POWER PLANT - FOR SALE

GE FRAME 6B

GE FRAME 6B

OEM: GE

MODEL FRAME 6B

DETAILS

GEMS6001BTURBINE GENERATOR

ISO RATING	FREQUENCY
39 MW	50 Hz

EOH	STARTS
68,448	2,166

FUEL TYPE

Dual Fuel Capable

POWER GENERATION: 39MW ISO

GE FRAME 6B GAS TURBINE – HEAVY INDUSTRIAL TYPE

Turbine and Generator Package - Balance of Plant – Turbine Control System and Generator Controls

TECHNICAL SPECIFICATION OF THE ONE (1) UNIT OF FRAME 6B GAS TURBINE (34 MW) AND ITS RESPECTIVE ANCILLARIES

POWER PLANT - FOR SALE

GE FRAME 6B

1. Total Generation - The total Equivalent Operating Hours ("EOH") for the gas turbine at KLPP Plant since commissioning until 2016 is as follows:

Unit	Commissioning Year	Total EOH
GT11	1998	68,448

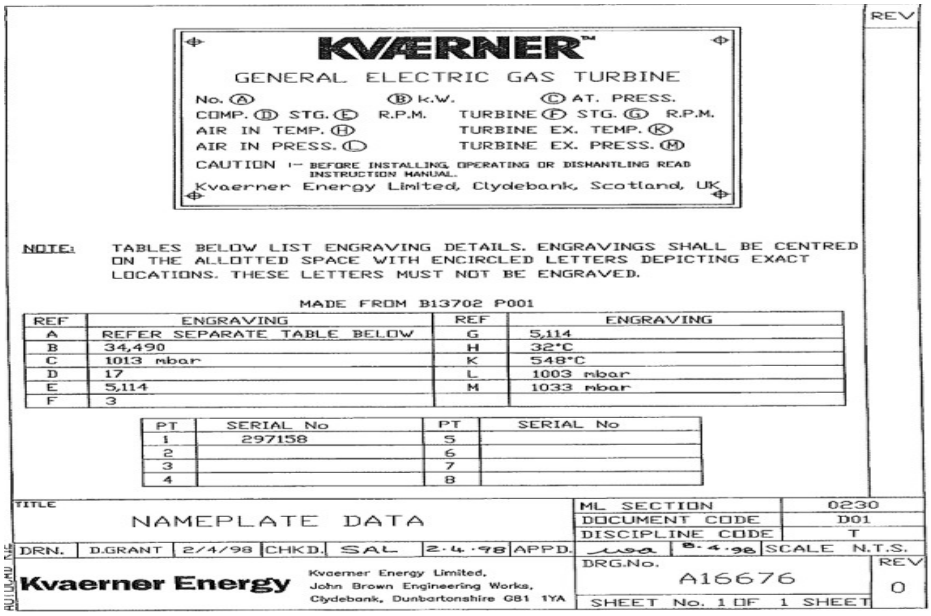
2. Total Starts - The total starts for the gas turbine at KLPP Plant since commissioning until 2016 is as below:

Unit	Commissioning Year	Total Starts
GT11	1998	2,166

MAJOR EQUIPMENT - Details of the main equipment are as follows:

3. <u>Gas Turbine 11 (Frame 6)</u>

Serial No:	297158
Model	GE Frame 6 (6001B)
Make By	Scotland (K.E.L)
Year Make	1997
Turbine Stage	3
Compressor Stage	17
Rating	34,490 KW
Operating Speed	5114 rpm



KVÆRNER™

GENERAL ELECTRIC GAS TURBINE

No. (A) (B) K.W. (C) AT. PRESS.
COMP. (D) STG. (E) R.P.M. TURBINE (F) STG. (G) R.P.M.
AIR IN TEMP. (H) TURBINE EX. TEMP. (K)
AIR IN PRESS. (L) TURBINE EX. PRESS. (M)
CAUTION :- BEFORE INSTALLING, OPERATING OR DISMANTLING READ INSTRUCTION MANUAL.
Kvaerner Energy Limited, Clydebank, Scotland, UK

REV

NOTE: TABLES BELOW LIST ENGRAVING DETAILS. ENGRAVINGS SHALL BE CENTRED ON THE ALLOTTED SPACE WITH ENCIRCLED LETTERS DEPICTING EXACT LOCATIONS. THESE LETTERS MUST NOT BE ENGRAVED.

