank Heater: The lube oil tank immersion heater ensures the lube oil tank temperature is adequate for starting in cold conditions. The tank heater shall also facilitate a short lube oil temperature warm-up period after a cold start. Electrical supply contactors are not included.

2.8 CONTROL SYSTEM:

A. Overview: The turbine/generator control system shall control and monitor the turbomachinery package including the gas turbine and driven equipment. The system shall be expanded to include monitoring and control of the heat recovery steam generator, duct burner, diverter valve, natural gas compressor, and any other equipment that is directly package related. The system architecture shall be based on a Rockwell Automation/Allen-Bradley hardware and software platform and include fully integrated generator, vibration and fire and gas monitoring and control subsystems. The offskid configuration control system shall be mounted in an offskid console with a full set of hardwired cables connecting to the package. An independent backup shutdown system shall provide additional protection. This shuts the package down in a safe and orderly manner in the event of malfunction of the primary control system.

B. Component Descriptions: The control system shall have the following components:

1. Controller
2. Input/Output Modules
3. Vibration Monitoring System

4. Backup Shutdown System
5. Fire and Gas System
6. Combination Generator Control Module
7. Control System Power Supplies
8. Interconnect Cables – Offskid Control Systems
9. System Monitoring and Control Functions
10. Display and Monitoring System

2.9 GENERATOR CONTROL AND MONITORING:

A. General Description:

1. For generator control and monitoring, the control system incorporates a Rockwell Automation/Allen-Bradley combination generator control module (CGCM). The CGCM provides generator control, protection and monitoring. Three excitation control modes shall be available:
   a. Automatic voltage regulation (AVR) - A constant generator output voltage is maintained.
   b. Power factor (PF) control - A constant power factor is maintained when operating in parallel with a large power source.
   c. Reactive power control - A constant reactive load is maintained when operating in parallel with a large power source.
2. The following excitation control features shall be available:
   a. Under frequency limiting
   b. Over and under excitation limiting
   c. Reactive droop compensation
   d. Cross-current compensation
   e. Line-drop compensation
3. Protection features for the driver and driven equipment shall include:
   a. Field current limit
   b. Generator overcurrent
   c. Generator overvoltage
   d. Generator undervoltage
   e. Loss of excitation current
   f. Loss of operating power
   g. Loss of sensing
   h. Over excitation voltage
   i. Overfrequency
   j. Underfrequency
   k. Phase rotation error
   l. Reverse power
   m. Reverse volt amp reactive (VAR)
   n. Exciter (rotating) diode monitor

2.10 ENCLOSURE:

A. General Description:

1. A complete package enclosure shall be provided. The enclosure housing shall be a completely self-contained, weatherproof, insulated, and sound-attenuated system. The enclosure shall be mounted on the package skid.
2. The sides of the enclosure shall consist mostly of doors supported by narrow panels to allow for access to major components. The engine shall be capable of being removed from either side of the package after the doors and narrow panels are removed in that area. All maintenance enclosure doors include a stainless steel three-point heavy-duty door locking mechanism, handles, hinges, latching mechanism, internal lock override release, restraining device and attaching hardware.
3. The enclosure panels shall be treated with fiberglass material for sound attenuation and thermal insulation. Weather stripping shall be installed between all panels for sealing and sound attenuation. The enclosure shall be factory assembled on the package skid prior to shipment. The following standard features shall be included with the basic enclosure:
   a. Inlet and exhaust ventilation silencers
   b. Single fan ventilation system
   c. Pressurization system
   d. AC lighting
   e. Equipment handling system
   f. Stainless steel door hardware
   g. IP34 Rating

B. Enclosure Features:

1. Inlet and Exhaust Ventilation Silencers: The enclosure ventilation openings shall be equipped with silencers and weather louvers.
2. Single-Fan Ventilation: A single high-efficiency motor-driven fan shall provide enclosure ventilation. The ventilation fan shall provide airflow to ensure the enclosure internal air temperature remains within acceptable limits.
3. Enclosure High Temperature Alarm: A heat sensor, completely separate from the fire system thermal detectors, shall be mounted in the enclosure. The sensor shall be set to activate an alarm and shutdown if enclosure temperature is abnormally high.
4. Pressurization System: The driver section of the enclosure shall have a positive pressure to prevent the entry of potentially hazardous external atmospheres through the enclosure seams. A differential

pressure switch shall be provided to indicate an alarm when low enclosure pressure is detected.

