

## 7. Scope, Limits and Exclusion of Supply

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### 7.1 Three (3) Gas Turbine Generator Units, Each Including:

#### 7.1.1 The Gas Turbine Package Consisting Of:

##### 7.1.1.1 The Gas Turbine Compartment:

- Multi-stages, axial flow compressor
- Modulated inlet guide vanes
- Three-stages turbine
- Multi-chambers combustion system
- gas/ liquid fuel) combustion system with conventional combustors • Combustion Life Extendor system (CLEX®)
- Ignition system with spark plugs and U.V. flame detectors
- Borescope openings for maintenance inspection
- Seismic type vibration sensors on bearing caps for protection
- Proximity type sensors for shaftline displacement monitoring
- Thermocouples for measuring exhaust temperature
- Thermocouples on bearing drains
- Thermocouples on bearing metal
- Exhaust plenums
- 2 X 50 % Exhaust frame blowers
- On/off line compressor and off line turbine wet washing system
- Turbine dry cleaning on base piping
- Turbine dry cleaning off base skid and interconnecting piping
- Water injection system for NOx control
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- Smart Cool down

##### 7.1.1.2 The Auxiliary Systems and separate skids:

- Starting and cooldown system with:
  - MV starting AC motor
  - Hydraulic torque convertor
  - Rotor turning device by AC Poney motor
- Auxiliary coupling and gear:
  - Flexible auxiliary coupling

- Auxiliary gear box
- Lubricating oil system with:
  - Duplex lube oil filters
  - Duplex lube oil to water heat exchangers
  - Shaft driven main lube oil pump
  - Full flow AC motor-driven auxiliary lube oil pump
  - One (1) partial flow 125V DC motor driven emergency lube oil pump
  - Lube oil tank
  - Lube oil mist eliminator with single extraction fans
  - Lube oil heater
- Hydraulic oil system with:
  - Shaft driven hydraulic oil pump
  - Full flow AC motor driven auxiliary hydraulic oil pump
  - Duplex hydraulic oil filters
  - Single high pressure fuel filter
- Gas fuel system with (separate module):
  - Gas fuel stop and control valves
- Liquid fuel system with :
  - One (1 x 100%) high pressure fuel pump
  - Single high pressure fuel filter
  - Flow divider
- Atomizing air system with:
  - One (1 x 100%) atomizing air cooler
  - One (1 x 100%) atomizing air compressor
- Water Injection For NOx Level Reduction With:
  - One (1 x 100%) AC motor driven pump
  - Single filter
  - Flow metering system
  - Flow control valve

#### **7.1.1.3 Couplings:**

- Gas Turbine Load Coupling for GE Elin Generator

#### **7.1.1.4 Gas Turbine Packaging**

- Lagging and enclosures
  - Off base acoustical enclosure around gas turbine, accessory module, exhaust plenum and load.
  - Off base enclosure for gas fuel module
  - Off base enclosure for water injection module
  - Compartment ventilation and heating
  - Dual vent fans (2 x 100%)

- Gas detection system
  - Gas detection sensors for Turbine compartment and Gas fuel compartment (Analog transmitters)
- Fire detection and protection system with:
  - High pressure CO2 system with release mechanism and distribution piping in the protected spaces
  - Thermic detectors to release automatically the extinguishing media

#### **7.1.1.5 Hazardous area classification**

GE's equipment (e.g. air intake, Gas Turbine enclosures, etc...) must be installed outside any Site Hazardous Area Classification (HAC). For equipment part of GE's scope of supply, an Hazardous Area drawing will be provided during realization phase.

### **7.1.2 Product Risk Analysis**

Risk Analysis Studies will be performed for GT / Auxiliaries according to GE's practices, compliant to EN ISO 12100.

The final deliverable for the customer will be the Residual Risk Summary. Risk Analysis studies regarding GE's scope of supply will be internal and GE proprietary.

On request, GE can present its methodology to the customer.

