DERWICK

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SCOPE OF SUPPLY

.

Gas Turbine

Base-mounted gas turbine including:

- Modulating IGV (inlet guide vanes)

Combustion System

- Dry Low NOx combustion system
- Combustion system features
  - Thermal barrier coated liners
  - Nimonic transition pieces
  - Reuter Stokes SiC flame detectors
  - Compressor inlet heating
    - Stainless steel water injection piping (GT unit)
- Water injection for NOx control
  - Liquid fuel
  - Off base water injection skid with:
    - Enclosure
    - Space heater
    - Water injection pump with variable frequency drive
    - Water filter

Fuel Systems

Gas Fuel System

- Natural gas
- Stainless steel gas piping
- Natural Gas Flow measurement System Orifice Plate
- Calibration of Natural Gas Flow Measurement System - Orifice
- Single gas strainer
- Gas fuel valves on accessory base
- Gas fuel temperature < 365°F (185°C)
- Gas fuel conditioning equipment
  - Fuel gas scrubber, cyclone type
  - Duplex absolute separator filter
    - Fuel gas chromatograph system
  - One (1) system provides signals for up to four (4) gas turbines

Liquid Fuel System

- Stainless steel fuel oil piping
- Duplex, low pressure fuel filters, on-base
- Main liquid fuel filter differential pressure transducer, 96LF
- Liquid fuel/atomizing air module
- Single, motor driven, atomizing air compressor
- Motor driven, 1x100% capacity, main liquid fuel pump
- Main liquid fuel pump inlet pressure transducer, 96LP
- Liquid fuel recirculation system during gas fuel operation
  - On-base piping in turbine compartment and LF/AA module
  - Requires fuel forwarding pump in operation if not supplied with gas turbine scope
- Distillate fuel forwarding system configured to supply one (1) gas turbine

  - Inlet/discharge valves for skid isolation
- Duplex fuel oil strainer with differential pressure switch and gauge
  - AC motor driven distillate fuel pump with pressure switch
  - One (1) back-up ac motor driven distillate fuel pump per forwarding skid
  - Motor starters not provided in the gas turbine scope of supply
  - Pressure regulating valve
  - Separate distillate fuel heater skid (up to 20°F rise) with thermal relief valve (one (1) heater skid per turbine)
    - Inlet/discharge valves for skid isolation
    - SCR control panel mounted on skid unless area is rated Class 1, Group D, Div 2 or IEC Zone 2. When skid is rated as a hazardous area, the control panel must be installed in a climate controlled, non-hazardous area. This installation is not included in the gas turbine scope of supply.
  - Carbon steel fuel oil piping
  - Electrical conduit & junction boxes
  - Instrumentation and gauges (dual metric/English)
  - Weatherproof acoustic enclosure(s)
    - With fire detectors
    - With vent fan and lighting
  - No enclosure for the fuel forwarding skid
  - Hazardous area rating (Class 1, Group D, Div 2 or IEC Zone 2)

- Distillate fuel management spool piece
  - Inlet/discharge valves for skid isolation
  - Combined pressure regulating/stop valve
  - Flow meter
    - With local and remote flow and totalizer readout
    - With ± 0.5% system accuracy for the design fuel
  - Carbon steel fuel oil piping

Lubricating and Hydraulic Systems

Pumps

- AC motor driven dual lube oil pumps
- AC motor driven dual hydraulic pumps

- Used for jacking oil also
- DC motor driven, emergency lube oil pump
- AC/DC motor driven auxiliary generator seal oil pump

Filters and Coolers

- Dual lube oil system filters
- Dual hydraulic oil filters
- Dual lube oil coolers
  - Plate/frame type with stainless steel plates
- ASME code stamp
  - Lube oil coolers
  - Lube oil filters

Lube Oil Piping

- 304L stainless steel lube oil feed pipe
- Carbon steel lube oil drain pipe
- Lube system valve stainless steel trim
- Automatic GMAW or GTAW root pass weld, lube oil feed and drain piping

Mist Elimination

- Lube vent demister

Oil Reservoir

- With heater for -20°F (-29°C) ambient temperature
- With provisions for lube oil conditioner

Instrumentation

- Delta pressure switches for alarm for lubrication and hydraulic oil filters
- Lubrication oil tank level transmitter

Inlet System

- Refer to GEK 111330a “Operation and Maintenance Recommendations for Gas Turbine Inlet Air Filter Compartments” provided in chapter 22 of this Appendix, for operation and maintenance information for the GT inlet system.

- Inlet system arrangement
  - Up and forward inlet system arrangement
- Inlet compartment
  - Self-cleaning inlet filter
  - Compressor bleed air supply for filter cleaning
  - Severe duty filter media (high humidity/corrosive environments)
  - 50 micron moisture separator
  - Coalescing filters
  - Inlet compartment local differential pressure indicator (gage) across each stage of filtration and overall filter compartment system
  - Inlet compartment differential pressure alarm
  - Three thermocouples for inlet air temperature measurement
  - Inlet filter compartment support steel (Seismic Zone 4, <= 120 mph wind speed loads per UBC 1997)
  - Evaporative cooler, 85% effective
    - Stainless steel piping
    - Redundant pumps (lead/lag)
    - Stainless steel pump casing material
  - Caged ladder access to inlet filter compartment
  - Left hand access to inlet filter compartment
  - Electric hoist with 500 lb lift capacity
  - Inlet filter compartment interior lighting
- Air processing unit (APU) for filter cleaning
  - With 304 stainless steel piping and dual filters
  - APU heat tracing kit if required due to site minimum ambient temperature rating
- Inlet compressor bleed heating
  - DLN premix turndown inlet bleed heat control
  - Compressor pressure ratio operating limit bleed heat control
  - Bleed heat manifold located in inlet duct
  - Inlet bleed heat control valve(s)
- Inlet ducting
  - Inlet duct section arrangement per proposal mechanical outline
  - Inlet silencing
  - Inlet 90 degree elbow

- Inlet transition piece
- Inlet expansion joint
- Inlet ducting support steel (Seismic Zone 4, <= 120 mph wind speed loads per UBC 1997) (Refer to proposal drawing for scope)
  - Outdoor unit
- Compressor inlet humidity sensor
  - Triple redundant sensors
- Compressor inlet temperature thermocouple

• Inlet viewing window in plenum area
• Inlet system atmospheric protection
  - Zinc rich paint inside and outside of inlet filter compartment
- Two-part epoxy overcoat inside and outside inlet filter compartment
  - Zinc rich paint with two-part epoxy overcoat on evaporative cooler unwetted section
  - Zinc rich paint inside and outside of inlet ducting with two-part epoxy overcoat on all inside surfaces exposed to airflow as well as all outside surfaces
  - Galvanized, galvannealed or carbon steel with zinc-rich primer for all interior surfaces not exposed to airflow
  - Corrosion-resistant inlet silencing perforated sheet
  - Galvanized inlet support steel

Exhaust System

Arrangement

• Exhaust diffuser with an axial exit
• Exhaust expansion joint
• Exhaust system materials and atmospheric protection
  - Carbon steel exhaust system shell and stiffeners
  - 409 stainless steel internal lagging
  - Inorganic zinc primer

Couplings

• Rigid load coupling

- Load coupling guard

Gas Turbine Packaging

- Lagging and enclosures
  - On-base accessory compartment lagging
  - Off-base acoustic enclosure for turbine only
  - Off-base load coupling compartment enclosure
  - Acoustic barrier wall around exhaust diffuser
- External junction boxes
  - Epoxy-coated carbon steel junction boxes, rated NEMA 4 or glanded IP56, dependent on whether wiring is compliant with NEC or IEC standards
  - Cast aluminum may be substituted as needed for flame-proof enclosure requirements, as determined by the hazardous area map for the project
- Compartment ventilation, pressurization and heating
  - Dual turbine compartment vent fans
  - Dual accessory compartment vent fans
  - Dual load compartment vent fans
  - Dual vent fans for liquid fuel and atomizing air skid
  - Compartment freeze protection heating
- Heated turbine and accessory compartments for humidity control
- Plant arrangement
  - Turbine designed for installation outdoors
  - Right hand accessory module
  - Multi shaft STAG
  - Mounting pads only; exterior unit walkways are not part of the power train scope of supply
  - Interior turbine compartment grating
- Base painting
  - Standard primer only