5. Lighting: Fluorescent lighting shall be provided to illuminate the enclosure interior. Lighting on/off switches shall be provided on the enclosure exterior.
6. Equipment Handling Kit:
   a. An internal gas turbine and component handling kit is provided that consists of the following:
      1) Internal trolley rail for turbine maintenance and removal.
      2) 3048-mm (1 O-ft) external extensions to the maintenance frame trolley rails with support frame (shipped separately)
      3) Rail hugger chain-fall hoists and trolley
   b. The trolley beam extension shall allow the gas turbine removal through the side of the enclosure. One end of the beam extension attaches to the inside trolley rail; the other end is f1oorstanding. The gas turbine shall be able to be removed through either enclosure side and placed on a truck bed or cart.
7. Sound Attenuation
   a. Enclosure ventilation openings shall be equipped with silencers to achieve sound attenuation as specified in Section 23 05 51.
   b. The enclosure design shall comply with U.S. Occupational Safety and Health Administration (OSHA) standards for eight-hour employee exposure.
8. Fire and Gas System:
   a. Enclosed packages shall include a fire and gas control system. Fire and gas system shall provide gas monitoring, fire detection, and extinguishing agent release using an advanced distributed architecture to monitor gas, heat, and optical flame detectors. The system shall communicate with the control system to initiate a shutdown if a fire or a high gas level is detected. On the package exterior, indicator lights, strobe lights, and an alarm horn shall provide system status. A keyswitch shall be provided to inhibit the system and a push button switch shall be provided to manually release the fire-extinguishing agent.
   b. The primary fire detection system shall use multi-spectrum IR (MIR) flame detectors. The system shall include an automatic optical integrity feature to provide a continuous check of the optical surfaces, detector sensitivity, electronic circuitry of the detector-controller system, and automatic fault identification with digital display of system status in numerical code. The secondary detection system shall consist of rate-compensated

thermal detectors. The two detection systems shall act independently in detecting and reporting a fire.

c. The fire system control panel shall provide system supervision (for open circuit, ground fault, or loss of integrity), initiate alarm and release of fire suppression agent, and visual display of system status. The suppression system agent release shall be activated automatically with release solenoids located on the fire suppression skid. The CO_2 suppression system shall be activated manually by switches mounted on the gas turbine enclosure or at the suppression skid. If a fire is detected, the fire detectors shall transmit an electrical signal to the fire system control panel to activate the fire alarm and suppression system.

d. The enclosure shall be equipped with two gas detectors: one at the gas turbine enclosure ventilation air inlet and the other at the ventilation exhaust to provide continuous monitoring of combustible gases. The detectors shall consist of IR hydrocarbon sensors that provide input to the logical operating network (LON) module. The gas turbine start signal shall be interlocked with the combustible gas monitoring system to ensure the atmosphere is safe prior to initiating a turbine engine start. An alarm shall be initiated if the gas monitor fails.

9. Enclosure Configuration: An enclosure shall house both the gas turbine and generator.

10. Dust Protection System: The enclosure ventilation inlets shall be equipped with a single-stage, disposable, barrier-type filter unit equipped with a differential pressure alarm switch. The ventilation exhaust openings are equipped with back-draft dampers to prevent the entry of dust when the unit is not running.

11. Door Open Alarm: The enclosure doors shall be equipped with a door position switch that will initiate an alarm when any enclosure door is not closed securely.

12. CO_2 Fire Suppression System

a. The enclosure shall be equipped with a CO_2 fire suppression system consisting of a primary total flooding distribution system and a secondary metered distribution system to extend the design concentration of 37 percent CO_2 for 20 minutes.

b. On fire detection by the fire and gas detection system, the detectors shall transmit an electrical signal via the fire control panel to activate the fire suppression system release solenoids located in the CO_2 fire suppression cylinder cabinets. On receipt of this signal, the solenoid actuated control heads shall activate

the CO_2 cylinders, releasing CO_2 into the enclosure. CO_2 pressure actuates the pressure trip operated dampers that close all vent openings. CO_2 release control heads shall be provided with manual release levers.

