Technical & Commercial Offer
GTES-25P Block-module
Gas-Turbine Power Plant
on the base PS-90GP-25
gas-turbine engine

2011

1. Type and Application

The GTES-25P gas turbine plant (hereinafter named as GTES) is designed to produce and supply electric power to industrial and living residence users. AC is generated by a synchronous three-phase TTK-25-2T4G turbo-generator driven by the GTU-25P gas turbine, which is based on the PS-90EU-25 engine.

The GTES can be used as main and back-up power sources. It can operate independently, in parallel to other electric power sources or in parallel to an electrical power system. It is capable of recovering exhaust gases heat in boilers, both hot water or steam, (the boiler parameters and supplier are defined together with the gas turbine plant customer). The GTES operates on fuel gas.

GTES type:
- three-phase AC;
- gas turbine;
- with an air cooling system;
- modular-type;
- single module type;
- container design type.

2. Brief Description

GTES-25P Gas-Turbine Plant is developed and manufactured by Aviadvigatel JSC, Perm;

TTK-25-2T4G turbo-generator manufactured by LZTEM "PRIVOD", Ltd., Lysva.

The Power Plant can be placed both inside the building and on the specially prepared open-air platforms. The method of the GTES dislocation is coordinated with the Customer and specified in a delivery contract.

The module Power Plant is packaged in containers and transported to the destination place by separate modules (blocks). Individual modules and components are mounted directly at the GTES dislocation place.

GTES is operated from separate control panel that is an industrial PC. One control panel is delivered with the first GTES for two or more GTES at one site.

GTES layout is performed by General designer by design and building the necessary set of constructions and units that provide GTES operating.

3. GTES-25P main performance ratings

Parameters are given for station conditions (P_{amb} = 760 mm Hg, T_{amb} = $+15^0$ C, inlet losses – 100 mm H_2O, outlet losses – 100 mm H_2O) at rated duty mode (Ne), fuel gas – natural gas) (other types of fuel are to be agreed upon with Manufacture)

Rated power at generator terminals, MW	22,5
Rated power at power turbine shaft, MW	23,3
Heat rate at exhaust t_{exh}=110 ^oC, kcal/hr (MW)	26,11
Rated electric current frequency, Hz	50
Rated electric current voltage, V	11000
Rated power factor	0,8

* Rated power of 22,5 MWe is maintained when the engine inlet air temperature (Tin) is no higher than +15°C and maximum power of 27,0 MWe (20 % overload) with the turbine flow path nominal gas temperature not exceeded is maintained at temp. not higher than minus 4°C; but no more than 10 % of the life to the engine overhaul.

Electric power quality parameters

Stable deviations of voltage under steady-state thermal conditions with symmetrical load within 10-100% rated power range being unchangeable, %	± 1,0
Stable deviations of frequency under steady-state thermal conditions with symmetrical load within 10-100% rated power range being unchangeable, %	± 0,4
Transient deviation of voltage during drop-rise of symmetrical load (10% of rated power), %	± 5 5
Recovery time, second, no more than	5
Transient deviation of frequency during drop-rise of symmetrical load (10% of rated power), %	± 8 5
Recovery time, second, no more	5

Performance

Generator terminals efficiency, %	36,2
Power turbine shaft efficiency, %	37,5
Compressor pressure ratio	26,6
Turbine inlet gas temperature, ^0C	1277
Power turbine outlet (exhaust) gas temperature, ^0C	477
Power turbine outlet (exhaust) gas flow, kg/s	75,9
Specific fuel consumption (at Hu=11780 kcal/kg), kg/kW hr	0,198
Total factor of fuel efficiency t_{exh}=110 ^oC, %	85,1
Coefficient of excessive air in exhaust gas	3,39

GTES inlet fuel gas parameters:

- pressure (gage), kgf/cm2 — 42...45
- temperature, °C — +5…+50

Rated speed of generator rotor, rpm	3 000
Rated speed of engine power turbine, rpm	5 000
NOx emission (15% O_2 and 50…100% Ne), no more than, mg/nm3	150
Equivalent noise level during maintenance, dBA	80

GTES life:

- to overhaul, hours	25 000
- total service, hours	100 000

GTES electric power supply system

Power of GTES ancillary electric power supply:

- when preparing for start and engine start, no more than	300
- with loaded operation, no more than, kW	100

Maneuverability parameters

Time of GTES automatic start-up from warmed up condition with further transfer to the minimum gas generator rotor speed (idle), including the ventilation mode that lasts up to 5 minutes, no longer than	7
GTES operation time under warm-up condition, min., no longer than	5
Time required for GTES starting and loading from the output of the command for gas turbine start-up to loading initiation, including warming up, min., no longer than	12

