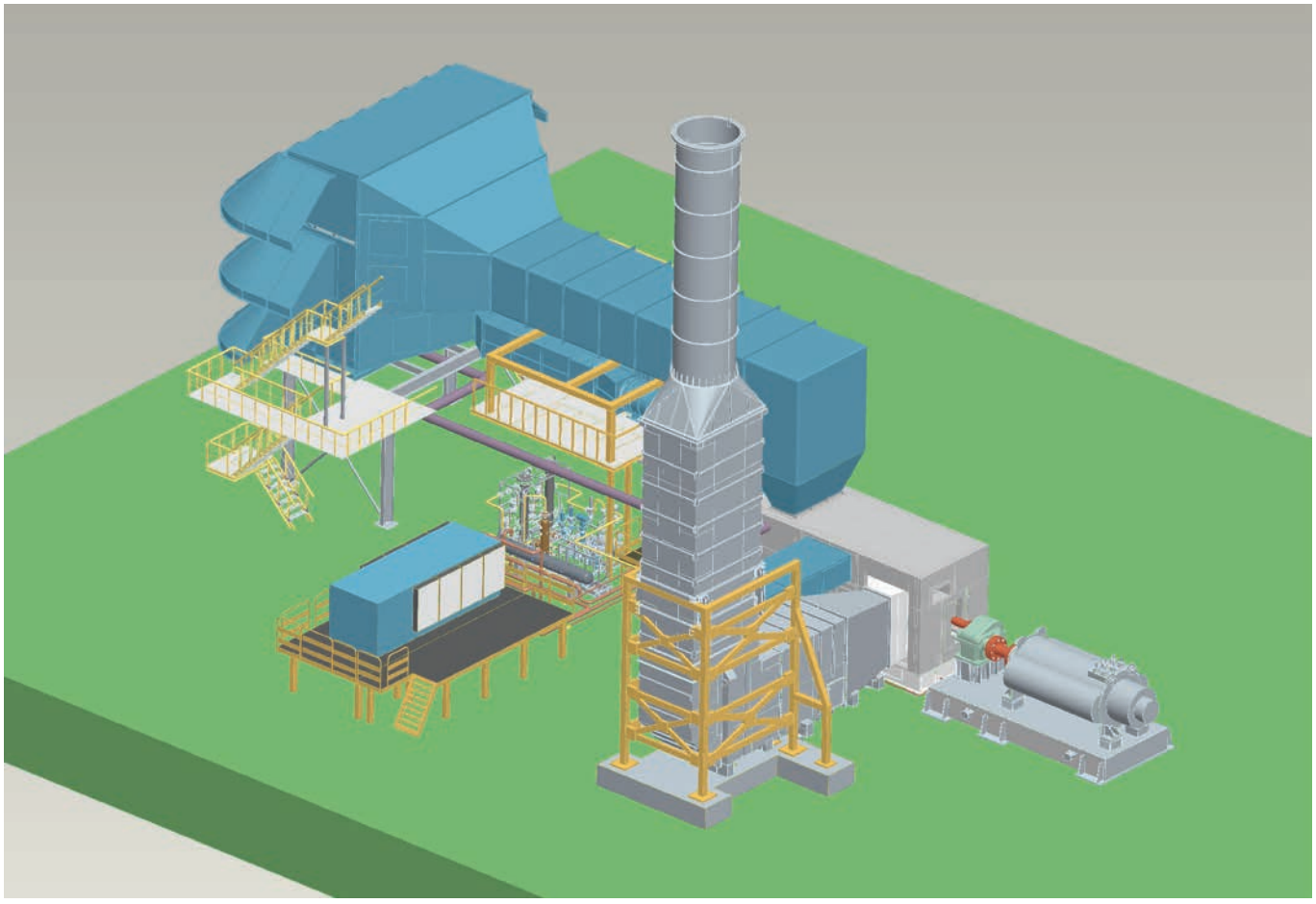
REP HOLDING

Gas Turbine Power Stations Based on 16 MW Gas Turbines



Package supplies of power equipment

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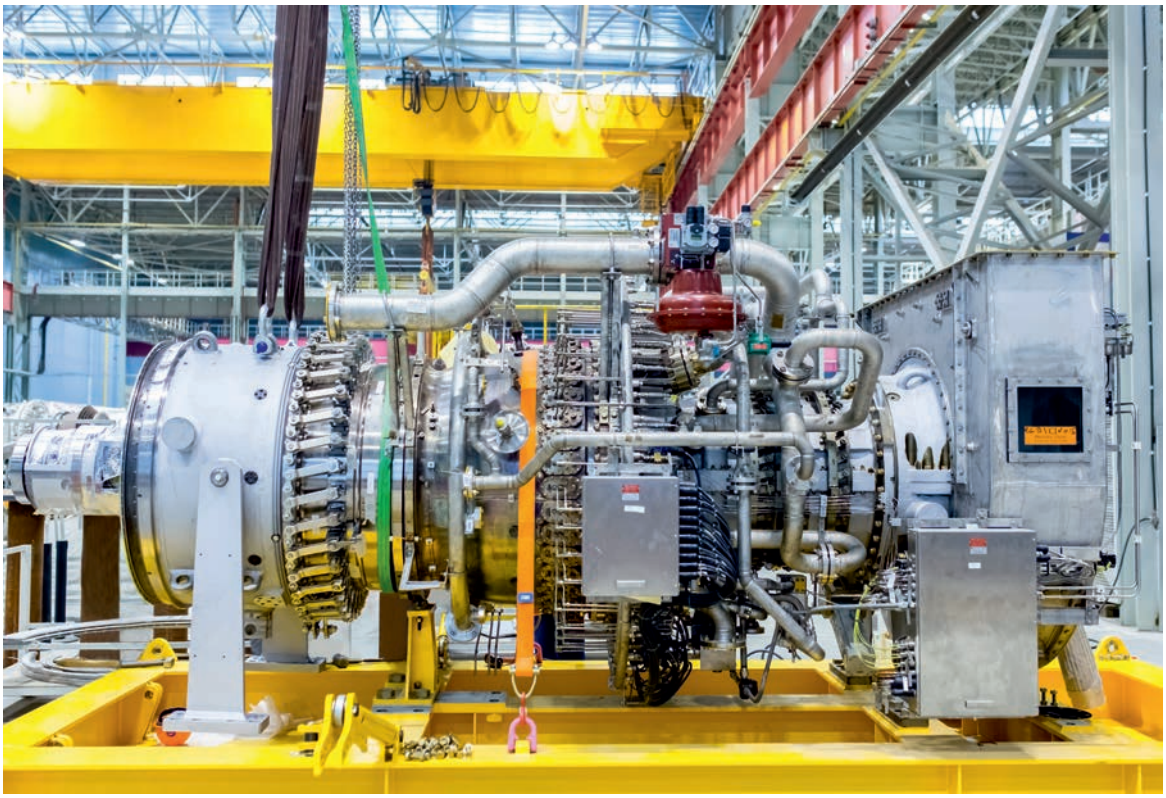
Gas Turbine Power Stations Based on 16 MW Gas Turbines

JSC "REP Holding" is a leading Russian power engineering holding, a manufacturer and supplier of new-generation power equipment.

It performs engineering design, manufacture and package supply of power and electrical equipment for