- Interconnecting Lube Oil Feed and Drain piping between accessory compartment and liquid fuel/atomizing air skid
- UBC 1997 Seismic Zone 4 loads (except for inlet and exhaust)
- UBC 1997 Seismic Zone 4 loads for inlet and exhaust
- Hazardous area classification
  - NEC Class1, Group D, Division 2
    - Turbine compartment
    - Natural gas fuel compartment
    - Liquid fuel/atomizing air module

- Special features
  - Blank set of nameplates for on-site engraving by others
  - Dual (metric-English) indicators and gauges

Fire Protection System

- Fire detection system - heat detectors
  - Turbine compartment
  - Accessory compartment
  - Number 2 bearing tunnel
  - Generator collector compartment
  - Liquid fuel and atomizing air skid
- Smoke detection system
  - Control cab/PEECC
- Compartment warning signs
- Compartment exterior alarms
- CO2 supply system
  - One low pressure CO2 tank per unit
  - Tank suitable for 0-120°F (-18 to 49°C)
  - Tank also suitable for temperatures below 0°F (-18°C)
  - Tank to be located in a shelter (not part of the power train scope of supply), for ambient temperature above 120°F (49°C)
- Fire protection piping
  - Purchaser's connections on right side of unit only
  - Turbine compartment
  - Accessory compartment

- Number 2 bearing tunnel
- Liquid fuel and atomizing air skid
- FM-200 fire protection piping for the PEECC

• Hazardous atmosphere sensors in compartments
- CHx sensors - natural gas compartment
- Triple modular redundant sensors in the gas compartment
- CHx sensors- turbine compartment
- Triple modular redundant sensors in the turbine vent duct
- H2 sensors - generator collector compartment
- Triple modular redundant sensors in the collector compartment
- H2 sensors - generator terminal enclosure

• Hazardous atmosphere detector readout
- CHx
- H2

Cleaning Systems

• On base piping for on and offline compressor water wash system
• Water wash skid
- Water storage tank and freeze protection
- Stainless steel tank
- Capability to heat water to 180°F (82°C)
- Single skid for the site
- One (1) skid can be connected to up to four (4) units, washing one (1) unit at a
time (on-base storage tank sized for one [1] off-line wash)

Cooling Water System

• Cooling system temperature regulating valve
• System suitable for:
- Water/propylene glycol coolant mix

Starting Systems

- Generator start with load commutated inverter
- Static start isolation transformer
- Oil filled

  - Outdoor installation
  - Bottom entry cable connection, HV and LV
  - Isolation transformer fed from auxiliary bus
- Redundant Ethernet link to turbine control panel
- Shared static start across power blocks using cross ties
  - Two (2) static starts for three (3) gas turbines
- Change-over function in LCI controls
- LCI output isolation switch (89MD)
- LCI cross-connect tie switch (89TS)
- AC line reactor
- Single dc link reactor
- Water-to-water heat exchanger, shipped loose

• Rotor turning systems
  - Turning gear and motor for rotor cooldown
  - Rotor indexing (borescope inspection)

Miscellaneous Systems

Special Systems

• Exhaust frame blowers on turbine compartment roof
  - Bearing area blowers also included

Generator

General Information

• Hydrogen cooled generator with conventionally cooled armature
• Outdoor installation
• 60 Hz generator frequency
• Generator voltage 18.0 kV
• 0.85 power factor (lagging)
• Capability to 0.95 power factor (leading)
• Class “F” armature and rotor insulation
• Class “B” temperature rise, armature and rotor winding
• Generator bearings
  - End shield bearing support

- Elliptical journal bearings
- Roll out bearing capability without removing rotor
- Insulated collector end bearing
- Online bearing insulation check
- Offline bearing insulation check with isolated rotor

• Monitoring Devices
- Two (2) velocity vibration probes at turbine end, one (1) at collector end
- Provisions for key phasor-generator
- Permanently mounted flux probe mounted in stator wedge (Monitoring system not included)
- Proximity vibration probes
  - Two (2) probes per bearing at 45° angle

• Generator Field
- Direct cooled field
- Two-pole field
- Finger type amortissuers

Generator Gas Coolers

• Coolers shipped installed
• Generator gas cooler configuration
- Five (5) horizontally mounted simplex coolers
- Coolers located in generator base
- Cooler piping connections on left side as viewed from collector end
- ASME code stamp
- Single wall cooler tubes
- Victaulic cooler couplings
- Plate fins
- Cooling water manifold and isolation valves
- Companion flanges for cooler connection

• Generator gas cooling system characteristics
- Coolant temperature - 20°F approach
- Generator capacity with one section out of service 80% with Class “F” rise

  - TEMA class C coolers
  - Maximum cooler pressure capability - 125 psi
  - Coolant 55% water and 45% propylene glycol by volume
  - Fouling factor 0.0010
- Generator gas cooler construction materials
  - 90-10 copper-nickel or copper tubes as appropriate
  - Carbon steel tube sheets
  - Carbon steel waterbox and coupling flanges with epoxy coating
  - Aluminum cooler tube fins

Generator Lube Oil Systems and Equipment

- Bearing lube oil system
  - Generator lube oil system integral with turbine
  - Sight flow indicator
- Bearing lift oil system
  - Stainless steel lift oil piping and tubing
  - Lift oil supplied from turbine oil system
- Lube oil system piping materials
  - Stainless steel lube oil feed pipe
  - Carbon steel lube oil drain pipe
  - Welded oil piping

Generator Grounding Equipment

- Neutral grounding equipment
  - Neutral ground transformer and secondary resistor
  - Mounted in terminal enclosure
  - Motor operated neutral disconnect switch

Generator Temperature Devices

- Stator winding temperature devices
  - 100 ohm platinum RTDs (resistance temperature detector)
  - Dual element RTDs
  - Grounded RTDs
  - Nine (9) stator slot RTDs
- Gas path temperature devices

- 100 ohm platinum gas path RTDs
- Dual element temperature sensors
- Four (4) cold gas
- Two (2) hot gas
- GTG-2 (common cold gas)

- Bearing temperature devices
  - Chromel alumel (type K) thermocouples
  - Dual element temperature sensors
  - Two (2) bearing metal temperature sensors per bearing
- Collector temperature devices
  - 100 ohm platinum RTDs
  - Single element temperature sensors
  - Collector air inlet temperature sensor
  - Collector air outlet temperature sensor
- Lube oil system temperature devices
  - Chromel alumel (type K) thermocouples
  - Dual element temperature sensors
  - One (1) bearing drain temperature sensor per drain

Packaging, Enclosures, and Compartments

- Paint and preservation
  - Epoxy based primer
- High voltage bushings
  - High voltage bushings shipped installed
  - Six (6) ambient air cooled, high voltage bushings
- Generator Terminal Enclosure
  - Terminal enclosure shipped separate
  - Top mounted
  - Neutral terminals integral with line-side terminal enclosure
- Line-side terminal enclosure
  - Terminal enclosure shipped separate
- Generator Terminal Configuration
  - Phase sequence R-C-L when looking at enclosure terminals
  - Outgoing power connection on right side when viewed from collector end

- Collector compartment/enclosure
  - Collector compartment/enclosure shipped separate
  - Collector/brush holding rigging
- Generator Terminal Accessories
  - Line CTs
  - Lightning arresters
  - Voltage transformers
  - Neutral CTs
- Compartment lighting
  - AC lighting
    - Collector compartment
- Foundation hardware
  - Generator alignment fixators
  - Generator alignment key(s) - collector end
  - Generator alignment key(s) - turbine end