13. Fire Cylinder Cabinets: The extinguishing agent cylinders shall be supplied in a weatherproof cabinet. The cabinets shall be equipped with service doors. The manual pull levers shall be routed by cable to the exterior wall of the cabinet.

2.11 AIR INLET SYSTEM:

A. General Description: Air inlet shall be in the vertical position with air inlet systems and support structures.

B. Prefilter and Barrier Inlet Air Filter: The prefilter and barrier inlet air filter system shall be suitable for the environment in which the turbine/generator is installed. The system shall consist of vertical moisture eliminators, direct-contact prefilter elements, and high efficiency barrier filter elements. Access doors shall be provided in the filter housing for servicing. Provide an insect screen. Provide 3 sets of filter. One set shall be used for startup.

C. Air Inlet Silencer: Air inlet silencers shall be incorporated into the air inlet ducting to reduce noise levels.

D. Provide a combustion air cooling coil, downstream of the inlet air filters, capable of cooling combustion air from 100.2 dB/78wB to 59 degrees F dB/49.4 wB to maintain turbine entering air conditions. Chilled water is available at 44 degrees F supply and 58 degrees F return temperature. Both the filter and coil shall be supported from the turbine enclosure by manufacturer-provided supports. The cooling coil leaving air temperature shall be controlled by the turbine controller to maintain optimal entering air temperature to the turbine by modulating a two-way control valve.

2.12 EXHAUST SYSTEM:

A. General Description:

1. The turbine/generator manufacturer shall provide a complete exhaust system including diverter valve and heat recovery system to meet specific application requirements. The system shall be designed to minimize the backpressure imposed on the gas turbine exhaust and provide a smooth flow transition into the exhaust heat recovery device.

2. The exhaust system typically shall consist of all components installed downstream of the engine exhaust bellows expansion joint, including silencers, diverter valve and externally insulated ducting, that are necessary to ensure a smooth flow of exhaust gas from the

engine. The exhaust duct system shall be terminated in a manner that precludes recirculation of exhaust products through the engine air inlet or oil cooler.

3. Exhaust silencing is required. Mount and support the equipment and limit the exhaust silencer pressure loss. Silencers and expansion joints shall be provided by the turbine manufacturer.

B. Exhaust Silencer: The exhaust silencer shall be connected to the gas turbine exhaust by externally insulated ducting and a cylindrical bellows.

C. Turbine Exhaust Heat Recovery System:

1. See Section 23 52 33.20.

2.13 FUEL GAS COMPRESSOR PACKAGE

A. A fuel gas compressor (FGC) package shall be provided to boost the incoming gas pressure from the utility to that required by the prime mover. The package shall include, but not necessarily be limited to, the following:

1. 1, 100%-capacity, rotary screw type gas compressor and electric motor driver(s).
2. Motor starter.
3. Variable Frequency Drive (if required)
4. Suction/discharge manifolding to the edge of the skid
5. Intercoolers and aftercoolers
6. Filters, separators and scrubbers
7. Lube oil system
8. Gas/Oil Coolers
9. Automatic on/off systems
10. Flow and pressure control systems
11. All valves, relief valves, drains, vents, instrumentation and compressor accessories required by applicable codes, and VA Boiler Plant Safety Device Testing Manual. Reference Section 23 08 11.
12. Sound attenuation enclosure and silencers to limit sound levels to 85 DBA.
13. Ventilation as required to limit gas levels per NFPA. Include notification/alarm of excessive gas levels within the enclosed area.
14. Surface preparation and painting for indoor exposure per manufacturer’s standard.
15. Provide cooled shell and tube heat exchange to cool the package. Available chilled water is 44 degrees F supply and 58 degrees F return temperature.
16. Computer-based compressor package control system including pressure controls, meters, gages, alarms and miscellaneous controls, locally

mounted in modular enclosure. All control equipment requiring a conditioned space shall be centrally located in a conditioned environment. Control system shall be capable of interface with PCS via data link.