gas, oil, metallurgical and chemical industry, power generation and integrated power grid.



GTU-T16

«REP Holding» offers manufacture and package supply of the equipment for a gas turbine power station based on 16 MW gas turbine units.

Gas turbine power unit rated at 16 MW

Description

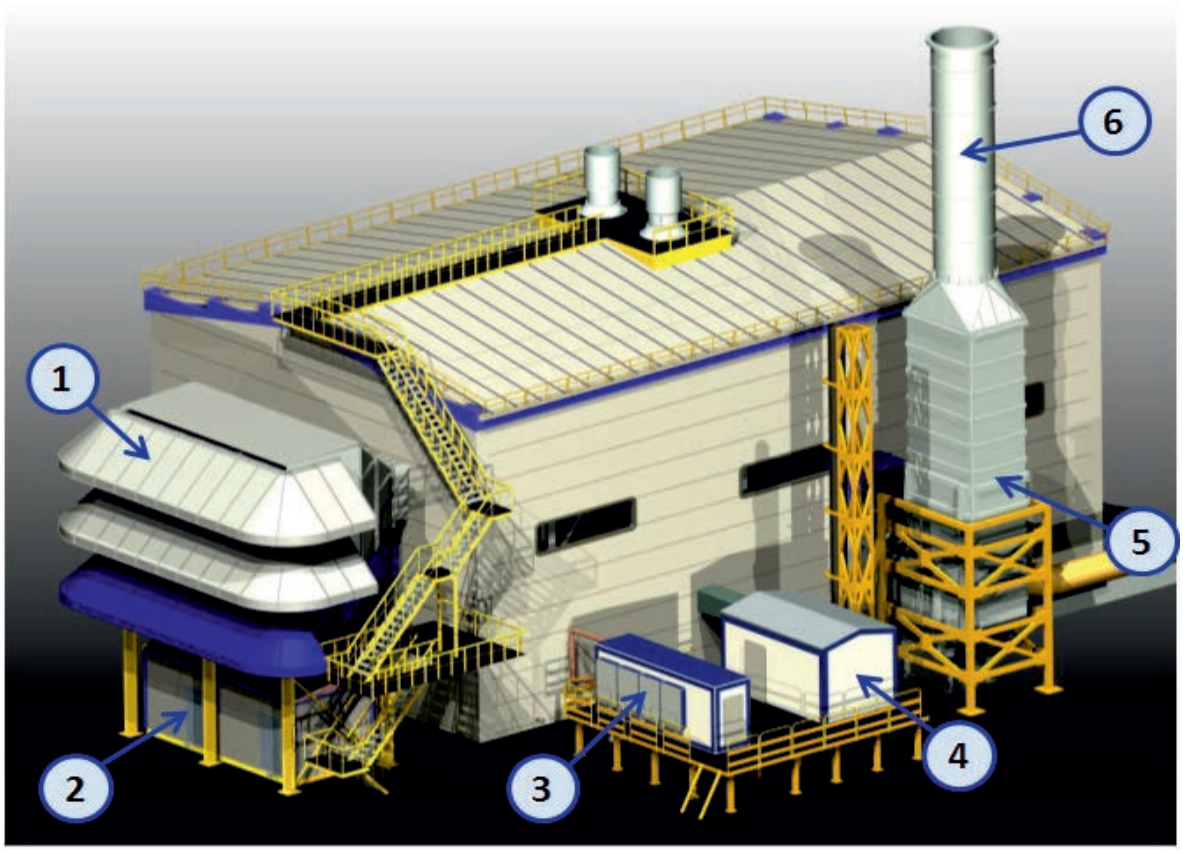
GTE-16 high-tech gas turbine power plant, simple cycle, based on T16 gas turbine engine is designed by REP Holding engineers in partnership with GE Oil & Gas based on GE innovative technologies.