Hydrogen Systems and Accessories

- Hydrogen gas manifolds
  - Auto purge gas purge control manifold
  - Hydrogen/CO2 control valve assembly
  - H2/CO2 bulk feed connections
  - H2 Bottle manifold not provided
  - CO2 bottle manifold not provided
- Hydrogen detection system
  - H2 detection sensor(s)
    - Collector compartment
    - Terminal enclosure
- Seal oil system
  - Control unit mounted in collector compartment
  - Stainless steel seal oil feed pipe
  - Carbon steel seal oil drain pipe

Electrical Equipment

- Motors
  - TEFC motors
  - Coated with antifungal material for protection in tropical areas
  - Energy saver motors
  - Extra severe duty motors
  - Cast iron motor housings
- Heaters
  - Generator stator heaters
  - Generator collector heaters
  -

Generator Excitation Systems, Static Components

- Bus fed static excitation with warm backup bridge

Excitation Module Features

- Control/monitor/display through turbine control panel
  - Voltage matching in turbine control system
  - Power factor controller in turbine control system
  - Var controller in turbine control system
  - Selection of automatic or manual regulator
  - Raise-lower of the active regulator setpoint
  - Enter setpoint command
  - Display field amps
  - Display field volts
  - Display transfer volts
- Redundant Ethernet link to turbine control panel
- Built-in diagnostic display panel
  - Automatic voltage regulator (AVR)
  - Manual voltage regulator (FVR)
  - Automatic and manual bi-directional tracking
  - Reactive current compensation (RCC)
  - Temperature compensation for UEL and OEL
  - Volts per hertz limiter (V/Hz LIM)
  - Volts per hertz protection (24EX) (Backup to 24G)
  - Over excitation limiter (OEL)
  - Offline/online over excitation protection (76EX)

  - Loss of excitation protection (40EX)
  - Bridge ac phase unbalance protection (47EX)
  - Under excitation limiter (UEL)
  - Generator overvoltage protection (59EX)
  - Generator field ground detector trip (64FT)
  - Field over-temperature alarm
  - Field ground detector alarm (64FA)
  - Exciter phase voltage imbalance (47EX)
  - Bridge over-temperature (26EX)
- Local operator interface, panel mounted
- Dual source internal bulk power supply
- Millivolt shunt for field
- Surge protection
  - VT disconnect and CT shorting switches
  - Two phase current sensing
  - Three phase voltage sensing
  - Single pole dc field contactor/bridge
- Thyristor bridge circuit filtering
- Shaft voltage suppressor circuit (mounted in panel)
- Power system stabilizer

Performance

- 2.0 response ratio and 160% VFFL (100°C) ceiling @ Vt = 1.0pu

Excitation Location

- Installed in LCI/EX compartment

PPT Features

- Freestanding oil-filled PPT for outdoor installation
- PPT fed from auxiliary bus

LCI Features

- LCI located in LCI/EX compartment
- LCI output isolation switch (89MD)
  - Located in LCI compartment

- LCI cross-connect tie switch (89TS)
  - Located in LCI compartment
- LCI disconnect switch (89SS)
  - Located in generator terminal enclosure
- LCI fuse
  - Located in compartment with LCI

Generator Current Transformers and Voltage Transformers

- Current transformers (CTs)
  - Line-side CTs with relaying class C800 and metering class 0.3B-1.8 (ANSI C57.13)
  - Neutral-side CTs with relaying class C800 and metering class 0.3B-1.8 (ANSI C57.13)
  - Line side CTs
    - CT 13, 14, 15 (miscellaneous functions)
    - CT 19A, C (excitation)
    - CT 21, 22, 23 (generator differential relay)
  - Neutral CTs
    - CT1, CT2, CT3
    - CT4, CT5, CT6
    - CT7, CT8, CT9
    - CT10, CT11, CT12
- CT calibration curves, provided after equipment ships
  - For line-side CTs
  - For neutral-side CTs
- Voltage transformers (VTs)
  - Fixed
  - VT2, generator line side
  - VT4, generator line side

Gas Turbine-Generator Controls and Electric Auxiliaries

Control Cab/Packaged Electric and Electronic Control Compartment (PEECC)

- Weatherproof, climate controlled, base mounted enclosure
- Redundant HVAC system
- Mounted on pedestals

Gas Turbine Control System Panel Features

- Triple Module Redundant (TMR) SPEEDTRONIC™ Mark VIe with non-remote I/O
  - Redundant unit data highway (UDH)
- Auto/manual synchronizing module with synchronizing check function
- Generator stator overtemperature alarm (49)
- Load limiter
- Purge cycle
- Island mode operation for DLN units
- Automatic transfer from gas to liquid fuel
- Customer alarm/trip contact for CRT display
- Additional customer input contacts (digital), as available
- Additional customer output contacts (digital), as available
- Provision for analog inputs from customer, as available
- Provision for analog outputs to customer, as available
- Maximum of 12 RTDs inputs for customer use
- Power source selector
- Totalizing fuel flows
- Vibration alarm readout and trip
- Electrical overspeed protection
- Constant settable droop
- Power factor calculation and display
- Power factor control
- VAR control
- VARS shedding
- Tie-line VAR control
- Manual set point preselected load

- External load setpoint, 4-20 mA control
- Airflow calculation and readout
- Inhibit/initiate auto synchronization from remote location
- Time synch
  - Time input signal, for devices on the power train network, is not part of the power
    train scope of supply

Local Operator Station

- Commercial grade personal computer
- Operator interface 19" rack
- PC table
- Color monitor
  - Rack mounted
  - 17 in. LCD monitor or equivalent
- Keyboard with built-in cursor positioning device
- Printer
  - Color ink jet printer
- Display in English language
- Unit Ethernet equipment

Generator Protection Panel

Generator Protection Panel Hardware

- Mounted in PEECC
- GE Multilin G60 Generator Management Relay
- GE Multilin T60 Transformer Management Relay
- GE Multilin C60 Breaker Management Relay
- Generator Digital Multimeter
- Lockout relays
- Test switches (per one-line)
- Generator breaker trip switch (52G/CS) and lamps
- Gas auxiliary monitoring panel (GAMP)
  - Humidity sensor readout

- Hazardous atmosphere detector readout
- Bently Nevada 3500 vibration monitor

Generator Management Relay (G60)

- Generator overexcitation (24)
- Phase undervoltage (27P)
- Reverse power/anti-motoring (32)
- Loss of excitation (40)
- Current unbalance/negative phase sequence (46)
- Phase time overcurrent (51PV)
- Neutral ground overvoltage (stator ground) (59N)
- Phase overvoltage (59P)
- Stator ground protection, (third harmonic) (27TN)
  - Site data required for setting
- Generator over frequency (810)
- Generator under frequency (81U)
- Phase Distance (21)
- Out of Step (78)
- Stator differential (87S)
- Voltage transformer fuse failure (VTFF)

Breaker Management Relay (C60)

- Inadvertent energization (50/27)
- Breaker failure with timer (50/62BF)
- Breaker failure (50BF)
- Bus ground detection (59BN)
- Voltage transformer fuse failure (VTFF)

Transformer Management Relay (T60)

- With three (3) restraints
- Unit differential (87U)
- Transformer neutral overcurrent (51TN)
- Latch output contact for transformer fault pressure (63PTX)

Digital Generator Protection System (DGP)

Note: Refer to proposal one-line diagram for complete discrete relay scope

- Generator protection lock-out relay (86G1A)
- Generator protection lock-out relay (86G2A)
- Inadvertent energization lock-out relay (86IE)
- Breaker failure lock-out relay (86BF)
- Unit differential lock-out relay (86U)
- Transformer differential lock-out Relay (86T)
- Breaker Cross tripping dual breaker trip coils (94GB-1,2)
- Breaker status auxiliary relay (52GX-1)

Features Integrated Into Gas Turbine Control System

- Gas turbine control system with speed matching, synchronization and check
- Manual synchronization displayed on gas turbine control system operator interface
- Auto/manual synchronizing module with generator voltage matching displayed on gas turbine control system operator interface
- Load control in gas turbine control system
- Temperature indication for generator RTDs