### **7.1.3 Generator**

#### **7.1.3.1 General Information**

- Totally enclosed water-to-air cooled (TEWAC) generator
- Outdoor installation
- 50 Hz generator frequency
- Generator voltage 15.0 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
  - Tilting pad bearings
  - Roll out bearing capability without removing rotor
  - Insulated collector end bearing
  - Offline bearing insulation check with isolated rotor
- Monitoring Devices
  - Provisions for key phasor-generator
  - Proximity vibration probes
    - Two probes per bearing at 45° angle
- Generator Field

- Direct cooled field
- Two-pole field
- Finger type amortissuers

### **7.1.3.2 Generator Gas Coolers**

- Cooler assembly shipped separate
- Generator gas cooler configuration
  - Two (2) horizontally mounted duplex coolers
  - Coolers located on generator roof
  - Cooler piping connections on left side as viewed from collector end
  - Single wall cooler tubes
  - Raised cooler face flanges
  - Plate fins
- Generator gas cooling system characteristics
  - Coolant temperature
    - 20°F approach
  - Coolant: 30% Ethylene glycol and 70% water by volume
  - Generator capacity with one section out of service 100% with Class “F” rise
  - TEMA class C coolers
  - Maximum cooler pressure capability - 125 psi
  - Fouling factor 0.001
- 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

### **7.1.3.3 Generator Lube Oil Systems and Equipment**

- Bearing lube oil system
  - Generator lube oil system integral with turbine
  - Pre-fabricated factory fitted lube oil pipe
  - Sight flow indicator
- Lube oil system piping materials
  - Stainless steel lube oil feed pipe
  - Stainless steel lube oil drain pipe
  - Welded oil piping

### **7.1.3.4 Generator Temperature Devices**

- Stator winding temperature devices
  - 100 ohm platinum RTDs (resistance temperature detector)
  - Dual element RTDs
  - Ungrounded RTDs
  - Six (6) stator slot RTDs
  - Six (6) extra stator RTDs in separate slots

- Gas path temperature devices
  - 100 ohm platinum gas path RTDs
  - Dual element temperature sensors
  - Two (2) cold gas
  - Two (2) hot gas
- Bearing temperature devices
  - 100 ohm platinum RTDs
  - Dual element temperature sensors
  - Two (2) bearing metal temperature sensors per bearing
- Collector temperature devices
  - 100 ohm platinum RTDs
  - Dual element temperature sensors
  - Collector air outlet temperature sensor
- Lube oil system temperature devices
  - 100 ohm platinum RTDs
  - Dual element temperature sensors
  - One (1) bearing drain temperature sensor per drain

#### **7.1.3.5 Generator Packaging, Enclosures, and Compartments**

- Paint and preservation
  - Epoxy based primer
- Collector compartment/enclosure
  - Collector compartment/enclosure shipped installed
- Foundation hardware
  - Generator shims and plates
  - Generator centerline alignment guide
  - Generator alignment key(s) - collector end
  - Generator alignment key(s) - turbine end

#### **7.1.3.6 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

#### **7.1.3.7 Generator Acoustic Protection**

- Barrier wall on coupling only.

#### 7.1.4 The Gas Turbine Generator Control Equipment:

The Gas Turbine Generator Control Equipment is Located into an air conditioned (2x100%) Packaged Electrical & Electronics Control Compartment (PEECC) designed for outdoor installation and consisting of:

- SPEEDTRONIC Mark VIe turbine control panel
  - including proximitors monitoring
  - One (1) redundant power supply 115/220 VAC
  - Anti-condensation heater and lighting
  - Redundant unit data highway (UDH)
  - Totalizing gas fuel flow
  - Totalizing water injection flow
- Local operator interface <HMI> server including: Desktop computer with 22" LCD color display, Keyboard & mouse
- Screens and alarms in English language
- Dot matrix printer for local HMI
- ETHERNET interface to the plant DCS via <HMI>, OPC-TCP/IP protocol (local)
- Firefighting control panel
- Generator control, excitation, regulation and protection panel with:
  - One (1) digital automatic channel and one (1) digital manual channel (for AVR only)
  - One (1) power circuit to feed the exciter field.
  - Excitation bridge back-up
  - Automatic channel back-up
  - One (1) digital generator protection relay.
    - Power system stabilizer (PSS) system software
      - study
      - tests/tuning on site
    - Modbus interface
    - Generator protection redundancy
    - Protection settings calculation
    - Generator gross output meter active and reactive power class 0.2 (could be located in the auxiliary cubicle if lack of space in the generator control panel)
    - IP41 protection degree
    - Test plugs (per site)
    - Redundant power supply
  - Overall protection 3 branches differential 87B
- GTG Motor Control Center:
  - Two (2) Incoming Circuit Breakers (Normal/Standby)
  - Unit AC/DC Motor Control Center, withdrawable type for motor feeders above 11kW
  - Unit AC/DC sub-distribution panel, non- withdrawable

- 40 kVA Sub-distribution Transformer
- Excitation Transformer
- DC System:
  - 125 VDC lead acid unit battery (1x100% designed for 3 hours safe shutdown) with two (2x100%) battery chargers
- UPS System:
  - One (1) UPS Inverter rated at 2500 VA dedicated to GT Emergency auxiliaries consumptions