The gas turbine engine, industrial type, features high efficiency (37%), high service life, high availability and serviceability, low harmful emissions (NOx<25 ppm).

Full compliance with GOST R 29328-92 "Gas Turbine Units to Drive Electric Generators".
The main equipment of the unit is standardized as much as possible and is to be assembled using modular units

Purpose and Application

- The power unit is designed to generate electric and thermal power
- is supposed to be used at thermoelectric power stations and central heating and power plants
- As an option, it can be equipped with a waste heat recovery boiler, steam or hot water one, for simultaneous generation of electric and thermal power (cogeneration) with a coefficient of fuel heat utilization more than 80%.
- GTE-16 is to be installed in the main building of the electric power station or in the individual easy-to-assemble hangar-type building.



Hangar-type building for installation of GTE-16 with functional systems:

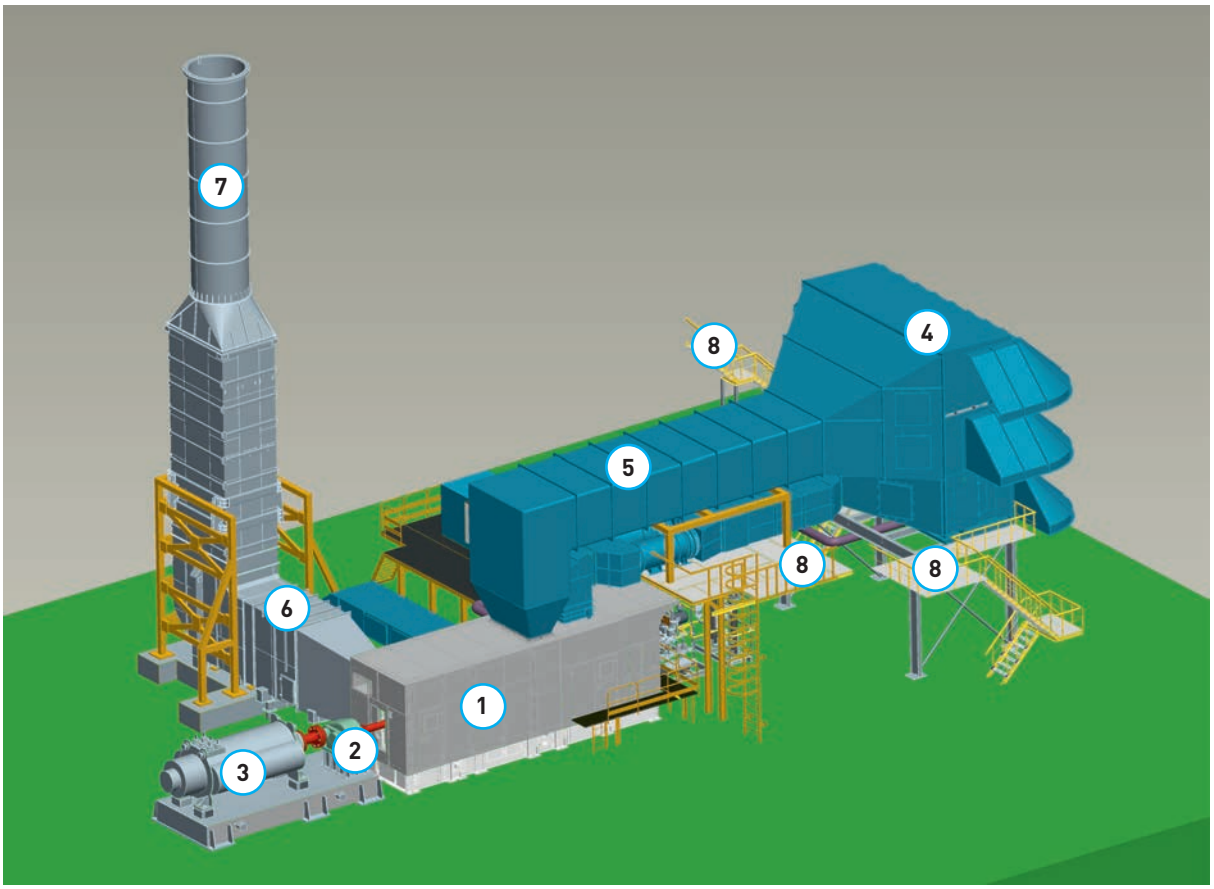
1 - Filter house; 2 – fire-fighting facilities compartment; 3 - oil air-cooler;
4 - building air heating unit; 5 - gas duct with a silencer; 6 - exhaust pipe