17. Provide power distribution panel for single-point power supply connection to unit. Provide all necessary circuit breakers, starters and control power transformers.
18. Provide fuel gas and heat detection system and interface controls with existing boiler plant control system.

2.14 ACCESSORY EQUIPMENT:

A. Components and systems within Vendor’s Scope shall be skid mounted, and complete including all control valves, piping, equipment, instrumentation, controls, alarms, wiring, insulation, cladding and any other items required for a complete, functional, highly reliable and highly-automated installation in accordance with good engineering practices and the rigorous demands of industrial power plant service.

B. Battery Charger System:
   1. The battery charger system shall consist of a battery charger and batteries to provide 24 VDC emergency power to the control console, fuel valve, bleed valve and variable guide vane actuators, and the DC backup lube oil pump. The battery charger system shall be designed for indoor installation in a nonhazardous area. Battery includes:
      a. Valve Regulated Lead Acid
   2. Valve Regulated Lead Acid: The batteries shall be mounted freestanding in a floor-standing cabinet. The batteries shall be shipped wet, fully charged and ready for use.

C. Turbine Cleaning System:
   1. Provide turbine compressor cleaning system to facilitate periodic cleaning of the turbine compressor. The cleaning system shall be designed for use in salt-laden or dusty environments or where compressor contamination from hydrocarbon vapors is possible. The turbine compressor cleaning system shall be composed of the following systems:
      a. On-crank cleaning system
      b. On-line cleaning system
   2. Both cleaning systems shall be independent of each other and include a separate distribution manifold with pressure atomizing spray nozzles in the engine air inlet collector, onskid piping, strainer, and solenoid shutoff valves to deliver water or approved cleaning fluid to the manifold

3. Turbine Cleaning Cart: A portable offskid cleaning tank shall be provided to supply cleaning fluid to the skid edge cleaning system connection. The cleaning tank shall be used to mix, hold, and pressurize the turbine cleaning solution. The tank shall come with wheels that are removable for stationary installation.
4. Package Lifting Kit: A package lifting kit shall be shipped separately that contains slings, spreader bars, and assorted hardware to facilitate separate lifting of the driver and driven equipment modules with or without an export crate.

D. Provide deionization, filtration and water injection equipment necessary to control emissions to the scheduled values indicated on the Drawings. Emissions requirements for this site shall be confirmed by the VA PM/COTR.

2.15 QUALITY ASSURANCE AND TESTING:

A. Testing: Factory testing shall be in accordance with the manufacturer’s engine test specifications and as specified below. The customer or customer's designated representative shall observe factory production tests listed in the production and testing schedules. The production test facility shall provide a comprehensive test program using simulators to perform static testing of package systems to verify control, system operation, and component calibration.

1. Test Phases: Manufacturer’s production test facilities shall provide a three-phase test program. The first phase uses simulation equipment to perform static testing of the control console and package systems to verify electrical and fluid system continuity and calibration. The second phase shall consist of interconnecting the package and control console to undergo additional simulated systems testing of the total package. In the final phase, the package shall be controlled and monitored by its own control console and the computerized test facility.
2. Generator Package Acceptance Testing:
   a. The basic package assembly, which includes the gas turbine, reduction-drive gearbox, generator, package-mounted accessories, and control console, shall be tested as a complete system to ensure proper integration and function in accordance with the manufacturer’s package test specifications. Results are recorded and maintained by the manufacturer. The acceptance test shall include the following:
      1) Starting and combustion cycles
      2) Lubricating oil system temperature and pressure measurements
      3) Vibration measurements

4) Turbine and generator temperature measurement
5) Load/speed transient testing
6) Test facility is capable of 1 MW Max Load
7) Malfunction and safety devices testing
8) AC metering and control circuitry testing (if AC metering is supplied), calibration of AC metering circuits is performed by bench testing.

b. The package shall be tested with the generator.