## **7.2 Off-Base Unit Mechanical Auxiliaries Including:**

### **7.2.1 The Inlet Air System, For Each Unit, with:**

- Up & forward orientation
- Self cleaning type air filter
- with Evaporative cooler
- Hoods
- With synthetic media cartridges
- Ducting and inlet silencer
- Supporting steel structure

### **7.2.2 The Side Exhaust System, For Each Unit, with:**

- Expansion joint between the exhaust plenum and transition piece
- Transition piece including low frequency silencer
- Exhaust duct personal protection around Low Frequency silencer only

### **7.2.3 Air Processing Unit:**

Each Gas Turbine is supplied by an outdoor Air Processing Unit, located close to the GT and is designed to supply compressed air to the GT's self-cleaning air filter. It includes:

- Extract from system from GT
- Auxiliary Compressor
- Adsorption air dryer
- Instrument air
- Air Processing Unit in container 10 feet

### **7.2.4 The Gas Fuel Off-Base System Including For Each Unit:**

- Final gas separator, vane pack, manual drain
- Duplex coalescing filter
- Manual drain for duplex coalescing filter
- Heat insulation for duplex coalescing filter
- Electrical tracing for duplex coalescing filter
- Shut off and vent valve skid, gas piloting system stainless steel
- Heat insulation for shut off valve and vent valve skid
- Electrical tracing for shut off valve and vent valve skid

- Gas flow meter

## 7.2.5 The Liquid Fuel System

### 7.2.5.1 The Light Liquid Fuel Forwarding System Including For Each Unit:

- Skids are suitable for installation in hazardous area classified zone 2.
- One (1) LDO forwarding skid with:
  - Two (2) full flow AC motor driven forwarding pumps

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### 7.2.5.3 The Filtering system (could be combined in one skid or separated in two) with the following feature:

#### 7.2.5.3.1 The Light Liquid Fuel Filtering System Including For Each Unit:

- Skids are suitable for installation in hazardous area classified zone 1
- One (1) Light Liquid Fuel filtering skid with:
  - Two (2) filters with stainless steel washable cartridges Beta 17=200
  - One (1) fuel accumulator
  - One (1) volumetric flow meter with by-pass
  - One (1) stop valve
- Insulation and heat tracing
- Pulse transmitter added on the oval wheels fuel totalizer for remote indication of totalized flow or actual flow

#### 7.2.5.3.2 The self-cleaning Heavy Liquid Fuel Filtering Skid Including For Each Unit:

- One (1) heavy oil filtering skid with:
  - Two (2) filters with metallic cartridges

#### 7.2.5.3.3 The Heavy Liquid Fuel Filtering Skid Including For Each Unit

- One (1) heavy oil filtering skid with:
  - Two (2) filters with metallic cartridges
  - One (1) fuel accumulator
  - One (1) volumetric flow meter with by-pass
  - One (1) pneumatic operated transfer three-way valve

### 7.2.5.4 Liquid The Heavy Fuel, Vanadium Injection skid:

- One (1) vanadium inhibitor injection skid with:
  - Two (2) AC motor driven metering pumps
  - One (1) tank
  - One (1) unloading pump



### **7.2.5.5 Sump Tank**

The sump tank is preassembled and includes:

- One (1) sump tank (2 m3 capacity, steel tank) electrical pump and heater

### **7.2.6 Off-Base Cooling Loop For Gas Turbine And Generator Cooling Systems Including For Each Unit:**

- One (1) battery of water to air fin fan coolers with AC motor driven fans (with 100% capacity)
  - With one (1) extra motor fan for the complete battery
- Two (2 x 100%) AC motor driven water pumps (on closed circuit loop) and valves
- Atmospheric expansion tank with level, filling plug with steel structure

### **7.2.7 CO2 High Pressure Fire Protection For Gas Turbine Unit Including For Each Unit:**

- One (1) H.P. CO2 cylinders rack
  - Inside a storage container with:
    - Air conditioning system
- Unit fire protection panel installed indoor for 3 zones:
  - Gas Turbine Auxiliaries
  - Gas module
  - Load gear
- Two (2) sets of HP CO2 bottles:
  - First one erected on CO2 RACK connected for one CO2 concentration test
  - Second one with cylinder valves not connected (range storage condition -18°C to 45°C) to replace first one set after test.