If necessary (depending on the reconstruction project for a specific power facility), an option of placing the unit in the existing building can be considered.

GTE-16 components

GTE-16 applies the T16 gas turbine engine, complete with the main and auxiliary equipment:

- Gas turbine (GT);
- Turbo-generator (TG) for GT;
- Gearbox between GTU and generator;
- Filter house;
- Waste heat recovery boiler (option – if required);
- Fuel gas booster compressor (option – if required);
- Air-, gas – duct system;
- Automatic process control system (APCS);
- Electric equipment;
- Metal structures, maintenance platforms etc.

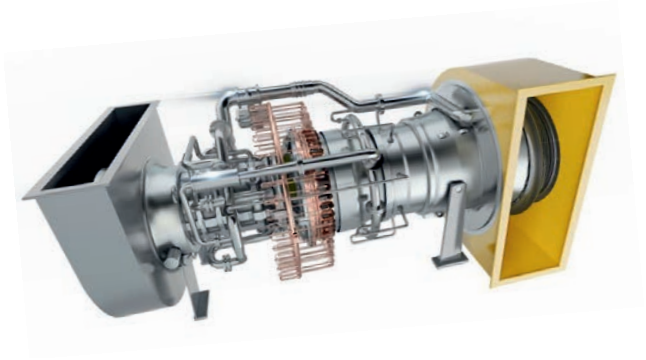


GTE-16 power unit (the hangar walls are not shown for clarity)

1 - Gas turbine, 2 - gearbox, 3 - turbo-generator, 4 - filter house, 5 - cycle air duct,
6 - gas duct with a silencer, 7 - exhaust pipe, 8 - maintenance platforms

GTE-16 advantages

- High reliability due to modern design practices, materials and technology employed in the design of its main element – gas turbine engine;
- Total life cycle – 200 ths. hours;
- Long repair intervals;
- High electric efficiency;
- High economic efficiency of the unit in various operating conditions;



Gas turbine engine rated at 16 MW, 3D model

- Most of the component parts are from Russian manufacturers, with a high contribution of REP Holding ;
- A possibility of repairing on the Customer's site;
- A possibility of quick removal of the gas turbine engine while performing a repair, due to the lateral roll-out from under the enclosure.

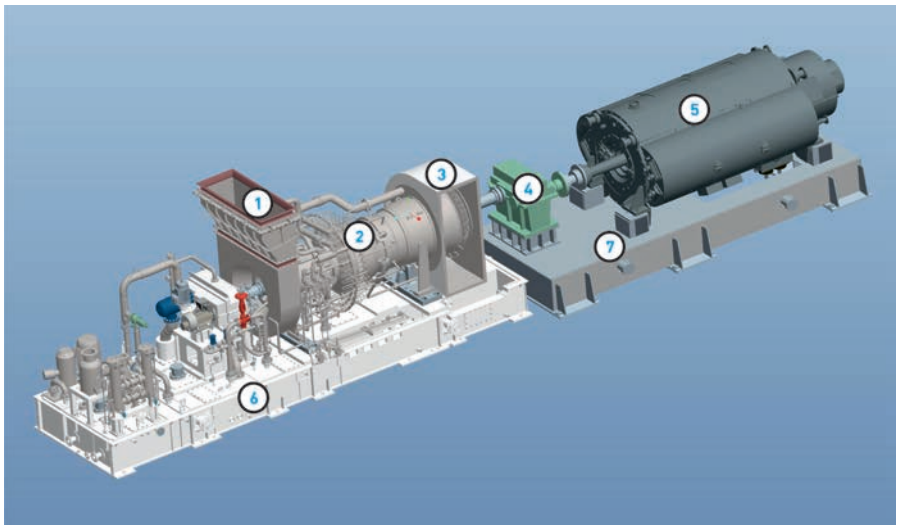
Package supply of the equipment by REP Holding provides:

- optimal layout solutions
- Employment of modern technical solutions
- Operating costs reduction
- Maximum operational reliability of all the GTE components
- Reduction of the equipment delivery time
- Complex service maintenance

General Technical Data

The main technical characteristics of the gas turbine engine at the nominal conditions, ISO

Description	UOM	Value
Shaft power, no less than	MW	16.5
Turbine efficiency, no less than	%	37.0
Off-gas flow	kg/s	54.3
Off-gas temperature	°C	490
Pressure ratio		19.0
Fuel flow (natural gas Qрн=50 MJ/kg)	kg/s	0.892
Gas generator rotor speed, maximum	rpm	10200
Output shaft rotor speed, nominal	rpm	7800
Emission (at 15% O_2 in dry combustion products): nitric oxide carbon monoxide	 mg/m^3 mg/m^3	 ≤50 ≤40
Overall dimensions of the engine (without piping)	M	11.6 × 3.6 × 4.2
Weight of the gas turbine module on the base plate	t	69
Specified service life	h	~200000



The main equipment of the power unit on the base plate (with the enclosure removed):
1 – inlet plenum; 2 - engine; 3 – exhaust plenum; 4 - gearbox;
5 - generator; 6 – engine base plate; 7 – generator and gearbox base plate

Gas turbine engine components

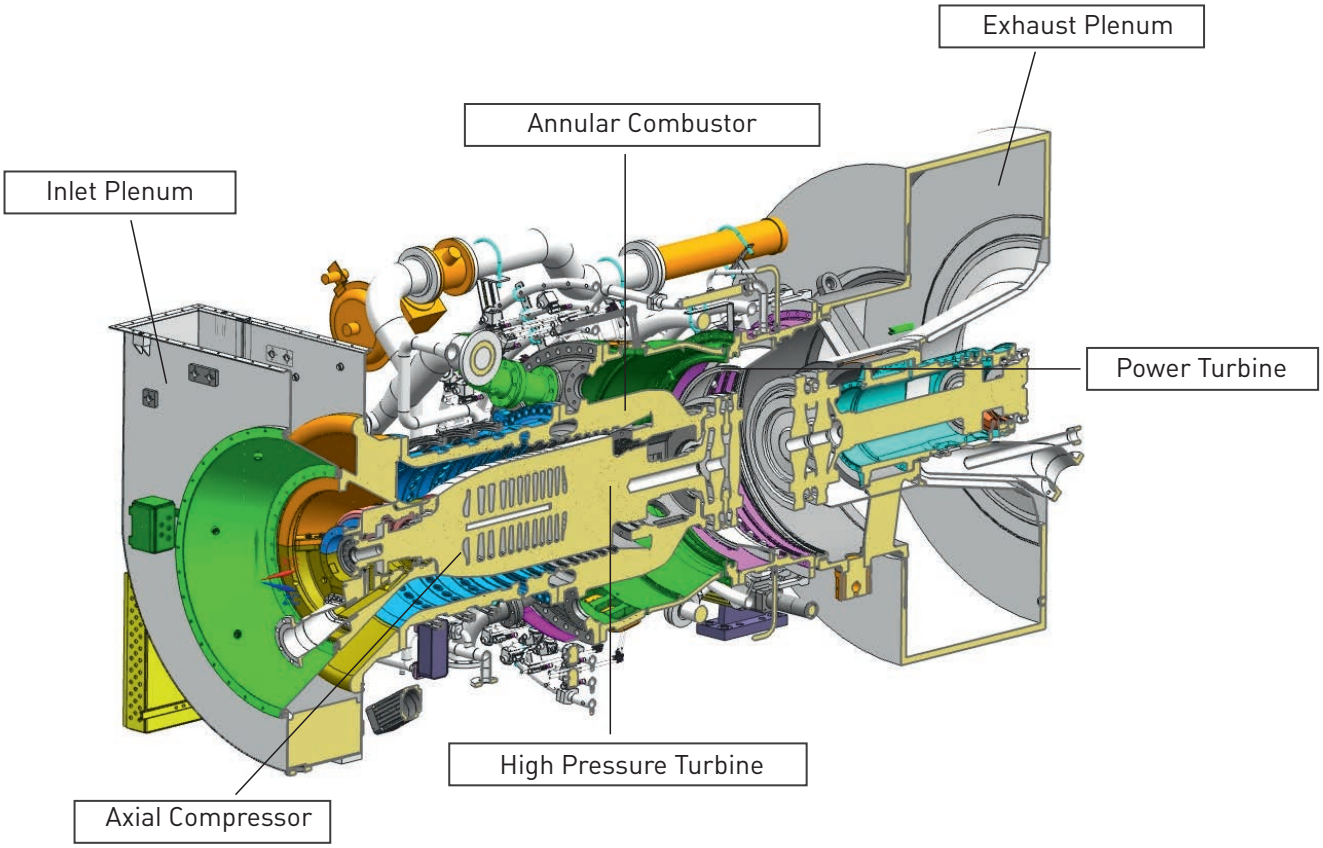
Compressor:
– Axial, 12- staged, with variable inlet guide vanes and variable guide vanes of 2 stages
– Casing with vertical and horizontal splits