MADE FROM B13702 P001

REF	ENGRAVING	REF	ENGRAVING
A	REFER SEPARATE TABLE BELOW	G	5,114
B	34,490	H	32°C
C	1013 mbar	K	548°C
D	17	L	1003 mbar
E	5,114	M	1033 mbar
F	3		

PT	SERIAL No	PT	SERIAL No
1	297158	5	
2		6	
3		7	
4		8	

TITLE: NAMEPLATE DATA

ML SECTION 0230
DOCUMENT CODE D01
DISCIPLINE CODE T

DRN. D.GRANT 2/4/98 CHKD. SAL 2·4·98 APPD. 8·4·98 SCALE N.T.S.

Kvaerner Energy
Kvaerner Energy Limited, John Brown Engineering Works, Clydebank, Dunbartonshire G81 1YA

DRG.No. A16676
REV 0
SHEET No. 1 OF 1 SHEET

POWER PLANT - FOR SALE

GE FRAME 6B

i. Air Intake System

2 Stage Filtration (Pre-Filter & Fine Filter) with evaporative cooling media before filters.

PRE-FILTER	G4 Class Reverse Flow Pocket Filter 595mmx595mmx330mm. 140pcs.
FINE FILTER	F8 Class Cassette Filter 592mmx592mmx292mm. 140pcs.

ii. Combustion System

The combustion system is a reverse-flow cannular type with 10 combustion cans arranged around the periphery of the compressor discharge casing. The major components consist of:

1. Dual Fuel nozzles
2. 2 Spark plugs
3. 4 Ultraviolet flame detectors
4. 10 Combustion Cans
5. 10 Combustion chamber - comb. liners & transition piece
6. 10 Crossfire tubes linking the 10 cans.

iii. Bearings

BEARING No.	CLASS	TYPE
1	Loaded Thrust	Tilting Pad - Equalizing
1	Unloaded Thrust	Taper Land – Non Equalizing
1	Journal	Elliptical
2	Journal	Elliptical

iv. Fuel System

Fuel Gas System (On-Base)

Fuel gas is delivered to the combustion chamber by the on-base fuel gas system. The system is designed to deliver fuel gas at the correct pressure and flow rates to meet all starting, acceleration and loading requirements of Gas Turbine operation.

POWER PLANT - FOR SALE

GE FRAME 6B

The following major components comprise the on-base fuel gas system:

1. Gas Strainer
2. Stop/Speed Ration and Control Valve Assembly (VGA) comprising:
   a. Gas Control Valve (VGC) with Linear Variable Differential Transducers (LVDTs) (96GC-1 and 2)
   b. Gas Stop Ratio Valve (VSR) with LVDTs (96SR-1 and 2)
   c. Gas Stop Ratio Valve Control Servovalve (90SR)
   d. Gas Control Valve Control Servovalve (65GC)
   e. Gas Fuel Trip Valve (VH5)
   f. Gas Fuel Hydraulic Supply Filter (FH7)
3. Gas Vent Solenoid Valve (20VG-1)
4. Gas Pressure Switch (63FG-3)
5. Pressure Gauges
6. Pressure Transducers (96FG-2A, 2B and 2C)
7. Distribution Manifold

Fuel Oil System (On-Base)

The on-base fuel oil system pumps and distributes fuel, as supplied from the off-base fuel forwarding system, to the ten nozzles of the combustion system. After the filtration, the fuel flow is divided into ten equal parts for distribution to the combustion chambers at the required pressure and flow rate. The system includes:

1. Low-Pressure Fuel Oil Filter (FF1)
2. Stop Valve (VS1)
3. Main Fuel Oil Pump (PF1)
4. Bypass Valve Assembly (VC3)
5. Flow Divider (FD1)
6. Magnetic Pickups (77FD-1, 2 And 3)
7. Check Valves (VCK1-1 to 10)
8. Pressure Gauge Assembly with Selector Valve
9. False Start Drain Valve Assembly (VA17)
10. Fuel Nozzles
11. Pressure Switch (63FL-2

v. Lube Oil System

The lubrication requirements for the Gas Turbine and Generator units are furnished by a common forced-feed lubrication system. This system includes a tank, pumps, heat exchangers, filters, valves and various control and protection devices. It provides both normal lubrications and for absorption of the heat rejection load of the Gas Turbine. The lube oil is circulated to the two main turbine bearings, generator bearings, reduction gear, and to the turbine accessory gear. Additionally, a portion of the pressurized lube oil is diverted and filtered again for use as control fluid by the hydraulic control devices.