Brands of used oil types

Engine: Petrim per TU 38.401-58-245-99, EPM 10 TU 38.1011299-90 or Turbonycoil 210A AIR 3514/A;
Gearbox/generator: Tp-22C TU-38.101821 or Tp-22 GOST 9972 (recommended foreign-origin oil of similar type: TURBO T 32 (Shell))
Non-recoverable oil losses, kg/running hour, no more than:

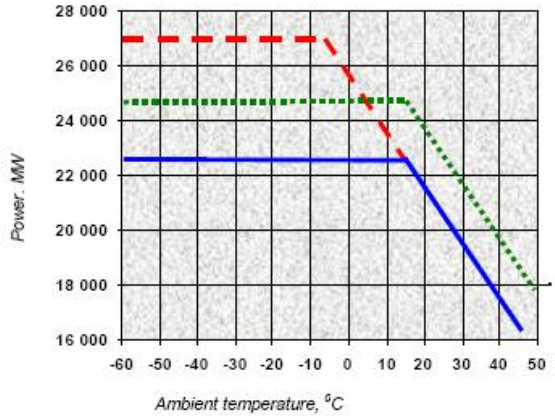
- engine — 0,4
- gearbox — }0,3
- generator

Operation conditions

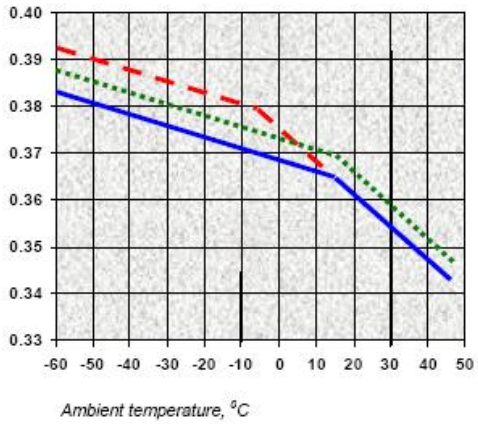
Acceptable ambient air parameters:	
- temperature, tamb, 0C	-60…+45
- barometric pressure Pamb, mm Hg	630…800
relative humidity, %	up to 100
Withstand seismic effects by Scale MSK-64 with the intensity of:	7
GTES dimensions, LxWxH, m, (no more)	(24,0x3,0x2,8)
Weight of GTES, kg, no more than	24,0 x 15,0 x 8,5
Weight of the heaviest transportation block in delivery condition, kg,	213 000
	68 000

GTES-25P PARAMETERS AT STATIONARY CONDITIONS
Hu = 11 780 kcal/kg, inlet/outlet losses 100/100 mm H_2O

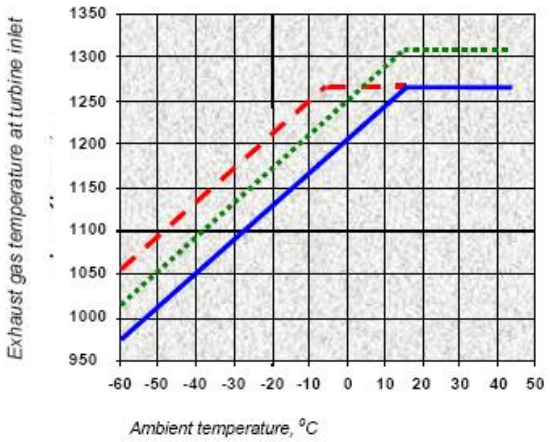
Generator terminals power



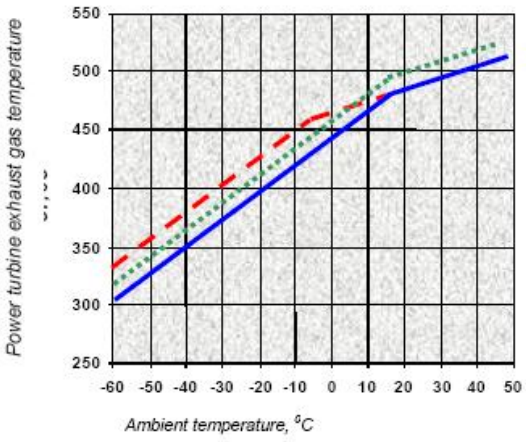
Generator terminals efficiency



Exhaust gas temperature at turbine inlet



Power turbine exhaust gas temperature



Maximum duty mode

Peak duty mode

Rated (base) duty mode

GTES-25P gas turbine power plant with capacity of 23MW (nominal rated mode) based on one PS-90GP-25 gas-turbine power engine and gas turbo generator.

