

# PROPOSAL

Presented To:

**Derwick Associates**

for

**2 x Frame 7F Gas Turbine  
Equipment**

*Prepared By*



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Derwick Associates.**

**Introduction**

Derwick Corp. ("DC") is pleased to provide this proposal to Corporacion Venezolana de Guyana ("CVG") for One (1) Brand New GE Frame 7F Gas Turbines.

## **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 only
- 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**

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- 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  $\pm 0.5\%$  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)

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- 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,  $\leq$  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,  $\leq$  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, galvanized 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

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## **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 amortisseurs

### **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 @  $V_t = 1.0pu$

### **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 (81O)
- 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 VIe 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.

<b>Equipment System</b>	<b>Limits of Seller Scope</b>
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

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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	Scheduled Date
Unit 1	GE Frame 7F Generating Set (Never Used)	December 31,2009

## 1 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 USABILITY						
Fuel Type	LHV Btu/SCF (kJ/NM <sup>3</sup> )	Wobbe Number	Major Components	Operation al Comments	Applicability SAC	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 <sup>3</sup> ) 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 <sup>3</sup> ) 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**





DERWICK ASSOCIATES CORP.

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