### **7.2.8 One Washing Skids per unit Including:**

- Each skid will be dedicated to one unit
- washing skids able to perform Compressor (On & Off-Line) and Turbine (Off-Line) with:
  - Water tank stainless steel, sized to allow one turbine and one compressor washing
  - First charge of Detergent supplied by GE

### **7.2.9 Off-base interconnecting piping including, for Each Unit:**

- Gas Fuel Off-Base piping including For Each Unit:
  - Interconnecting piping between gas filtering skid, shut off valve skid and the gas module
- Liquid Fuel piping Including For Each Unit:
  - Interconnecting piping between additive injection skid and filtering skid
  - Interconnecting piping between filtering skid and GT
  - Piping from/to forwarding skids (heavy and Light distillate) are not provided
- Water injection piping including For Each Unit:
  - Interconnecting piping between water injection skid and GT

- Off-Base Cooling piping Including For Each Unit:
  - Interconnecting piping among the fin-fan cooling module, pumping skid, expansion tank, G.T and generator
- Lube oil piping Including For Each Unit:
  - Interconnecting piping between GT lube oil boxes and generator bearings
  - Interconnecting piping from GT enclosure to atmosphere
  - Interconnecting piping between lift oil module and generator
- Compressed air from GT
  - Interconnecting piping between GT compressor and Air processing unit.
  - Interconnecting piping from air processing unit to air inlet filter.
  - Interconnecting piping from air processing unit to various consumers (water injection skid, fuel oil filtering skid,...).
- Fire Protection piping including For Each Unit:
  - Interconnecting piping from CO2 module to protected compartments
- Washing Skid piping including:
  - Interconnecting piping between washing skid and the gas turbine
- Draining piping Including For Each Unit:
  - Piping draining for GTG group
- Other requirements:
  - all other piping inside enclosures are provided by GE up to 500mm outside the enclosures.
- Support for pipes
- Counter flanges, except for fuel oil

## **7.3 Off-Base Unit Electrical Auxiliaries Including:**

### **7.3.1 One (1) Generator Line Accessory Compartment (GLAC), Per Unit, Consisting Of:**

- One (1) set of VT's and CT's for metering, generator protection and regulation
- One (1) additional set of VT's
- One (1) additional set of CT for generator protection redundancy
- Surge capacitors and lightning arrestors
- Input connection designed for NSPB (Non Segregated Phase Bus bars)
- Output connection designed for IPB (Isolated Phase Bus bars)

### **7.3.2 One (1) Generator Neutral Accessory Compartment (GNAC), Per Unit, Consisting Of:**

- CT's for generator protection
- One (1) additional set of CT for generator protection redundancy
- Input connection designed for NSPB (Non Segregated Phase Bus bars)
- Generator grounding by transformer and secondary connected resistor

### **7.3.3 Off base low voltage (armoured) cabling according to arrangement as per Layout included in tab 17a including:**

- Interconnection LVpower , control and instrumentation cables between PEECC and other equipment supplied by GE
- With the exception of the MV cables (6,6kV) from/to Starting motor MV Cell.
- Optical fiber for remote with a limited length of 100 meters
- Engineering of associated trays and conduits

## **7.4 Remote Control & Monitoring**

- One (1) Remote HMI with 22" LCD dual monitor and with dot matrix printer
- One (1) Historian for 3 GT (including 1 color laser printer)
- ETHERNET interface to the plant DCS via <HMI>, OPC-TCP/IP protocol (remote)
- Remote Services Gateway, one (1) per site : RSG computer, lockbox. Broadband connection is required such as DSL, cable, satellite or equivalent interface

## **7.5 Miscellaneous**

- The following consumables:
  - First charge of lubricating oil plus 10%
  - First charge of anti corrosion & anti freeze product for the closed cooling system
  - Excluding cabling up to the liquid fuel forwarding skid
- Startup commissioning spare parts
- Anchoring and base plates for turbo generator
- Embedded pieces for turbo generator
- Template for anchor bolts positioning (for several units project, we do supply one single template for each block of three gas turbine units)
- Touch up products for primary coat
- Painting products for final coat on external surfaces of equipment (supplied by GE, to be applied on site by others)
- Special tools for the gas turbine including (one (1) set per site):
  - Installation tools list
  - Major inspection: specific tools for GT rotor dismantling (lateral exhaust)
  - Hydraulic torque wrench for GT casing dismantling
  - Rotor turning device with motor pump
  - Major inspection: tool kit for GT casing dismantling
  - Major inspection: disassembly tools for complete GT rotor
- No load gas turbine factory tests according to Manufacturer's standard (First unit only tested)
- Generator test according to manufacturer's standard
- Automated Water Wash: Single pushbutton control replaces 50+ manual operations bringing significant time and labor savings. Seller will provide necessary valves and control software updates to implement this option at a later stage. Installation costs are not included in this proposal.