4. GTES-25P delivery set

Equipment	Quant.
1. Engine unit, included: - inlet chamber; - gas turbine engine PS-90GP-25 (on frame), with oil feeding units and automatic machinery; - "engine- reducer" transmission with the cover; - pipe lines (for fuel gas, for oil, for ablution and drainage); - electric start system;	1
2. Reducer and generator unit, included: - reducer on the frame; - turbogenerator; - safety coupler with the cover; - pipe lines;	1
3. Outlet unit, included: outlet device with adapter and jack	1
4. Fan unit of engine department	1
5. Air intake, included: - silencer; - 3 staged air cleaning unit;	1
6. Heat exchanger (air-air)	1
7. Engine oil feeding unit, including engine oil feeding equipment	1
8. Reducer and generator oil feeding unit, including - Reducer and generator oil feeding system equipment; - Reducer and generator firefighting equipment; - Reducer and generator fan system equipment	1
9. Electrotechnical unit with equipment	1
10. Automatic firefighting system	1
11. GTES automatic control system	1
12. Oil air-cooling device of engine oil feeding system	1
13. Oil air-cooling device of reducer and generator oil feeding system	1
14. Barriers and service platform	1
15. Outlet device silencer with supports	1
16. Exhaust	1
17. Toolware	1
18. Accessories set (according list), including assembling/dismantling accessories in engine and reducer turbounit	1
19. Operating single set of spare parts (for providing of operation one GTES for 25 000 hours)	1
20. In-line documentation set (according list)	1

5. ТТК-25-2Т4-G Turbogenerator

Turbogenerator is synchronous, bipolar generator, 3 phase, AC, frequency 50, voltage 11000V, with brushless excitation system. The generator set also comprises air cleaning and circulating unit. Generator cooling system is air, open (maybe closed cycle), with indirect coil cooling.

The turbogenerator features relay protection devices to prevent the IP54 according GOST 17494

Turbogenerator starts parallel operation in network by precision synchronization method.

Bearing lubrication is pressurized circulating from oil tank positioned on the PS-90EU-25 engine.

T22/T30 or T46 (GOST 32) turbine oil is used for lubrication.

ТТК-25-2Т4-G Turbogenerator the main rated parameters:

Parameter	
Rated capacity, kW	25 000
Capacity, kWA	31250
Phase connection, stator coil	У
Rated voltage, V	11,0
Stator phase current, A	1640,2
Short-circuit ratio, o. e., not less	0,55
Static overload, o. e., not less	1,9
Power factor, cos	0,8
Frequency, Hz	50
Generator rotational speed, rpm	3000
Rated efficiency, not less, %	98,2
Pin count	6
Heat resistance class of stator and rotor coil insulation	Р
Cooling water temperature in air cooler, not more, °C	+ 33
Consumption of cooling water, m /h	115
Waste value from turbogenerator, kW	420
Cooling water pressure in air cooler, MP	0,17-0,3
Cooling air temperature in turbogenerator, within, °C	+19-+40
Oil temperature at the input of bearing, °C	+35-+45
Oil consumption for bearing, l/min	50
Oil pressure at the input of bearing, MP	0,05-0,15
Exciting system	brushless
Noise level within 1 meter of turbogenerator, dB	not more 85
Rotating sense	right-handed
Turbogenerator weight, t	56,0

There are the platforms for installing vibration sensors for vibrations measurements in three directions on bearing body.

Turbogenerator cooling system is air, closed cycle (1S\UZ7A81 according GOST 20459) with 2 air coolers, which are on each side of turbogenerator.

Turbogenerator average life cycle is 40 years with the observance of inspections and repairs plane.

For prevention of the insulation moistening under turbogenerator longstop there are the built-in heaters in its body.

Temperature control of the turbogenerator active parts, cooling air, water and oil is realized resistance thermoelements.

5. GTES-25P Automatic Control System

Automatic control system ensures GTES-25P plant operation in all modes including parallel operation with similar units and (or) with power system and provides control, protection and diagnostics function.

The system is designed for:

- selfdiagnostics of automatic control system components, actuator gages, measuring channels in background and text modes;
- station assemblies control during prestarting preparation, idle spinning in operation and emergency modes;
- collection, first processing and indication of the current state of heat and power station operation process;

In operation mode automatic control system provides:

- gas-turbine engine starting and assigned load shutdown in accordance with the process;
- stabilization of assigned process mode;
- adjustment of turbine shaft rotational speed under load and to prevent gas-turbine engine shutdown at 100% load decrease and increase;
- ensurance of turbine rotor constant rotations;
- control of startings, shutdowns and load operation without operator;
- metering of electric power for consumers and auxiliary power;
- indication of high-voltage switches position;
- control of turbogenerator cooling;
- control of recovery heat exchanger in accordance with program;
- anti-icing system switch-on in accordance with program;
- process monitoring of power plant performance ratings;
- warning and emergency alarm;
- connection with high level control system;
- gas-turbine plant operation parallel to other power plants;
- connection with fire protection system;
- ventilation control per signal of increased gas content.