Combustion chamber:
– Annular, with 39 burners
– DLN system
- Equipped with flame detectors and ignition units
- Burner devices are controlled and removed (if necessary) without opening the turbine casing

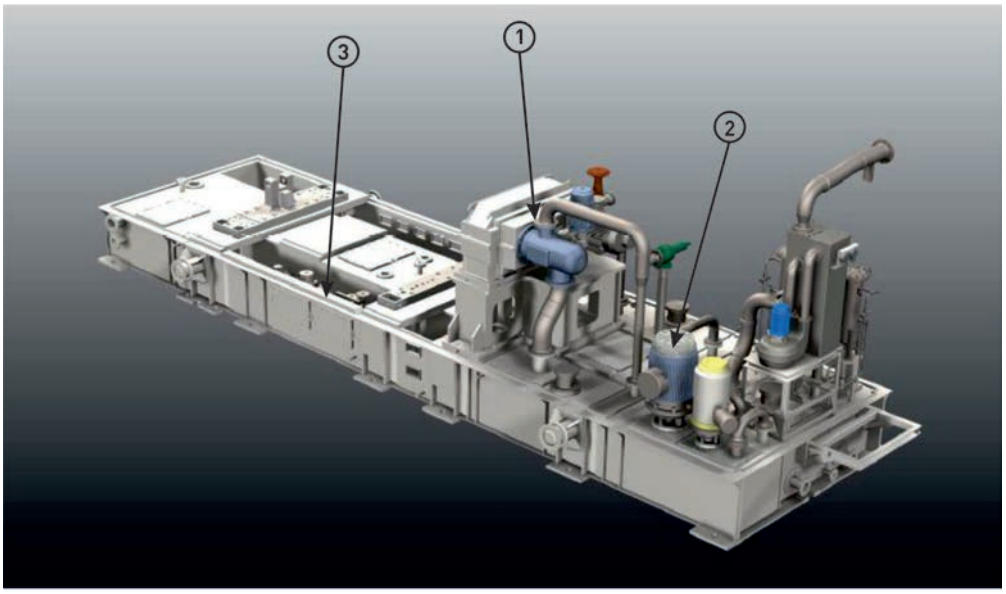
Gas generator turbine
- Axial, two-staged, with 3D optimized profile
- Cooled nozzles and buckets with protective coating

Free turbine
- Axial, two-staged, uncooled
- Uncooled shrouded nozzles and buckets

Compressor, combustion chamber and turbines of the gas turbine engine are structurally equipped with elements for boroscope inspection of the flow passage without opening the unit.
The T16 gas turbine engine is arranged as a single module on the oil tank frame with all the auxiliary devices and systems providing the gas turbine engine operability.
Lube oil of ТП-22С type is allowed for use.

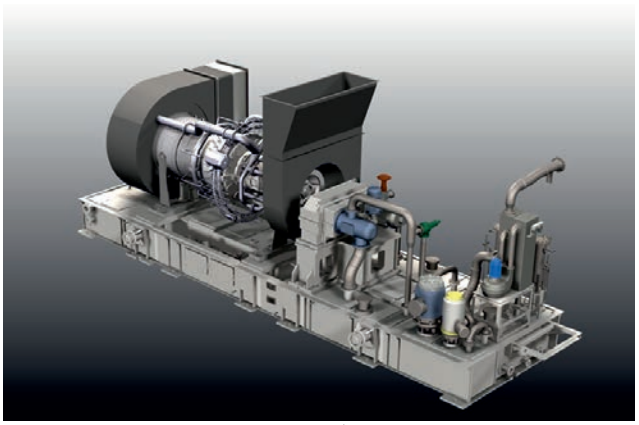


Longitudinal Profile of T16 Turbine

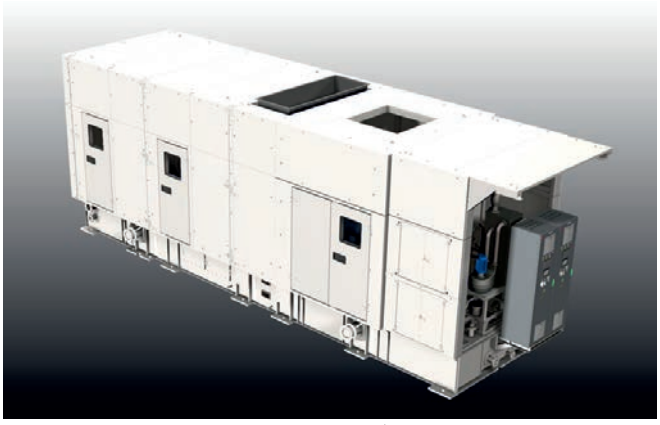


Gas turbine engine oil tank frame with the auxiliary systems:
1 – starting system; **2** – oil supply system; **3** – fuel supply system

To reduce the noise level and to maintain the heat balance, the turbo-unit is placed into the noise-proof and heat-insulating enclosure which is also designed for arrangement of the lighting system, transducers equipment and wiring with other components of the unit.