3. Generator Testing: The generator shall be tested in accordance with the Institute of Electrical and Electronic Engineers (IEEE) standard specifications and manufacturer’s specifications at the manufacturer's plant. These tests shall satisfy both the manufacturer and National Electrical Manufacturers Association (NEMA) requirements.
4. Acceptance Test Data: Acceptance test data shall be reviewed and approved by Test Engineering, Quality Engineering, and the project manager prior to submittal to the customer. Furnish test data four weeks after completion of acceptance testing to Owner. Test data results shall be reviewed prior to acceptance by PM/COTR. The test data shall include test result comparisons to manufacturer’s acceptance test specifications using calculations, graphs, strip charts, and descriptions. The acceptance test data generally shall include the following:
   a. Lubricating oil pressure, temperature, and flow
   b. Package temperatures
   c. Generator power
   d. Generator voltage, amperage, and frequency
   e. Engine compressor discharge pressure
   f. Package vibration levels

2.16 INSTALLATION AND DOCUMENTATION:

A. Mechanical Installation Requirements:
   1. General: The turbine generator package shall be installed by the Contractor per the manufacturer’s installation requirements. The manufacturer shall provide qualified personnel to direct the installation of the cogeneration equipment. The manufacturer’s representative shall conduct weekly site visits during the installation.
   2. Mounting: Mounting pad locations and weights for the package shall be clearly shown on the installation drawings. The equipment layout shall provide adequate floor space for major components

with sufficient room around the package for routine maintenance access.

3. Lube Oil Cooler: The lube oil cooler shall be mounted on an ancillary manufacturer-provided support frame on top of the enclosed package.
4. Gas Turbine Air Inlet System: The gas turbine air inlet shall be mounted on an auxiliary manufacturer-provided support frame on top of the enclosed package
5. Gas Turbine Exhaust System: The exhaust duct system shall be terminated at roof level per plans.
6. Documentation: Turbine/generator manufacturer shall provide extensive documentation for its Turbomachinery. This includes electrical and mechanical drawings, quality control data books, and operation and maintenance manuals.
7. Onsite manufacturer’s representative shall be provided during startup, testing and commissioning.

2.17 CERTIFICATION:

A. Turbine/generator package shall comply with:
   1. National Electrical Code (NEC)
   2. Occupational Safety and Health Administration (OSHA)
   3. National Fire Protection Association (NFPA)
   4. Underwriters Laboratories Incorporated (UL)
   5. American Society of Mechanical Engineers (ASME)
   6. National Association of Corrosion Engineers (NACE)
   7. Factory Mutual (FM)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
B. Turbine/Generator Package and Accessories: Arrange all equipment and piping to allow access to openings without disassembly of equipment or piping.

3.2 CLEANING AND PROTECTION FROM CORROSION

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

3.3 INSPECTIONS AND TESTS

A. The following tests and demonstrations, except pretests, must be witnessed by the PM/COTR or their representative and must prove that turbine/generator package, controls, instruments, and accessories comply

with requirements specified. When test results are not acceptable, corrections must be made and the test repeated at no additional cost to the Government. Pretests do not require the presence of the PM/COTR.

3.4 STARTUP AND TESTING

A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the PM/COTR and Commissioning Agent. Provide a minimum of 7 days' prior notice.

3.5 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.6 DEMONSTRATION AND TRAINING

A. Provide services of manufacturer's technical representative for four hours to instruct each VA personnel responsible in the operation and maintenance of units.
B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

3.7 TURBINE GENERATOR SYSTEM GUARANTEE, MAINTENANCE AND SERVICE CONTRACT PERIOD (FIVE YEARS)

A. Contractor shall guarantee that all provided material and equipment identified in this Section 23 50 10 will be free from defects, workmanship and will remain so for a period of one year from date of final acceptance of the CHP System by the VA. The Contractor shall provide original equipment manufacturer's equipment warranty documents to the PM/COTR, that certifies each item of equipment installed conforms to OEM published specifications.
B. The Contractor shall provide full maintenance, full service, annual overhaul and emergency call back for a period of five (5) years from date of final acceptance. The start of the 5 years of service contract shall be concurrent with the start of the 1-year guarantee identified in Paragraph 3.7, A, above. The 5-year maintenance service contract shall include all equipment identified in this Section 23 50 10. The Contractor shall provide a complete turbine/generator overhaul,

including replacement of turbine, at the end of the five-year warrantee. Upon completion of the turbine/generator overhaul, the Contractor shall fully test the system and perform acceptance testing witnessed by the PM/COTR and prove that the turbine/generator package meets the original specified requirements.

