

# Siemens Gas Turbine and Generator Package

## List of materials available on site

### Gas turbine

Design data of model **SGT5-4000F** Frequency 50 Hz

Type of gas turbine (heavy duty, single casing, axial flow design)

Turbine comprising:

- Compressor:
  - 15 Stages
  - One variable-pitch inlet guide vane rows
  - Extraction ports behind- stationary blade 5- stationary blade 9
  - Compressor pressure ratio approx. 17
- Ring combustor:
  - One Combustion Chamber
  - 24 burners
  - One ignition devices per burner
- Turbine
  - 4 Stages
- Bearings
  - 2 Bearings (journal @ turbine end, thrust + journal @ compressor end)
- Turning gear
  - Type hydraulic motor, speed 100 rpm
- Mechanical control and protection system
- Gas turbine instrumentation and actuation

### Gas turbine systems:

- Gaseous fuel package
  - One emergency stop valves
  - Two control valves (pilot + premix)
- Lubrication oil system with lube oil tank
  - Lube tank Capacity approx. 16,5 m<sup>3</sup> (Capacity of oil system approx. 15 m<sup>3</sup>)
  - Oil retention time approx. 8 min
  - Two oil mist extraction fans
  - Two Main oil pump type centrifugal 100 % capacity of one pump, drive AC motor
  - One emergency oil pump, type centrifugal, drive DC motor
  - One jacking oil pump, type vane pump, drive AC motor
  - One main oil filter, type duplex, capacity 2x100 %, filter mesh absolute 0.020 mm
  - One jacking oil filter, type cartridge, capacity 100 %, filter mesh absolute 0.020 mm
  - 2 x 100% plate type heat exchanger.
- Hydraulic clearance optimization (HCO) package
- Hydraulic oil package for control system

### Equipment for gas turbine:

- Fuel gas flow metering for performance test only
- Advanced compressor cleaning system (ACCS)
- Set of tools for initial assembly and inspection
- Set of major inspection tools and a set of standard tools

#### **Air intake system:**

- filter system, with pre- and high efficiency filter (multi-stage static filter)
  - Intake volume approx. 550 m<sup>3</sup>/s
  - Design pressure maximum/minimum +3000/-2200 Pa
  - Design temperature minimum -10 °C
  - Design temperature maximum +40 °C
  - Prefilter/Finefilter, number approx. 540, air flow per cell approx. 3650 m<sup>3</sup>/h, arrestance class acc. To EN 779: 1993 – Finefilter F5 – Prefilter F9
  - Initial pressure drop system\* approx. 580 Pa
  - Final pressure drop system between prefilter and GT compressor inlet (recommended filter change) approx. 1000 Pa
- inlet air filter house including weather hood, internal support structure, instrumentation, lighting, power sockets, manhole, access ladders, platforms and doors
- implosion doors (filter house)
- anti-icing (warm water to air heat exchangers)
- evaporative cooler
- interconnecting duct work with expansion joint, damper and silencer

#### **Exhaust gas systems**

- diffuser
  - Exhaust gas volume flow (at ISO-conditions) approx. 1535 m<sup>3</sup>/s
  - Design temperature minimum -10 °C
  - Design temperature maximum +40 °C
  - Design ambient temperature +15 °C
  - Design pressure minimum -2000 Pa
  - Design pressure maximum (diffuser) +5400 Pa
  - Design flue gas temperature (fuel gas operation) approx. 620 °C

#### **Noise enclosure for gas turbine:**

- Structural Steel with corrosion protection
- Noise abatement panels galvanized
- Internal service platforms and ladders galvanized
- Doors with safety windows
- Internal lighting including emergency lighting

#### **Ventilation system for gas turbine enclosure:**

- Air intake openings with protective grills, dampers and silencers
- Exhaust air handling unit on top of enclosure, equipped with back draft dampers, fans including mechanical redundancy and silencers

#### **Tight fitting noise enclosure for each of the following skids:**

- Fuel gas skid (ventilation system combined with the gas turbine enclosure ventilation system)