A)



B)

T16 turbo-unit with the auxiliary systems on the base plate:
A) with the enclosure removed; **B)** under the noise-proof and heat-insulating enclosure

Performance characteristics

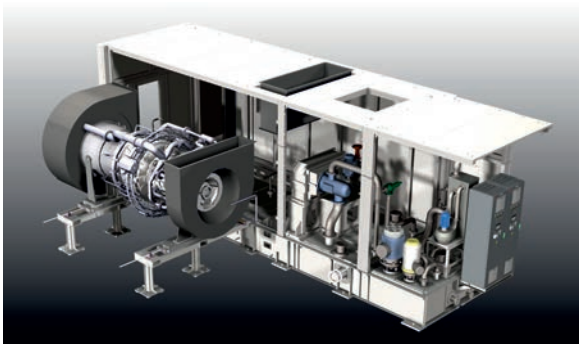
GTE-16 can be operated at the ambient air temperature from -60 to +50°C.

GTE-16 parameters (at the nominal conditions, ISO)

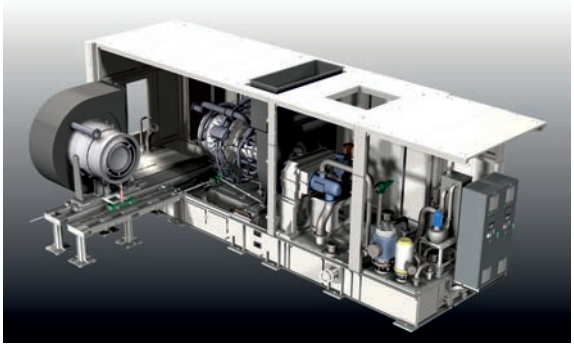
Description	UOM	Value
Power at the generator terminals	MW	16.0
Electric efficiency	%	35.86
Off-gas flow	kg/s	54.3
Off-gas temperature	°C	490

Modular design of the T16 gas turbine and easy access to the auxiliary systems vastly simplify servicing and maintenance of the gas turbine.

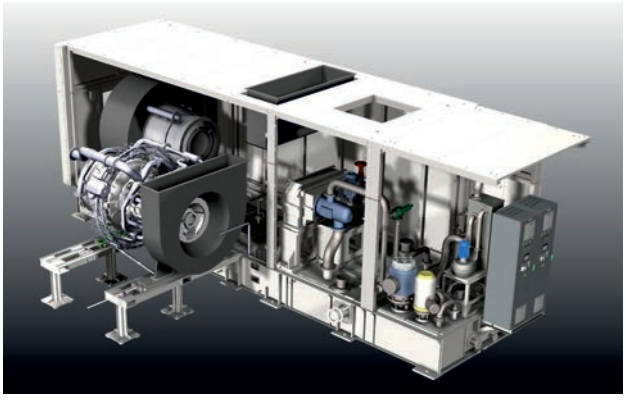
T16 arrangement on the base plate provides lateral roll-out of the high and low pressure parts, as well as of the entire unit, which makes it possible to perform comprehensive prompt technical maintenance