POWER PLANT - FOR SALE

GE FRAME 6B

The major system components include:

1. Lube Oil Reservoir and Piping

   The turbine base contains the 1700 US gallons (6435 litres) capacity storage tank for the lubrication system. It is fabricated as an integral part of the base structure and is located between the top and bottom plates of the lower steel beam framework. The bottom plate of the lube oil reservoir is positioned at a slight angle that slopes toward two drain pipes and plugs, one near the end of the base. Provisions are also made for access to the tank interior through a manhole located at the top of the tank. The reservoir filling connection is located at the tank side near the top.

   The lube oil pumps, starting diesel engine, accessory gear and other accessory devices are mounted on top of the reservoir. The heat exchangers and interconnecting pipework are mounted inside the lube oil reservoir. The lube oil piping, which consists of seamless steel piping with welded joints, is contained within the perimeter of the base. Where possible, the bearing lube oil feed pipes are situated within the drain headers.

2. Lube Oil Pumps

   The lubrication system has three lube oil pumps:

   a. Main Lube Oil Pump (P3) - a positive displacement type pump mounted in, and driven by, the accessory gear.

      The main lube oil pump (P3) is built into the inboard wall of the lower half casing of the accessory gear. It is driven by a splined quill shaft from the lower drive gear. The output pressure to the lubrication system is limited by a back-pressure valve (VR1) to main system pressure at 4.48 bar g (65 psi g).

   b. Auxiliary Lube Oil Pump (P2) – driven by a vertical a.c. (88QA) motor.

      The auxiliary lube oil supply pump (P2) is a submerged, centrifugal-type pump driven by a vertically mounted a.c. motor (88QA).
      Should the bearing header pressure decrease below the settling of pressure switch (63QA-2) due to failure of the main lube oil pump or for any other reason, an alarm will be initiated and the auxiliary lube oil pump will be automatically started.

On turbine shutdown, the a.c. motor-driven auxiliary pump starts at relay 14HS dropout. The pump continues to operate throughout the shutdown and cooldown period and runs until the 'COOLDWON OFF' display target is selected by the operator.

c. Emergency Lube Oil Pump (P1) –driven by a vertical d.c. (88QE) motor.

The emergency lube oil supply pump (P1) is a submerged, centrifugal-type pump driven by a vertically mounted d.c. motor (88QE).

The emergency lube oil pump is in operation during the turbine starting sequence and also during stopping sequences should a.c. power supplies be unavailable.

3. Hydraulic Oil System

Pressure-regulated, filtered lube oil from the bearing header of the Gas Turbine is used as the high-pressure fluid necessary for the hydraulic supply system requirements. The system provides the fluid power for operating the fuel control valves and inlet guide vane actuator.

The major system components include:

a. Main Hydraulic Pump (Ph1)

The main hydraulic supply pump (PH1) is a pressure-compensated, variable displacement, axial piston type pump driven by an outboard shaft of the accessory gear. It pumps lube oil (OR-1) from the turbine bearing header to the hydraulic manifold assembly. A pressure compensator (VPR3), built into the pump, controls and regulates the pressure in the hydraulic supply system when the pump is supplying sufficient oil to satisfy the demands of the system.

b. Hydraulic Supply Filters (Fh2-1 And 2)

From the output connection of the manifold assembly, the high-pressure fluid is piped through the system filters (FH2-1 and 2) and now becomes a high-pressure control fluid. The hydraulic supply system filters prevent contaminants and other wear particles from entering either the inlet guide vane system or the fuel valve control system.

Only one filter is in operation at any time during system operation. A transfer valve (VM4) permits changeover between either filter without interrupting the operation of the system. A differential pressure gauge is provided across the filters to indicate when the filter elements should be changed.

4. Pressure Relief Valve (VR1) in the main pump discharge
5. Bearing Header Pressure Regulator (VPR-2)
6. Lube Oil Heat Exchangers (LOH-1 and LOH-2)
7. Lube Oil Filters (LOF-1) and (LOF-2)
8. Control Oil Filters (COF-1) and (COF-2)

vi. Variable Inlet Guide Vane System

The following components are included in the inlet guide vane system:

1. Servovalve (90TV)
2. Linear Variable Differential Transducers (LVDTs) and Position Sensors (96TV-1 and 2)
3. Dump Solenoid Valve (20TV)
4. Hydraulic Dump Valve (VH3)
5. Hydraulic Actuating Cylinder (HM3)