#### **CO<sub>2</sub>-Fire fighting system for turbine unit, including:**

- Battery of high pressure bottles for CO<sub>2</sub> and direction valve station
- Piping system from bottle rack to spray nozzles inside the enclosures including supports
- Fire detection and control system with local panel

#### **Gas Turbine Control System**

- Turbine Controller
  - redundant automation processor for closed-loop control functions
  - I/O modules as per I/O
- Turbine Failsafe Protection and Trip System
  - failsafe system for protection and trip functions
- Turbine Function Group Automatic and Operational Protection System

- redundant automation processor for open-loop, sequence control functions and operational protection functions
  - I/O modules as per I/O
- Turbine Operating / Monitoring / Engineering System
- 2 Operator Terminal with two 19" LCD monitor, keyboard and mouse
  - Fault tolerant Application Server for operating, monitoring and engineering functions
  - 2 Printer (A4, Color Laser)
  - Turbine Bus System
  - Application Bus and Automation Bus with all necessary network components
  - Turbine Analysis System Win\_TS
  - Win\_TS Analysis System hardware + peripherals
  - software for system basic functions
  - software for Gas Turbine Special Condition Monitoring
  - software for Gas Turbine Vibration Analysis
  - software for Gas Turbine Thermodynamic Calculations
  - I&C Cables, turbine related special I&C cables ( flame monitoring cable, bus cable)
  - I&C Software (system and application programs) on disks
  - Signal Interface (OPC-link) with Plant DCS
  - Ethernet terminal point (RJ45 or Sub-D) for exchange of 500 signals at most 1 TP for all
  - Signal Interface (hardwired) with Plant DCS
  - terminal points for exchange of 70 binary signals at most
  - terminal points for exchange of 30 analog signals at most
  - terminal point for exchange of bus clock synchronization signal
- Generator protection cabinet (CHA)
- Synchronization / Synchro-check equipment (CHA)
- Gas detection system (CYQ)
- 2 Inverter for Siemens supplied turbine DCS in PCC (BRU)
- Starting frequency converter (CJT) consisting of:
- Line side and machine side B6C converter bridge
  - DC link between line side and machine side converter
  - Overvoltage protection on line side and machine side
  - Speed control
  - Compressor washing function
  - Boiler purge function (10 minutes)
- Active power 4.0 MW, Rated apparent power 5170 kVA, Rated input voltage 1.8 kV, DC link current 1940 A, DC link voltage 2100 V
- Thyristors: – Type T1451N5200, – Number per branch 1, – Rated current 2020 A, – Voltage rating factor 2.04
- Smoothing reactor ( DC link): – Rated current 1600 A, – Starting current 1940 A, – Inductivity 1.8 mH @ 2.5 kA, – Nominal insulation voltage Class H for 3 kV
- Rated losses 48 kW
- Degree of protection IP 30
- Type of cooling Forced air
- Required cooling air 4500 m<sup>3</sup>/h
- Noise sound pressure level at 50 Hz power supply 75 dB(A)
- Weight ( compact unit including DC link reactor) 2700 kg
- Static excitation equipment (CJT) consisting of: 1
- Fully controlled converter bridge type B6C
  - Redundant bridges 3 x 50 %
  - Disconnect switch for maintenance during operation
  - Equipment for rapid deexcitation
  - Line side overvoltage protection
  - DC side overvoltage protection
  - 2 manual and 2 automatic controller
  - Power System Stabilizer
  - Starting frequency converter transformer with metal enclosure (IP23) (MBJ)
  - Static excitation equipment transformer with metal enclosure (IP23) (MKC)
- Maximum cont. Excitation current IfN 1764 A, Excitation system nominal current IEN 1940 A, Ceiling

current IP (10s) 2646 A, Rated input voltage US 540 V, Ceiling voltage UP 625 V.