In emergency mode automatic control system transfers the gas-turbine plant in one of the following operation modes:

- full shutdown of gas-turbine plant;
- transfer of gas-turbine plant to idle operation until operator’s decision;
- transfer of gas-turbine plant to low mode.

6. Supplier Guarantees

- Saturn-GT guarantees correspondence of the gas-turbine plant to the operation requirements when operation conditions, transportation and storage requirements are fulfilled by the Consumer in accordance with the specifications and operation manuals.
- Guarantee operation term is 12 months as the gas-turbine plant is commissioned but not more than 18 months as shipped by the fabricator if all requirements of operation manual are fulfilled by the Customer.
- Saturn-GT (the Supplier) guarantees free of charge elimination of failures and damages as well as replacement of parts and components damaged during guaranteed term due to failure or premature wear-out because of application of not quality materials or materials noncorresponding to operation conditions, unsatisfactory fabrication.
- Guarantee terms for components are determined in accordance with specifications for their supply and should not be less than the gas-turbine plant guaranteed operation period.

7. Requirements for Customer to provide GTA-6RM standard operation

- Foundation preparation, assembly and operation of gas-turbine plant must be performed in accordance with operation manuals.
  - Content in gas of agents causing metal corrosion (hydrogen sulfide, mercaptan sulfur, alkaline metals, chlorides, carbon dioxide) must be agreed between the supplier and the consumer. Content of water vapors in fuel gas should not exceed values corresponding to saturation state in fuel manifold.
  - In case of recompressor application for fuel gas preparation, oil content in fuel gas must be max 15 mg/kg of gas.

- Power supply system must provide supply of gas-turbine plant with AC, 380V for supply of starting oil pump, shaft-rotating unit motor, oil evacuation pump, automatic control system, tubular electric heaters of oil in oil tank.

- Adjustment and starting of gas-turbine plant at operation site must be performed under direct supplier supervision. Opening and reporting of set completeness must be performed at the presence of the supplier representative.

8. Transportation and storage

- GTES-25P components can be transported automobile, railway and water vehicles without distance limits. Design of gas-turbine plant ensures its modular transportation.
- GTES-25P delivery term is 15 months from the first advance payment according the Contract. Assembling, starting-up and adjustment are performed within 3 months.
- Operating personnel training is performed by Deliverer at site ore Supplier area within 15 days

- Spare parts for the product are preserved and shipped in containers for storage without represervation and must be kept for five years as shipped by the fabricator.

- Separate gas-turbine plant components, manifold set, spares, instruments, special devices and fixtures are packed in containers.

- Components and equipment package and preservation ensure their safety for two years as shipped by the fabricator.

- When gas-turbine plant components are kept for more than two years, revision and represervation of the equipment must be performed every two years on the gas-turbine plant in accordance with operation manual.

9. Service

Saturn-Gas Turbines service Management is responsible for assembling, commissioning and service of our objects. More then one hundred service experts check and fulfilled all services types.

Principle of operation – to fulfill complex services to Customer, co-ordination of GPU building suppliers and contractors interaction. Operation and Service Department was founded in 1996.

The main business of this Department is:

- After sale guaranty service;
- After sale service non guaranty products by service contracts;
- Units repair in the operation company;
- Recognize, registration, fault analyze in operation;
- Technical assistance for operation companies;
- Control for observance of service and operation rules;
- Supply of spare parts, equipment and devices and technical documentations;
- Customer GTU operation stuff study.

According the Customer requirement Saturn – Gas turbine organize the service point in the Customer field. The Saturn – Gas turbine specialist make:

- diagnostic;
- consultations;
- hardware replacement (if it need)

During guaranty period service is free of charge

Sarurn-GT is ready to deliver and assemble the heat and power station in any package set providing the Customer with all services for good price:

- *engineering;*
- *building and assembly;*
- *commissioning;*
- *servicing.*

JSC «Saturn – Gas Turbine »

Full name
JSC «Saturn – Gas Turbines», Russian Federation

Company status
Joint Stock Company

Main office:
Address: 16, Tolbuhin str, Rybinsk, Russia, 152914,

Igor D. Yudin
General Director
tel.: +7 (4855) 27-34-11
fax.: +7 (4855) 27-34-11
E-mail: igor.yudin@ gt.npo-saturn.ru

Ivan M. Belyaev
Deputy Commercial Director,
tel.: +7 (4855) 273-819; fax: +7 (4855) 273-945
E mail: ivan.belyaev@gt.npo-saturn.ru

Sergey A.Balyasov
Head of International Contract Department
tel.: +7 (4855) 20-53-70
fax: +7 (4855) 27-39-45
E-mail: sergey.balyasov@gt.npo-saturn.ru

Marketing Department
T/f: (4855)205-365

JSC «Saturn – Gas Turbine» also open for cooperation.