The inlet guide vanes are positioned by a hydraulic cylinder located on the turbine base. A hydraulic accumulator (AH2-1) is installed in the piping upstream of the inlet guide valve servovalve (90TV). It maintains the system pressure transient demand for operating the hydraulically actuated variable inlet guide vane system. The accumulator absorbs shock which might occur when the hydraulic pump starts. A 40 micron filter (FH6) is provided in the piping upstream of the accumulator and provides additional protection for the inlet guide vane components.

vii. Trip System

System Description

Low-pressure oil, piped from the lube oil system, is used in the trip oil system. The lube oil is passed through an orifice to become trip oil (OLT). The orifice is located in the piping from the bearing header supply to the trip oil system. This orifice limits the flow of the lube oil into the trip oil system and is sized such than an adequate capacity for all tripping device operations is ensured without causing starvations of the lube oil system when the trip oil system is activated.

A turbine shutdown is initiated through the trip system by dumping fluid pressure from the system, either directly or indirectly through solenoid operated stop valves (20FG) and (20FL). When oil in the trip oil system is dumped, fuel oil stop is closed by spring return action. When the turbine is started, the stop valve is energized to reset at the desired point in the starting sequence thus permitting trip oil pressure top open the fuel stop valve. The fuel stop valve will remain open until some action occurs or until the unit is shut down.

A check valve and orifice assembly is installed at the inlet of the fuel branch to limit flow into the fuel branch and allows free flow out of that branch. This network limits flow into the branch allowing fuel control without total system decay. However, when one of the trip devices located in the main artery of the system is actuated, the check valve will close and result in decay of all trip pressure. Pressure switches (63HG-1,2 and 3) and (63HL-1,2 and 3) monitor trip oil pressure to the respective gas fuel or fuel oil system. A direct reading pressure gauge and test valve are installed with each set of pressure switches to facilitate inspection and maintenance.

Overspeed Mechanism

An overspeed trip mechanism, mounted on the accessory gear, is utilized as a secondary trip device in the system. This mechanical device, located in the accessory gear, is actuated automatically by the overspeed bolt should the turbine speed exceed the bolt setting. As a result, a rapid decay in trip oil pressure (OLT) occurs which stops fuel flow to the turbine by action of the fuel stop valve.

viii. Atomizing Air System

A dual-fuel, low-pressure atomizing air system, which includes an integral fuel nozzle purge system, is installed on the Gas Turbine. The atomizing air system provides sufficient pressure in the air atomizing chamber of the fuel nozzle body to maintain the proper ratio of atomizing air pressure to compressor discharge pressure. Since the output of the main atomizing air compressor, driven by the accessory gear, is low at turbine firing speed, a starting atomizing air compressor provides the required pressure ratio during the firing and warmup period of the starting cycle.

The atomizing air system includes the following items of equipment:

1. Main Atomizing Air Compressor (CA1) – accessory gear-driven
2. Starting Atomizing Air (booster) Compressor (CA2)- belt driven by starting diesel engine.
3. Air Cleaner (separator) (PDS1)
4. Atomizing Air Pre-Cooler (HX1)
5. Atomizing Air Manifold
6. Differential Pressure Switch (63AD-1)
7. Temperature Switches (26AA-1 And 2)
8. Bypass Valve (VA18)
9. Bypass Valve Solenoid Valve (20AA)
10. Filter-Atomizing Air Control

ix. Starting System

Before the Gas Turbine can be fired and started it must be rotated (cranked) by accessory equipment. This is accomplished by a diesel engine, operating through a torque converter to provide the cranking torque and speed required by the Gas Turbine for startup. The starting system components include:

1. Diesel Torque

Rated Gross BHP	85°F (29.4°C)	60°F (15.6°C)	RPM
Rated Gross BHP (kW)	525 (392)	N.A.	2100
Continuous BHP (kW)	N.A.		N.A.
Engine Torque lb ft (NM)	1450 (1966)		1600

POWER PLANT - FOR SALE

GE FRAME 6B

Engine specification	
Original Manufacturer & Model	Detroit diesel 12V771T
Remanufacturer	*PowerForce*
Number of cylinders	12
Arrangements	v
Aspiration	Turbo-charged
Displacement CID. (Litres)	852 cu. ins. (13.97 L)
Bore X Stroke inches (Mm)	4.25'' X 5.0'' (108mm X 127mm)
Injectors	N75
Compression Ratio	18.7 : 1
Combustion Cycle	2-Cycle Detroit Diesel

2. Torque Converter with Ratcheting Mechanism

Model	4-SGE-2015-1
Type	Hydraulic Torque Converter
Number of stage	Single-stage

3. Hydraulic Ratchet System

   Components of the ratchet system include:

   a. Rotary Actuator/One-Way Clutch Mechanism in The Torque Converter Assembly
   b. Hydraulic Self-Sequencing Valve Ratchet and Clutch Assembly
   c. Starting Clutch Solenoid (20CS)
   d. Hydraulic Ratchet Pump Assembly
   e. Relief Valve (VR5)

4. Starting Jaw Clutch

In addition, there are several supplementary components required for sequencing and operation of the turbine starting system.