Thyristors: – Type of Thyristors T1509N1800, – Number of bridges 3 x 50%, – Voltage rating factor 2.35

Voltage controller: – Control accuracy 0.5 %, – Control range (with generator connected to the grid)

95..105 %, – Setting range (manual) 0 ..110 %, – Controller dead band 0.1 %, – Ceiling voltage factor 2.0, –

Excitation nominal response 3 s<sup>-1</sup>, – Initial excitation time 10 ms.

Rated losses (without transformer) 10.5 kW

Type of cooling Forced air

Required cooling air 2500 m<sup>3</sup>/h

Noise sound pressure level at 50 Hz power supply 70 dB(A)

Weight 1100 kg

Degree of protection IP 30

### **Fuel gas system**

- 2 Dust-liquid separator, Vertical, dual stage,

- 1st stage: baffle plate
- 2nd stage: coalescer cartridge

MAWP: 44 barg

MAWT: +60°C

- Consumption metering system, Orifice type, acc. to spec. of DGTI-2008-0131

- 10" (DN250) ANSI 300
- MAWP: 47 barg

consisting of:

Flow straightener, Inlet piping, Flow meter, High pressure calibration, Outlet piping, Thermowell, Gasket, Dust cap for pressure connection

- Two Efficiency heater U-Tube bundle with trapped tube plate, carbon steel 10" (DN250) ANSI 300 2/2-way

- Dust-liquid separator, Vertical, dual stage,

- 1st stage: baffle plate
- 2nd stage: coalescer cartridge

MAWP: 44 barg

MAWT: +170°C

- Condensate tank Horizontal with two saddles 2,000 l, double wall

MAWP: atmospheric

MAWT: +60°C

- Final filter Vertical, single stage, Cellulose cartridge

MAWP: 44 barg

MAWT: +170°C

- 5 Shut-off valve, pneumatic actuated, Ball valve, flanged 10" (DN250) ANSI 300

MAWP: 44 barg

MAWT: +170°C

- Pneumatic actuator Single action, spring return 10" (DN250) ANSI 300 without control unit, without reducing unit, without venting unit, without solenoid valves, etc.

### **Air-Cooled Generator Type: SGen5-1000A**

**Rating: MVA: 328; kV: 20 kV; Frequency: 50 Hz; RPM: 3000; pf: 0.85; Water-to-Air Cooled (TEWAC)**

For simple-cycle gas turbine and multi-shaft combined-cycle power plants

The SGen5-1000A air-cooled generator for the SGT5-PAC 4000F features:

- World class efficiency with low maintenance design
- Multi-zone, indirectly cooled stator windings
- Roebelled stator windings with brazed solid end connections
- Radially ventilated stator core attached to bed plate
- Global Vacuum Pressure Impregnated (GVPI) stator core and stator winding
- Core suspended on two axial springs
- Radially ventilated and cooled rotor winding
- Two low pressure "push" fans mounted at each end of the rotor
- Weather and sound proof outer generator enclosure
- Overhung collector and brush holders

Generator mainly comprising of:

- Bedplate
- Spring mounted, GVPI, radially cooled stator core
- Conventionally cooled stator winding with class F insulation

- Rotor shaft forging including two shaft mounted ventilation fans
- Radially cooled rotor winding with class F insulation
- Inner enclosure covering and completing the ventilation circuit
- 6 High voltage leads at the top of the generator
- 2 Bearings supported in pedestals that are mounted on the bedplate
- Overhung collector with collector ring assembly and brush holder
- Fixators and grout for fixatores for mounting on foundation
- Foundation bolts , nuts and washers
- Axial and transvers anchors

Resistance Temperature Detectors (Platinum, 100 ohms at 0 degrees C):

- 12 duplex Slot RTDs embedded in the armature windings.
- 2 duplex RTDs in the generator warm air cooler inlet.
- 4 duplex RTDs in the generator cold air cooler outlet.
- 1 duplex RTD in the excitation cold air inlet.
- 1 duplex RTD in the excitation warm air outlet.