Generator Protection Panel Metering

- Generator digital multimeter (Nexus)
  - Generator volts
  - Generator Amps: Phase 1,2,3 and Neutral
  - Generator Watts
  - Generator VARs
  - Generator frequency
  - Generator VA
  - Generator power factor
  - MWH - Generator Watt-Hours
  - MVAH - Generator VA-Hours
  - Generator VAR-Hours

Generator Protection Panel Outputs

- Nexus meter with KYZ pulse output module (field configurable)
- Generator watt/VAR transducer 4-20 mA output for input to TCP (96GG-1)
- Generator TCP/droop control transducer 4-20 mA output (96GW-1)

Generator Protection

- Generator electrical protection equipment
  - Shaft voltage monitor in turbine controls

Batteries and Accessories

- Lead acid battery
- Two (2) single-phase battery chargers, each sized 100% capacity

Motor Control Center

- MCC mounted in control compartment
- Tin-plated copper bus-work

Remote Control and Monitoring Systems

- HMI Ethernet communications link using GSM protocol
- Site Ethernet equipment in central control room
- Ethernet cables internal to components and compartments, as well as Ethernet switches
- Remote HMI, multi-unit control
  - Two (2) per site
- Commercial grade personal computer
- Color monitor
  - Table top
  - 20 in. LCD monitor
- Trackball cursor control
- Mouse cursor control
- Table top keyboard
- Printer
  - Black and white laser network printer
  - Color laser jet network printer - One (1) per site

Rotor, Bearing and Performance Monitoring Systems

- Performance monitoring systems
- Air flow measurement sensors wired to gas turbine control system
  - Gas turbine performance monitoring calculations in operator interface
- Vibration sensors
  - Velocity vibration sensors
  - Proximity vibration sensors
  - Transducer for atomizing air compressor
- GE proximity vibration sensor monitoring
  - In the SPEEDTRONIC™ Mark Vle panel
  - HMI display
- Bently Nevada 3500 proximity vibration sensor monitor
  - Signals provided from turbine control panel
  - Mounted with auxiliary panel

Bearing thermocouples

- Bearing drain thermocouples
- Bearing metal thermocouples

Borescope access holes

Bently Nevada System 1

TGVAS

- Software for gas turbine/generator(s) Universal On Site Monitoring System (uOSM)
- Rack Mounted
- Shares HMI monitor, keyboard and positioning device
- ADH equipment for turbine control system
- Requires two dedicated analog phone lines, which are not part of the power train scope of supply

Motor Features

- TEFC motors less than or equal to 200 hp
- Coated with antifungal material for protection in tropical areas
- High ambient motor insulation
- Energy saver motors
- Extra severe duty motors
- Cast iron motor housings
- All redundant motors to be lead/lag
- Motor heaters connected to AC power, for all motors greater than 1 hp
- WP motors >200 hp
- NEMA Class F insulation, Class B temperature rise

Services

- Transportation
  - Generator shipped with rotor installed
- Documentation
  - English language
    - Motor data sheets (sent after equipment ships)
  - Copy of material certifications for gas turbine rotor forgings
  - Gas Turbine
    - Reference Drawing Manual
      - Online
      - Hardcopy: Quantity 2
      - CD ROM format: Quantity 5
    - Service Manuals
      - Online
      - Hardcopy: Quantity 2
      - CD ROM format: Quantity 5
  - Generator
    - Station Designer Handbook
      - Online
    - Reference Drawing Manual
      - Online
    - Service Manuals

    - Online
- Turbine maintenance tools
    - Guide pins (for removal or replacement of bearing caps, compressor casing and exhaust frame)
    - Fuel nozzle wrenches
    - Fuel nozzle test fixture
    - Spark plug electrode tool
    - Clearance tools
    - Fuel nozzle staking tool
    - Combustion liner tool
    - Bearing and coupling disassembly fixture
    - Turbine rotor lifting beam (one [1] for every four [4] units)
    - Turbine rotor lifting guides (one [1] for every four [4] units)
    - Basic maintenance tools and cart (one [1] set per site)
    - Hydraulic tools for removal of casing bolts (one [1] set per site)
    - Hydraulic bolt tensioning tool (one [1] set per site)
- Generator maintenance tools (one [1] set per site)
    - Rotor lifting slings
    - Rotor removal equipment including shoes, pans, pulling devices
    - Rotor jacking bolts
- Installation equipment
    - Trunions for generator
        - On permanent basis
    - Jacking bolts for generator
    - Turbine base fixators and shim packs
    - Turbine flush piping and consumables
        - One (1) set of piping for up to four units
        - One (1) set of consumables per unit
    - Power system stabilizer tuning study
    - Power system stabilizer (PSS) site testing

Customer Observation Points

- Observe unit rotor final balance
- Observe gas turbine unit ready for shipment
- Observe final electrical test (stator)
  - Winding resistance measurement
  - Insulation resistance measurement
  - High potential test
- Observe generator field overspeed and balance
- Observe final electrical test (generator field)
  - Winding resistance measurement
  - Insulation resistance measurement
  - High potential test
- Control panel inspection observations
  - Turbine control panel visual inspection
  - Turbine control panel software test

EXCLUSION

Listed below are the limits/exclusions to the Seller standard Scope of Supply. All piping, wiring, cables, ducts, etc. connecting to these points is furnished by Purchaser (others) unless modified by specification agreement.

Equipment System	Limits of Seller Scope
All piping, including Fuel Gas, Fuel Oil, Steam, Cooling Water, Heating Water, Demineralized Water, Lube Oil, Compressed Air, Instrument Air, Hydraulic Start Oil	Flanged or threaded connection on Seller baseplate.
Inlet Air-to-Filter	Atmosphere (non-standard duct by others)

Turbine Package Ventilation/Cooling Air	Atmosphere (non-standard duct by others)
Turbine Exhaust	Exhaust flange on main baseplate
Instruments on Seller's Baseplate	Terminal box on baseplate
Instrument wiring in Turbine Control Panel	Wiring Terminal block in Turbine Control Panel
High Voltage Connections	Bus bar in Seller Lineside cubicle
Generator Ground Connections	Seller Neutral cubicle
Electric Motors	Terminal box on individual motor
Ladders and Platforms for Air Filter	Ladders and Platforms for Inlet Air Filter maintenance only
24 V DC Batteries and Chargers for Control System and Fire and Gas Systems	Battery terminals to baseplate (if supplied loose)

Exclusions

- Civil engineering design of any kind
- Building and civil works
- Site facilities
- Drains and/or vent piping from the gas turbine package to a remote point
- Fuel storage, treatment and forwarding system
- Site grounding
- Lightning protection
- Power system studies
- Sensing and metering voltage transformers
- Machine power transformers, and associated protection
- Grid failure detection equipment
- Off-loading, transportation and storage
- Off-skid cabling, and design of off-skid cable routing
- Balance of plant and energy optimization controls
- Anchor bolts, embedments, and grouting (quoted separately)
- Distributed plant control

- Purchaser's remote control
- Field supervision (quoted separately)
- High voltage transformer(s), cables, and associated equipment
- Interconnecting piping, conduit, and wiring between equipment modules
- Plant utilities, including compressed air supply and off-skid piping
- Battery containment
- Lube oil measurement other than that defined in the scope of supply
- Additional lube oil breather ducting other than that defined in the scope of supply
- Fuel transfer pump
- Off-skid fuel block and vent valves
- Fuel supply pipework beyond the scope of supply
- Generator controls other than that defined in the scope of supply
- Load sharing control
- Balance of plant controls
- Field Performance Testing
- Site Labor
- Ladders, Stairs, and Platforms for equipment beyond the gas turbine

Attachment Scheduled Date(s)

Reference	Equipment Description TWO NEW UNITS GE 7FA	Scheduled Date
Unit 1&2	GE Frame 7F Generating Set (Never Used)	By Dec 31, 2009
Unit 3	GE Frame 7F Generating Set (Never used)	January 15, 2010

GENERAL

GE gas turbines have the ability to burn a wide range of gaseous fuels as shown in Table 1. These gases present a broad spectrum of properties due to both active and inert components. This specification is designed to define guidelines that must be followed in order to burn these fuels in an efficient, trouble-free manner, while protecting the gas turbine and supporting hardware.