C. The Contractor's maintenance personnel shall have the ability to contact the original equipment manufacturer for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time. This contact capability shall be provided by the Contractor and OEM at no additional cost to the VA.

D. All Contractor maintenance and supervisor personnel shall be fully qualified by the original equipment manufacturer and must provide two (2) copies of current and qualified original equipment manufacturer training certificates and original equipment manufacturer certification upon request.

E. The Contractor shall accomplish the following minimum requirements during the five-year guarantee period:

1. Required On-Site Visits:

    a. The Contractor shall visit, on-site, for a minimum of eight (8) hours, once every 12 weeks (minimum of 22 visits over the guarantee period), during the guarantee period, to perform inspection, preventive maintenance, equipment cleaning, and operational adjustments to maintain the System and report findings in written form relative to material condition and performance.

    b. The Contractor shall arrange all Facility visits with the PM/COTR or Boiler Plant Supervisor prior to performing the required maintenance visits.

    c. Service personnel shall report to the Boiler Plant Supervisor or his authorized representative upon arrival and again upon completion of the required work. A copy of the work ticket containing a complete description of the work performed shall be given to the residing Plant Operator.

    d. The Contractor shall maintain a log in the Control Room. The log shall list the date and time of all scheduled and unscheduled maintenance activities, fully describing the nature of each visit.

2. Response Time:

    a. A standard work week is considered 8:00 A.M. to 5:00 P.M. or as designated by the PM/COTR (or Boiler Plant Supervisor), Monday through Friday exclusive of Federal holidays. Scheduled

maintenance activities will be conducted during the standard work week interval.

b. The Contractor shall respond to and correct unscheduled maintenance during the standard work week within one (1) working day of its report.

c. The Contractor shall respond to emergency unscheduled maintenance within four (4) hours of its report. An emergency call-out is defined as an event that causes loss of a utility at a distribution point or within a building.

3. Inspections and Maintenance:

a. Inspections, service, repairs and preventive maintenance shall be performed by the Contractor in accordance with the OEM's recommended practice and service intervals during scheduled periods agreed to by the PM/COTR and Contractor.

b. The preventive maintenance schedule, functions and reports shall be provided to and approved by the Resident Engineer.

c. Work Not Included: Maintenance and repair service shall not include the performance of any work due to improper use; accidents; other vendor, contractor, or owner tampering or negligence, for which the Contractor is not directly responsible and does not control. The Contractor shall immediately notify the PM/COTR in writing upon the discovery of these incidents. The PM/COTR will investigate all reported incidents and render findings to Contractor.

4. Reporting:

a. The Contractor shall provide the PM/COTR a type written report itemizing each deficiency found and the corrective action performed during each scheduled and unscheduled visit. The Contractor shall provide the PM/COTR with sample copies of these reports for review and approval prior to acceptance testing of the equipment.

b. The Contractor shall provide a quarterly summary all equipment and sub-systems serviced during this guarantee period and service contract to PM/COTR by the tenth ($10^{th)}$ working day after the end of each quarter. The report shall highlight the performance of the systems during the quarter. The report shall also clearly and concisely describe the services rendered, parts replaced and repairs performed. The report shall prescribe anticipated future needs of the equipment and systems for preventive and predictive maintenance.

c. The Contractor shall maintain a separate log entry for each major component in the CHP System. The log shall list dates and times of all scheduled, routine, and emergency calls. Each emergency call shall be described with details of the nature and causes of emergency steps taken to rectify the situation and specific recommendations to avoid such conditions in the future.

d. The PM/COTR shall convey to the Chief, Facility Service, two (2) copies of quarterly reports for evaluation. The PM/COTR shall ensure a copy of these reports is entered into the CHP System’s official acquisition documents. The Chief, Facility Service, shall ensure a copy of these reports is entered into the System’s official technical record documents.

5. The 5-year guarantee shall include the following CHP components:
   a. Turbine generator package and accessories as specified in this section.
   b. Fuel gas compressor.
   c. Water injection plant for emissions control.
6. All air filters and oil filters shall be included in the 5-year guarantee period.

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