Thermocouples (Type K - chromelalumel):

- 1 triplex TC embedded in each bearing metal.
- Rotor grounding brushes
- Provision for vibration monitoring at bearings
- Space heater

Current transformers :

- Three (3) for each of the three phase line leads,
- Four (4) for each of the three neutral leads.
- Grounding equipment including grounding transformer, neutral tie, neutral cable and, groundingresistor
- All instruments wired to plugs or junction boxes

Generator Outer Enclosure including:

- coolers (2 x 25 %) and liquid detector for a TEWAC unit

Rotor removal and installation tools

## **Low Voltage Switchgear**

### **AC Switchgear**

- Rated insulation voltage 1000 V
- Rated impulse withstand current (Ipk) 110 kA
- Rated short time withstand current (Icw) 50 kA (1 s)
- Rated voltage AC 400 V, +10%, -10%
- System classification to IEC 60364 AC TN-C
- Ambient temperature max. +35° C (daily mean temperature)
- Surface treatment Frame parts: sendzimir galvanized
- Enclosure: powder-coated, RAL 7035 Degree of protection acc. to IEC 60529 IP41 IP00 to cable
- floor below

### **DC Switchgear**

- Control voltage (Us) DC 220 V
- Current transformer secondary rating 1 A
- Rated insulation voltage 1000 V
- Rated voltage DC 220 V, +10%, -15%
- System classification to IEC 60364 DC IT
- Ambient temperature max. +35 °C (daily mean temperature)
- Surface treatment Frame parts: sendzimir galvanized
- Enclosure: powder-coated, RAL 7035 Degree of protection acc. to IEC 60529: IP41, IP00 to cablefloor below
- Busbar rated short time withstand current (Icw) 10 kA
- Rated breaking capacity acc. to IEC 60269 10 kA

### **Battery, Charger, DC/DC Converter, Inverter**

The battery voltage ranges are as follows:

- Number of cells 108
- Design operating voltage 220 V
- Rated voltage 216 V (2.00 V/cell)

- Float charge voltage 241 V (2.23 V/cell)
- Boost charge voltage (consumers disconnected) 259 V (2.40 V/cell)
- Minimum discharge voltage 198 V (1.83 V/cell)

#### **Battery Charger**

- AC input voltage 400/230 V  $\pm 10\%$
- Input frequency 50 Hz,  $\pm 5\%$
- Float charge voltage 241 V (at 2.23 V/cell)
- DC output voltage setting range  $\pm 5\%$
- Regulation error of output voltage  $\pm 1\%$  on load variations 0-100 %, on frequency variations  $\pm 5\%$ , on input voltage variations  $\pm 10\%$
- DC output voltage ripple content  $< 5\%$  (pp) without battery
- Permissible ambient temperatures 0...+40°C
- Radio interference Class "A" according to EN55011
- Degree of Protection IP 31
- Cubicle colour RAL7035

#### **DC-DC Converter**

- DC input voltage 220V DC +10% -15%
- DC output voltage 26 V DC  $\pm 1\%$
- DC output voltage ripple content 1% rms
- Permissible ambient temperatures 0...+ 40° C
- Radio interference Class "A" according to EN55011
- Degree of protection IP 31
- Cubicle color RAL7035

#### **Inverter**

- DC input voltage 220 V DC
- Permissible range of DC input variation +10%/-15% rated conditions
- Bypass input voltage and frequency 1 x 230 V AC,  $\pm 10\%$ , 50 Hz
- Inverter output voltage 1 x 230 V AC, 50 Hz with deviation (static)  $\pm 1\%$ , with deviation (dynamic)  $\pm 5\%$
- Inverter output voltage setting range  $\pm 5\%$
- Inverter output voltage harmonic content  $\leq 3\%$
- Overload capability 150% for 1 minute
- Permissible ambient temperature 0...+40°C
- Radio interference Class "A" according to EN 55011
- Degree of Protection IP31
- Cubicle colour RAL7035
- Cooling method forced air (2 \* 100%)