Table 2 identifies the acceptable test methods to be used in determining gas fuel properties.

TABLE 1 FUEL GAS USABLILITY

Fuel Type	LHV Btu/SCF (kJ/NM^3)	Wobbe Number	Major Components	Operational Comments	Applicability SAC	Applicability DLE
Pipeline Natural Gas	850-1200 (33383-	45-60	Methane	No Restrictions	Yes	Yes
Medium BTU Natural Gas	400 - 850 (15709-33838)	20-45	Methane, Hydrocarbons (HC), carbon dioxide, Nitrogen	Requires > 700 BTU/scf (27492 kJ/NM^3) for starting. May require modified fuel nozzles.	Yes	No, See Note 8.
Liquefied Petroleum Gas (LPG)	2300-3200 (90330-125676)	70-75	Propane, Butane	May require specific fuel nozzles. Contact GE	Yes	No
Gasification Gases - Air Blown - Oxygen Blown	150-200 (5891-7855) 200-400 (7855-15709)	6-8 8-20	Carbon monoxide, Hydrogen, HC, Nitrogen, Water Vapor Carbon monoxide, Hydrogen, HC, Water Vapor	Contact GE	Yes	No
Process Gases	300-1000 (11782-39274)	15-50	Methane, Hydrogen, Carbon monoxide, Carbon dioxide	Requires >700 BTU/scf (27492 kJ/NM^3) for starting. Restricted	Yes	See Note 8
Refinery Gases	1000-1300 (39274-51056	45-60	Methane, Hydrogen, Carbon monoxide,	No restrictions. Hydrogen content should be reviewed by	Yes	See Note 8

Notes:

1. When considering the use of alternate fuels, provide details of the fuel constituents, fuel temperature, and expected engine usage conditions and operating characteristics to GE for evaluation and recommendations.
2. Values and limits apply at the inlet of the gas fuel control module.

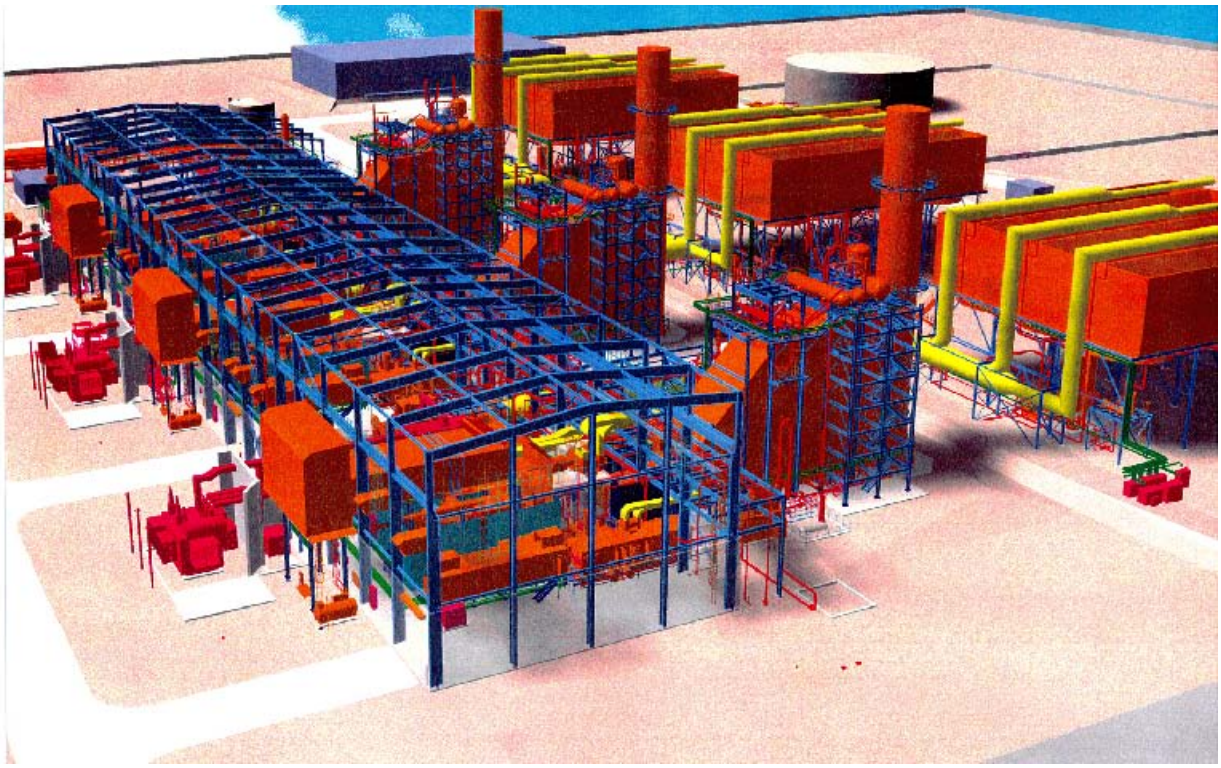
Design Criteria

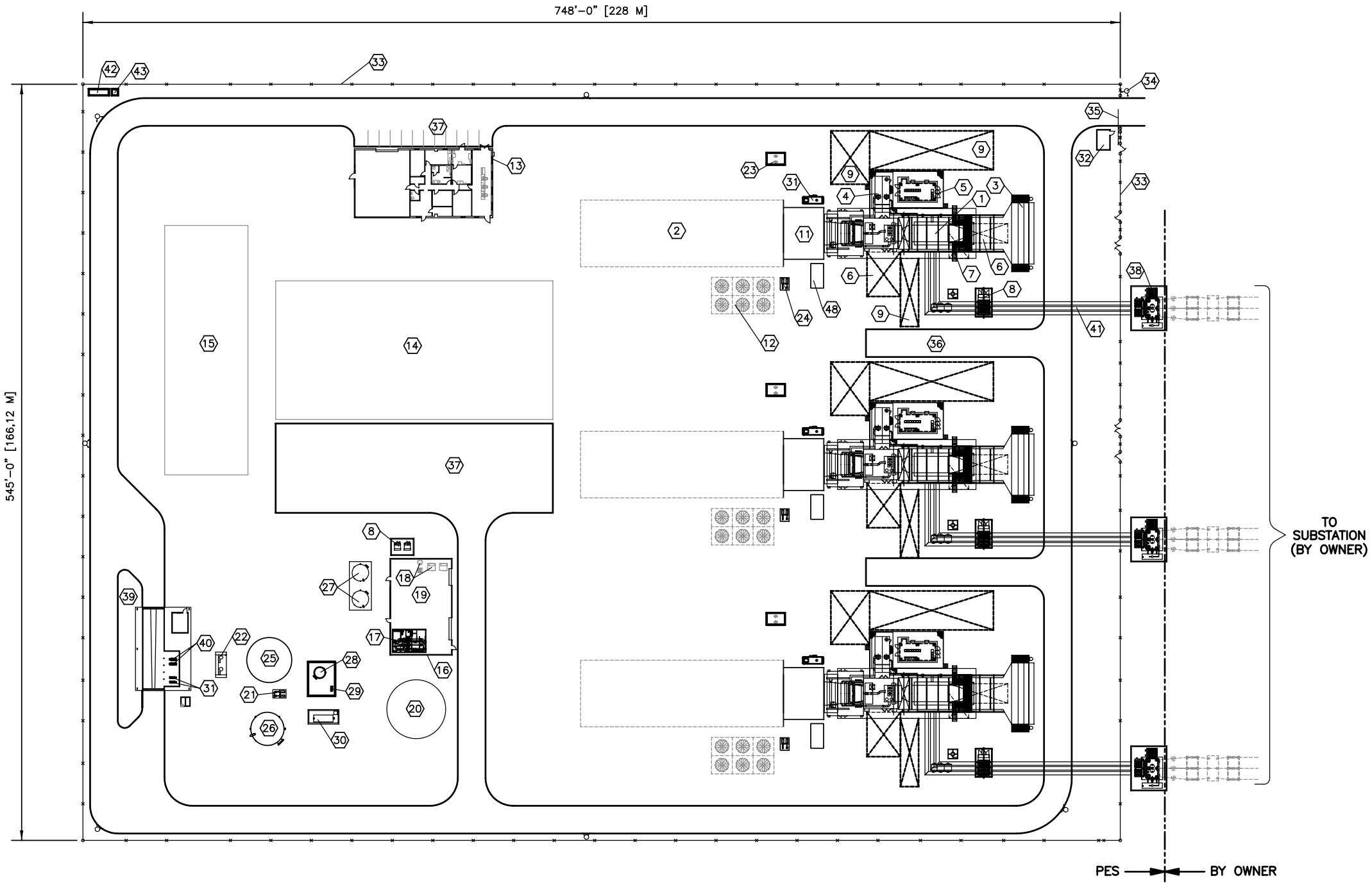
The following table outlines the criteria conditions at the proposed jobsite for the design of the equipment:

Location	TBD
Elevation	TBD
Design Point Ambient Temperature / Relative Humidity	TBD
Primary Fuel Source	TBD
Secondary Fuel Source	TBD
Seismic Design Criteria (BOP Equipment)	TBD
Maximum Wind Speed (Wind Load), MPH	TBD
Near Field Noise at 3 ft horizontal and 5 ft vertical, dBA NOTE 1	TBD
Far Field Noise, dBA NOTE 1	TBD at 400 ft / TBD at 700 ft

NOTE 1: Far field noise is based on single-unit only operation. Multiple units operating at the same time will have an impact on both near and far field noise levels.

Attachment A





LENGEND:

1. G.E. FRAME 7FA GAS TURBINE GENERATOR.
2. HRSG (FUTURE).
3. AIR INLET.
4. ACCESSORY MODULE.
5. PEECC.
6. TURBINE REMOVAL AREA.
7. COOLER REMOVAL AREA.
8. AUXILIARY TRANSFORMER.
9. LAYDOWN AREA.
10. CO2 TANK.
11. EXHAUST STACK.
12. LUBE OIL FIN FANS.
13. OFFICES/CONTROL/MAINTENANCE BUILDING.
14. STEAM TURBINE GENERATOR HALL (FUTURE).
15. STEAM TURBINE GENERATOR COOLING TOWER (FUTRE).
16. WATER TREATMENT BUILDING.
17. FIRE WATER SKID.
18. INSTRUMET AIR DRYER PACKAGE.
19. WATER TREATMENT EQUIPMENT AREA.
20. RAW/FIRE WATER TANK (300,000 GALS).
21. LIQUID FUEL FORWARDING PUMP.
22. LIQUID FUEL CENTRIFUGE PACKAGE.
23. FUEL GAS FILTER/REGULATOR.
24. LUBE OIL COOLING WATER PUMP.
25. LIQUID FUEL TANK (RAW–100,000 GALS).
26. LIQUID FUEL DAY TANK (CLEANED–50,000 GALS).
27. DEMIN WATER TANK (2–21,000 GAL EACH).
28. OILY WASTE TANK (5,000 GALS).
29. OILY WATER OFF–LOAD PUMP.
30. OILY WATER SEPARATOR.
31. LIQUID FUEL OFF–LOAD PUMP.
32. GUARD HOUSE.
33. PLANT FENCE.
34. LIGHTING POLE.
35. GATE.
36. ROAD.
37. PARKING AREA.
38. STEP–UP TRANSFORMER.
39. LIQUID FUEL OFF–LOAD AREA.
40. LIQUID FUEL FORWARDING PUMP.
41. ISO PHASE BUS.
42. GAS METER RUN.
43. ESD VALVE.

0 20' 40' 60' 80' 100' 200'

GRAPHIC SCALE

REVISED	CUSTOMER INFORMATION

NO.	DATE	BY	APP'D	DESCRIPTION
				REVISIONS

DRAWN	SL	09/21/08
CHECK		
DESIGN		
PROJ ENGR		
PROJ MGR		
QA MGR		
SCALE	1"=40'	SIZE D

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GENERAL ARRANGEMENT PLOT PLAN
THREE (3) FRAME 7FA SIMPLE CYCLE UNITS
FUTURE COMBINED CYCLE

XXXX JOB. NO.	DWG NO.	SH NO.	XXXX REV
TXXXX	SK	1	A

7FA EQUIPMENT OVERVIEW

Gas Turbine

Feature Specification
Primary Fuel Natural Gas
Starting Means Static Start
Air Filtration Two Stage Static
Exhaust System Axial Exhaust
Emissions Control Gas-Dry Low NOx
Outdoor Enclosure Turbine and Accessory Compartments
Off-Base Acoustic Enclosure Turbine and Accessory Compartments
Off-Base Acoustic Enclosure Turbine Compartment

Generator

Feature Specification
Model 7FH2
Cooling Hydrogen
Frequency 60 Hz
Power Factor (PF) 0.85 Lagging
Power Factor (PF) Capability to .90 Leading @ ISO
Conditions
Terminal Voltage 18.0 kV
Generator Excitation EX2000P-Static Bus Fed
Outdoor Enclosure Load Compartment
On-Base Lagging Accessory Base

Control Systems

Feature Specification
Turbine-Generator SPEEDTRONIC Mark VI

G.E. SCOPE OF SUPPLY

1. Gas Turbine Systems
2. Generator
3. Gas Turbine-Generator Controls & Electric Auxiliaries
4. Services

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7FA SCOPE OF SUPPLY

1. GAS TURBINE SYSTEMS

Gas Turbine

Base Mounted PG7241 (FA) 60 Hz gas turbine including:

- Modulating IGV

Combustion System

- Dry Low NOx combustion system -With inlet heating
- Compressor inlet humidity sensor
- Compressor inlet temperature thermocouple

Fuel Systems
Gas Fuel System

- Natural gas only
- Stainless steel gas piping
- Orifice type gas flow measurement system
- Single gas strainer
- Gas fuel valves on accessory base
- Gas fuel temperature supplied per GEI-41040F-Heater by Owner
- Gas Fuel cleaning equipment (fuel gas scrubber) (duplex)

Lubricating and Hydraulic Systems Pumps

- AC Motor driven dual oil pumps
- AC Motor driven dual hydraulic pumps
- DC Motor driven, emergency lube oil pump
- AC/DC Motor driven auxiliary generator seal oil pump
- Dual pump for pressure lift journal bearings in:
  Turbine
  Generator
  Generator seal oil pump

Filters and Coolers

- Dual lube oil system filters
- Dual hydraulic oil filters
- Dual lube oil coolers
  Plate/Frame type with stainless steel plates
- ASME code stamp
  Lube oil coolers
  Lube oil filters

Lube Oil Piping

- 304L stainless steel lube oil feed pipe
- Carbon steel lube oil drain pipe
- Lube system valve stainless steel trim

Mist Elimination

- Lube vent demister

Oil Reservoir

- With heater for –20 deg. F

Instrumentation

- Pressure switches for lubrication and hydraulic oil filters

Inlet System

- Inlet system arrangement
  Up and Forward inlet system arrangement
  Inlet compartment supports straddle ductline
- Inlet Filtration
  Two-stage static filter, prefilter and high efficiency filter
  Standard filter media (low humidity, non-corrosive environments)
  Weather protection on inlet filter compartment
  Inlet system differential pressure indicator
  Inlet system differential pressure alarm
  Inlet filter compartment support steel (Seismic Zone 4A=120 mph wind speed)
- Inlet system atmospheric Protection
  Zinc rich paint inside and outside of the inlet filter compartment
  Zinc rich paint on inlet filter compartment support steel
  Zinc rich paint inside and outside of inlet ducting with epoxy topcoat inside ducting
  Galvanized inlet silencing perforated sheet
  Zinc rich paint on inlet ducting support steel