## 7.6 Services

- End Of Manufacturing Report (EOMR) containing inspection & test records as per Contract Manufacturing Quality Plan (Tab.19) in English language on the following support:
  - through Internet using GE Document Management System
- Operation and maintenance manuals, according GE Energy Products – Europe standard form, in English language on the following support:
  - CD-ROM
- Transportation as per commercial section
- Installation commissioning site testing in respect of the fire protection system are excluded from GE's scope of supply

## 7.7 Terminal Points

### 7.7.1 Mechanical

- Air
  - Inlet face of the gas turbine air filter
- Exhaust gas
  - Outlet flange of the low frequency silencer (without expansion joint)
- Gas fuel
  - Inlet flange of the coalescing filter
  - Vent connections
- Liquid fuel
  - Inlet and outlet flanges of the Heavy Oil forwarding skid
  - Inlet flange on the [self-cleaning](#) Heavy Oil filtering skid
  - Outlet flange on the Heavy Oil filtering skid for the recirculation to storage
  - Inlet and outlet flanges of the Light Liquid Fuel forwarding skid
  - Inlet flange on the Light Liquid fuel filtering skid
  - Outlet flange on the Light Liquid fuel filtering skid for the recirculation to storage
- Cooling Water (Closed Circuit)
  - Filling connection on the expansion water tank
- Demineralized Water (NOx Control)
  - Inlet flange of water injection skid
  - Outlet flange on the skid for water recirculation to storage
- Washing Water (ON/OFF Line)
  - Filling connection on washing water tank
- Detergent (OFF Line Compressor Washing)
  - Filling connection on washing detergent tank
- Lube Oil
  - Inlet and outlet connection on lube oil tank for filling and emptying
- Sump
  - Outlet flanges of the sump pump

- Condensates
  - Outlet flange on gas fuel coalescing filter
- Ventilation
  - Inlet and outlet openings on the acoustical enclosures
- Evaporative cooler (Water For Evaporative Cooler)
  - Inlet flange on evaporative cooler water reservoir
  - Water drain connection for blow down
- Draining system
  - Interfaces points in the water recovery pit

### 7.7.2 Electrical

- Low Voltage (400 VAC) terminal points
  - Incoming circuit breakers terminals on GT MCC (normal and standby incomings)
- Control and instrumentation
  - Input & output terminals at control panels for interface to the plant control system
- Medium Voltage (6,6 kV) terminal points
  - Incoming terminals of the starting motor
- Medium Voltage (15 kV) terminal points
  - Outgoing terminals of the Generator Line Accessory Compartment
- Earthing
  - Terminal points on GTG base frame and various auxiliaries

## 7.8 Supplied By Others

### 7.8.1 Mechanical

- —  
Firefighting system (other than GT CO2 fire protection)
  - Site fire protection and detection system
- Piping
  - All piping systems beyond terminal points
- Compressed air system (service and control) (if any)
- Washing water (if any) and oily water drain system including water recovery pit, piping from connecting flange near the GT base, water treatment before discharge in sewage system (if any)
- Any crane and / or lifting facilities
- Machine shop equipment (if any)

- Laboratory equipment (if any)

## **7.8.2 Electrical**

- Unit step-up / step down transformer
- All MV and HV cables
- Generator circuit breaker (52G)
- Insulated Phase Bus ducts (IPB -downstream GLAC)
- Starting motor circuit breaker and protection
- Any MV and / or LV site switchboard
- Emergency diesel generating set and black start equipment (If any)
- Grounding grid and connections to the grounding cable
- Lightning protection
- Site lighting, fencing
- Cathodic protection

## **7.8.3 Miscellaneous & Services**

- Any generator type test
- Any on site painting product application
- All consumable, chemicals during erection, commissioning, testing and running of the unit(s)
- Soil investigation, analysis and factual report
- Any civil work, concrete structure, road, including design studies (except guide drawings for the supplied equipment)
- Grouting compound for GT unit(s)
- Installation commissioning site testing in respect of the fire protection system are excluded from GE's scope of supply
- All environmental permits and / or approvals such as (but not limited to) air, waste, fluids, coastal zone, noise, hydrology study
- All governmental permits and / or approvals such as (but not limited to) construction permit, environmental impact statements, licenses, exemptions
- Any other equipment or service not clearly indicated in our Scope of supply
- Any Site Electrical Network harmonic study