During the starting sequence, the Gas Turbine is driven through the accessory gear by the diesel engine, torque converter, output gear and the starting clutch. The starting clutch assembly and the engagement cylinders are mounted on the accessory gear assembly.

x. Gearboxes

Accessory Gearbox

DSIGN DATA – MODEL No. A519-B41			
Location of Shaft	**Driven Accessory**	**RPM**	**Approximate Load**

POWER PLANT - FOR SALE

GE FRAME 6B

No. 1 Outboard	Clutch	5100	---
No. 1 Inboard	Turbine Coupling	5100	---
No. 2 Outboard	Water Pump	3583	35 hp
No. 2 Inboard	(Machined to accept Brake)	3583	---
No. 3a Outboard	Fuel Pump	1814	108 hp
No. 3b Inboard	Atomizing Air Compressor	6003	380 hp
No. 4 Outboard	Hydraulic Supply Pump	1415	9 hp
No. 4 Inboard	Lube Oil Pump (Shaft Covered)	1415	31 hp

The accessory drive gear, located at the compressor end of the Gas Turbine, is a gearing assembly coupled directly through a flexible coupling to the turbine rotor. The function of the assembly is to drive each Gas Turbine accessory at the required speed and to connect and disconnect the Gas Turbine from the starting diesel engine. In addition, it contains the system main lube oil pump and the Gas Turbine over-speed trip bolt and mechanism.

The gear trains are contained within the gear casing. These provide the proper gear reductions to drive the accessory devices at the required speed and with the correct torque values. The starting clutch assembly is mounted forward on the horizontal joint of the main gear shaft and is used to connect and disconnect drive from the starting diesel engine to the Gas Turbine.

Accessories driven by the gear include:

a. The Main Lube Oil Pump
b. The Main Hydraulic Supply Pump
c. The Liquid Fuel Pump
d. The Main Atomizing Air Compressor

Load Gearbox

Load gearbox couples the turbine to the generator and acts as speed reducing device to reduce RPM of 5000 to Generator 3000 RPM

Type	TRL65CV
Nominal rating	54000 kW
API 613/88 service factor	1.3
Input speed N1	5114 RPM
Output speed N2	3000 RPM

Ratio	1.7045

xi. Generator

Type	T190-240
Rated speed	3000 RPM
Rated active power	33.8 MW
Rated power factor (cos φ)	0.8
Rated apparent power	42.25 MVA
Rated stator voltage	11 kV
Stator voltage variation	± 5 %
Rated stator current	2218 A
Rated frequency	50 Hz
Number of phases	3
Insulation class	F
Ambient air temperature	35 °C
Excitation system	TKJ 70/10
Type of cooling	air

xii. Exciter

Excitation	Rotating diode
Type	TKJ 70/10
Rated speed	3000 RPM
Overspeed	3600 RPM
Excitation power	226 kW
Rated power factor (cos φ)	0.8
Rated voltage	248 V
Rated current	513 A
Frequency	200 Hz
Number of poles	8

POWER PLANT - FOR SALE

GE FRAME 6B

SCHEDULED MAINTENANCE HISTORY	
Frame 6	**Frame 6 Generator**
CI (Nov 2000)	MI (April 2005)
HGPI (July 2002)	MI (June 2014)
MI (April 2005)	
CI (June 2007)	
HGPI (April 2012)	
CI (Oct 2013)	

MAJOR PLANT UPGRADES			
No	**Date of Modification**	**Description**	**Upgrade Works**
1	June 2009	GT12 High Flow GTD450 IGV upgrade	Replacement of end of life VIGV blades with higher flow upgraded material blades for power upgrade.
2	June 2009	GT12 CO2 Fire Protection System Upgrade	Upgrade obsolete system with new and more reliable CO2 circuit, heat detectors and cylinders.
3	Dec 2013	GT11 & GT12 Gas Detection System Upgrade	Upgrade of obsolete Crowcon system