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7FA SCOPE OF SUPPLY

Exhaust System Arrangement

- Exhaust diffuser with an axial exit
- Exhaust expansion joint
- Exhaust stack, if required, by Customer

Couplings

- Rigid load coupling
- Load coupling guard

Gas Turbine Packaging

- Lagging and enclosures
  - On-base accessory compartment lagging
  - Turbine and accessory compartment lagging
  - Load coupling compartment lagging
  - Off-base acoustic enclosure for turbine only
  - Off-base acoustic enclosure for turbine, accessory compartment and exhaust diffuser for 85A dBA
- Compartment ventilation, pressurization and beating
  - Dual turbine compartment vent fans
  - Dual accessory compartment lagging
  - Dual load compartment fan
  - Heated turbine and accessory compartments for humidity control
  - Dual vent fans for diffuser/exhaust area
- Plant Arrangement
  - Turbine designed for installation outdoors
  - Right hand accessory module
  - Unit walkways by customers, mounting pads by GE
- Turbine and accessory base painting
  - Standard primer
- UBC seismic zone #4
- Hazardous area classification
  - NEC Class 1, Group D, Division2
  - Turbine compartment
  - Gas fuel compartment
- Special features
  - Dual (metric-English) indicators and gauges

Fire Protection System

- Fire detection system
  - Turbine and accessory compartment
- Smoke detection system
  - Control cab/PEECC
- Compartment warning signs
- CO2 supply system
  - One low pressure CO2 tank per unit
  - Tank suitable for 0-120 deg. F (-18 to 49 deg. C)
- Fire protecting piping
- Hazardous atmosphere detectors in turbine and gas fuel compartments
- Hazardous atmosphere detector readout

Starting Systems

- Static Start
  - Generator start with inverter/regulator
  - Static start isolation transformer
  - Oil filled
- Shared hardware for two units
  - Isolation transformer fed from auxiliary bus
  - Shared hardware across power blocks using cross ties
  - PLC based changeover panel
  - 12- pulse, water-cooled LCI
  - Single dc link reactor
  - Water to water heat exchanger, shipped loose
- Rotor turning systems
  - Turning gear and motor for rotor cool-down
  - Rotor indexing (borescope inspection)

Miscellaneous Systems Special Systems

- Exhaust frame blowers on turbine compartment roof

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7FA SCOPE OF SUPPLY

2. GENERATOR

General Information

- Hydrogen cooled generator with conventionally cooled armature
- Outdoor Installation
- 60 Hz generator frequency
- Generator voltage 18.0 kV
- 0.85 power factor (lagging)
- Capability to .90 power factor (leading) @ ISO conditions
- Class "F" armature and rotor insulation
- Class "B" temperature rise, armature and rotor winding
- Generator Bearings
  - End shield bearing support
  - Elliptical journal bearings
  - Rollout bearing capability without removing rotor
  - Insulated collector end bearing
  - Online bearing insulation check
  - Offline bearing insulation check with isolated rotor
- Monitoring Devices
  - Two BN3300 probes per bearing at 45 deg. Angle with monitors
  - Two (2) velocity vibration probes at turbine end, one (1) at collector end
  - Provisions for key phaser-generator
  - Provisions for permanent flux probe
  - Proximity vibration sensors
- Generator Field
  - Direct cooled field
  - Two-pole field
  - Finger type amortissuers
  - Full-length coil slot amortissuers

Generator Gas Coolers

- Coolers shipped installed
- Generator gas cooler configuration
  - Five (5) horizontally mounted simplex coolers
  - Cooler piping connections on the left side as viewed from collector end
  - ASME code stamp
  - Single wall cooler tubes
  - Victaulic cooler couplings
  - Plate fins
  - Cooling water manifold and isolation valves
- Generator gas cooling system characteristics
  - Coolant temperature
  - -20 deg. F
  - TEMA Class C coolers
  - Generator capacity with one section out of service 80% with Class "F" rise
  - Maximum cooler pressure capability –125 psi
  - Fouling factor:.002
- Generator gas cooler construction materials
  - 90-10 copper-nickel tubes
  - Carbon steel tube sheets
  - Carbon steel waterbox and coupling flanges with epoxy coating
  - Aluminum cooler tube fins

Generator Lube Oil Systems and Equipment

- Bearing lube oil system
  - Generator lube oil system integral with turbine
  - Sight flow indicator
- Bearing lift oil system
  - Stainless steel lift oil piping and tubing
  - Lift oil supplied from turbine oil system
- Lube oil system piping materials
  - Stainless steel lube oil feed pipe
  - Carbon steel lube oil feed pipe
  - Welded oil piping
  - Flexible pipe as permitted by ANSI 31.3

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7FA SCOPE OF SUPPLY

Generator Grounding Equipment

- Neutral grounding equipment
  - Neutral ground transformer and secondary resistor
  - Mounted in terminal enclosure
  - Motor operated neutral disconnected switch

Generation Temperature Devices

- Stator winding temperature devices
  - 100 ohm platinum RTD's
    (resistance temperature detector)
  - Single element temperature sensors
  - Four (4) cold gas
  - Two (2) hot gas
  - GTG-2 (common cold gas)
- Bearing temperature devices
  - Chromel alumel (type K) thermocouples
  - Dual element temperature sensors
  - Two (2) bearing metal temperature sensors per bearing
- Collector temperature devices
  - 100 ohm platinum RTD's
  - Single element temperature sensors
  - Collector air inlet temperature sensors
  - Collector air outlet temperature sensor
- Lube oil system temperature devices
  - Chromel alumel (K) thermocouples
  - Dual element temperature sensors
  - One (1) bearing drain temperature sensor per drain

Packaging, Enclosures and Compartment

- Paint and preservation
  - Standard alkyd beige primer
- Generator terminal enclosure (GTE)
- Line-side terminal enclosure
  - Terminal enclosure shipped separate
  - High voltage bushings shipped installed
  - Six (6) ambient air-cooled, high voltage bushings
  - Isolated phase bus duct connection
  - Phase sequence R-C-L when looking at enclosure terminals
  - Outgoing power connection on right side when viewed from collector end
  - Lighting arrestors
  - Voltage transformers, fixed
- Current Transformers
  - Relaying Class C800
  - Metering Class- 0.3B- 1.8 (ANSI C57.13)
  - CT Ratio-800: 5A
  - Line CT's
  - CT16, CT17, CT18
  - CT19 for extension
  - CT19A and CT19C for EX2000
- Neutral Terminal enclosure
  - Integral with lines side terminal enclosure
  - Neutral tie
  - Neutral CT's
  - CT1, CT2, CT3
  - CT4, CT5, CT6
  - CT7, CT8, CT9
  - Top mounted
  - Forced ventilation
- Collector Compartment
  - Collector Compartment shipped separately
  - Outdoor
- Compartment Lighting and Outlets
  - AC Lighting
  - Collector Compartment
- Fountain Hardware
  - Generator Shims
  - Generator Alignment Key(s) – collector end
  - Generator Alignment Key(s) – turbine end
  - Generator Alignment Key(s) – axial

Hydrogen Systems and Accessories

- Hydrogen Control Cabinet
  - NEMA 1 cabinet in collector compartment
  - Hydrogen Gas Manifolds
  - Auto purge gas purge control manifold
  - Hydrogen/CO2 control manifold in collector compartment

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7FA SCOPE OF SUPPLY

- Seal Oil System
  - Control unit mounted in collector compartment
  - Stainless steel seal oil feed pipe
  - Carbon steel seal oil drainpipe

Electrical Equipment

- Motors
  - TEFC Motors
  - Coated with antifungal material for protection in tropical areas
  - High Ambient motor installation
  - Motor Heaters connected to AC power
  - Extra severe duty motors
  - Cast iron motor housing
- Heaters
  - Generator Stator Heaters
  - Generator Collector Heaters
  - Generator Terminal Enclosure Heaters

Generator Excitation Systems, Static Components

- Static excitation with dual hot backup bridge

Excitation Module Features

- Control/ Monitor/Display through TCP
  - Power Factor controller in turbine control system
  - Var controller in turbine control system
  - Selection of automatic or manual regulator
  - Voltage matching in turbine control system
  - Raise-lower of the active regulator setpoint
  - Enter setpoint command
  - Display field amps
  - Display field volts
  - Display transfer volts
  - Display field temperature
- Built-in diagnostic display panel
  - Automatic voltage regulator (AVR)
  - Manual voltage regulator (FVR)
  - Automatic and Manual bi-directional tracking
  - Reactive current compensation (RCC)
  - Volts per hertz limiter (V/Hz LIM)
  - Volts per Hertz protection (24EX) (backup to 24G)
  - Over excitation limiter (OEL)
  - Offline/online over excitation protection (76EX)
  - Loss of excitation protection (40EX)
  - Bridge ac phase unbalance protection (47EX)
  - Under excitation limiter (UEL)
  - Generator over voltage protection (59EX)
  - Generator field ground detector (64F)
  - VT failure detector (VTFD) (60EX)
- Dual source internal bulk power supply
- Millivolt shunt for field
- Surge protection
  - VT disconnect and CT shorting switches
  - Two phase current sensing (CT's A, C)
  - Three phase voltage sensing
  - Single pole dc field contact/bridge
- Thyristor bridge circuit filtering
- Shaft voltage suppressor circuit (mounted in panel)
  - Field de-excitation circuit (with field discharge inductor)
  - 125 Vdc field flashing circuit (when required)
  - Bridge disconnect: ac no load
- Power system stabilizer

Performance

- 2.0 Response and 160% VFFL (100 degree C) ceiling@ VT=1.0pu
  - EX2000 ENCLOSURE LOCATION
- Installed in LCI/EX

LCI Features

- LCI located in LCI/EX compartment
- LCI output isolation switch (89MD)
  - Located in LCI compartment
- LCI disconnect switch (89SS)
  - Located in generator terminal enclosure
- LCI fuse
  - Located in compartment with LCI

PPT Features

- Freestanding oil filled PPT
- PPT fed from auxiliary bus

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7FA SCOPE OF SUPPLY

3. GAS TURBINE-GENERATOR CONTROLS & ELECTRIC AUXILIARIES

Control Cab/Packaged Electric and Electronic Control Compartment (PEECC)

- Control panels mounted on a common skid
- Weatherproof, climate control, base mounted enclosure
- Supplemental wall mounted air conditioner by General Electric
- Interconnection cables (hard wire) within enclosures by G. E.
- Interconnection cables (hard wire) between packages by Customer

Gas Turbine Control System Panel Features

- Triple modular redundant (TMR)
- Skid mounted control panels
- Auto/Manual synchronizing module with synchronizing check function
- Generator stator overtemperature alarm (49)
- Droop control
- Load limiter
- Purges cycle
- Customer alarm/trip contact for CRT display
- Additional customer input contacts
- Additional customer output to customer
- Provision for 8 selectable analog inputs from customer
- Provision for 8 selectable analog output from customer
- Wet low NOx data for EPA compliance
- Vibration alarm readout and trip
- Electrical overspeed protection
- Constant settable droop
- Power factor calculation and display
- Power factor control
- VAR Control
- Manual set point pre-selected load
- Mounted in PEECC

Local Operator Station

- Commercial grade personal computer
- Color Monitor
  - Tabletop
  - 15-inch screen
- Mouse cursor control
- Table top AT 101 keyboard
- Printer
  - 24 pin dot matrix
- Display in English Language
- 50 foot of Arcnet cable between gas turbine control system panel and local operator interface <I> for indoor use
- RS232C two way serial link (MODBUS) via local <I> Power 120V ac 60 Hz
- Mounted in PEECC

Rotor, Bearing and Performance Monitoring Systems Bentley Nevada 3500

- Performance monitoring systems
  - Performance monitoring sensors wired to gas turbine control system
- Vibration Sensors
  - Velocity vibration sensors
  - Proximity vibration sensors
- Bentley Nevada 3500 Monitor
  - Relay outputs wired to gas turbine control panel
- Bearing Thermocouples
  - Bearing Drain thermocouples
  - Bearing metal thermocouples
- Borescope access holes

Generator Control Panel Generator Control Panel Hardware

- Mounted in PEECC
- Skid mounted with turbine panel

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7FA SCOPE OF SUPPLY

- DGP with test plugs
- DGP without Modbus communication interface
- DGP with communication interface
- DGP with oscillography capture
- DGP with printer port
- DGP with redundant internal power supply
- Generator breaker trip switch (52S/CS)
- Humidity sensor readout
- Bentley Nevada vibration monitor(s)

Digital Generator Protection System (DGP)

- Generator overexcitiation (24)
- Generator under voltage (27G)
- Reverse power/ anti-motoring (32-1)
- Loss of excitation (40-1,2)
- Current unbalance/negative phase sequence (46)
- System phase fault (51V)
- Generator overvoltage (59)
- Stator ground detection (64G1)/(59GN)
- Generator over frequency (810-1,2)
- Generator under frequency (81U-1,2)
- Generator differential (87G)
- Voltage transformer fuse failure (VTFF)

Generator Protection Discrete Relays

- Synchronizing undervoltage relay (27BS-1,2)
- Voltage balance relay (60)
- Breaker or lockout trip coil monitor relay (74)
- DC tripping bus, blown fuse protection relay (74-2)
- Generator differential lockout relay

Main Transformer Digital Protection

- SR 745 relay with two restraint windings (86T/87T)

Main Transformer Discrete Relays

- Main transformer lockout relay (86T-1)

Features Integrated into Gas Turbine Control System

- Gas turbine control system with speed matching, synchronization and check
- Manual synchronization displayed on gas turbine control system
- Auto/manual synchronizing module displayed on gas turbine system <1>
- Load control in gas turbine control system
- Temperature indication for generator RTD's

Generator Control Panel Metering

- Generator digital multimeter
  - VM - Generator volts
  - AM – Generator Amps: Phase 1,2,3 and Neutral
  - MW – Generator Mega watts
  - MVAR – Generator Mega VAR's
  - FM – Generator frequency
  - MVA – Generator MVA
  - PF – Generator Power factor
  - MWH – Generator Megawatt Hours
  - MVAH – Generator MVA Hours

Generator Control Panel Transducers

- Generator watt/VAR transducer 4-20 mA output for input to TCP (96GG1)
- Generator TCP/droop control transducer 4-20 mA output (96GW-1)
- Generator power factor transducer 4-20 mA output for customer (96GP-1)
- Generator VAR transducer 4-20 mA output for customer (96GR-1)

Generator Protection

- Generator electrical protection equipment
  - Ground brush rigging

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7FA SCOPE OF SUPPLY

Batteries and Accessories

- Lead Acid Battery
- Single phase battery charger
- Battery and Charger mounted in the PEECC

Motor Control Center

- MCC mounted in control cab/PEECC
- Tin-plated copper bus-work
- 42 kA bracing
- 480V 60 Hz auxiliary power

Motor Features

- TEFC motors (200hp)
- Coated with anti-fungal material for protection in tropical areas
- High ambient motor insulation
- Energy saver motors
- Extra severe duty motors
  - Cast iron motor housing
  - All redundant motors to be lead/lag
  - Motor heaters
    Rated 110/120 volts, 50/60 hertz
  - WP motors > 200 hp
    Trunions for generator
    On loan basis only
    Jacking bolts for generator
    Foundation/installation washer and shim packs
  - Power Systems Studies
    Provided by customer

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