Rolling-Out of the Entire Turbounit



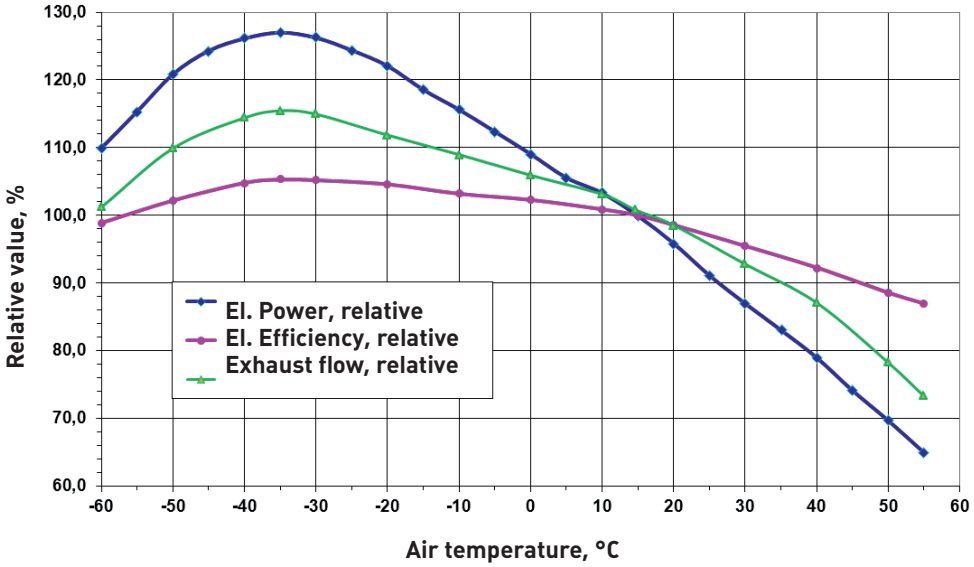
Low Pressure Turbine Rolling-Out



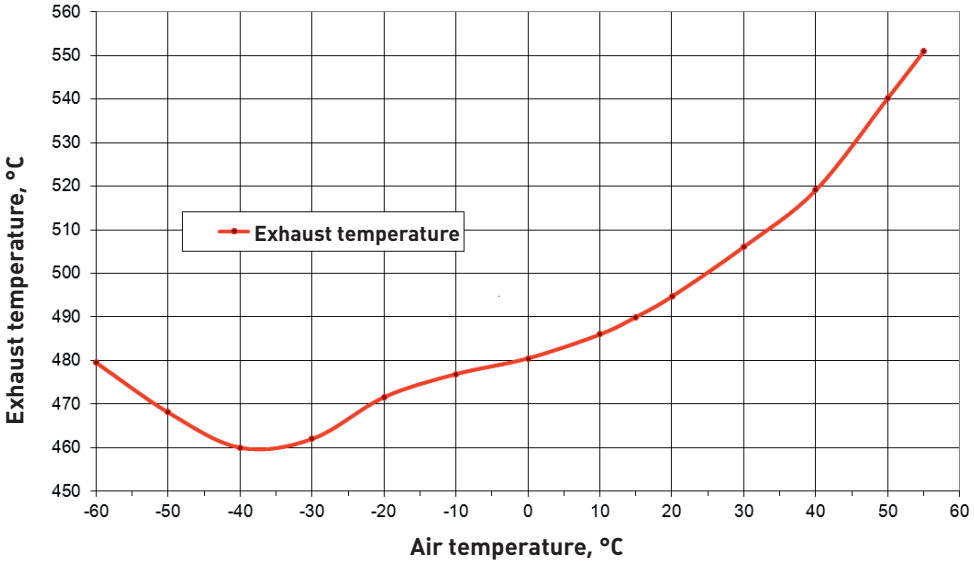
Rolling-Out of Gas Generator

Climatic characteristic of GTE-16

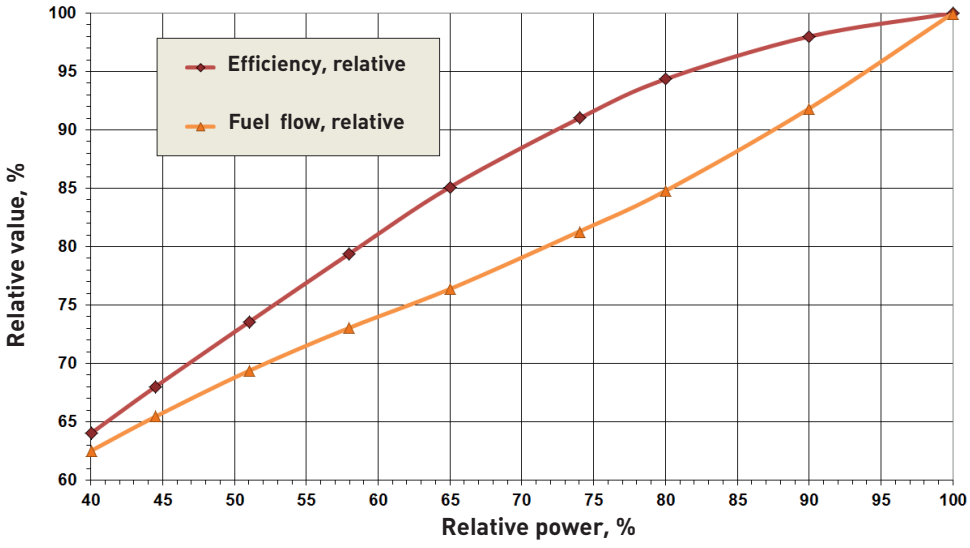
Relative values of power, efficiency and off-gas flow versus ambient air temperature
The values at 100% correspond to the nominal parameters



Off-gas temperature versus ambient air temperature



Performance characteristic of GTE-16 (at +15 °C)
Relative values of efficiency and fuel flow versus relative power
The values at 100% correspond to the nominal parameters.

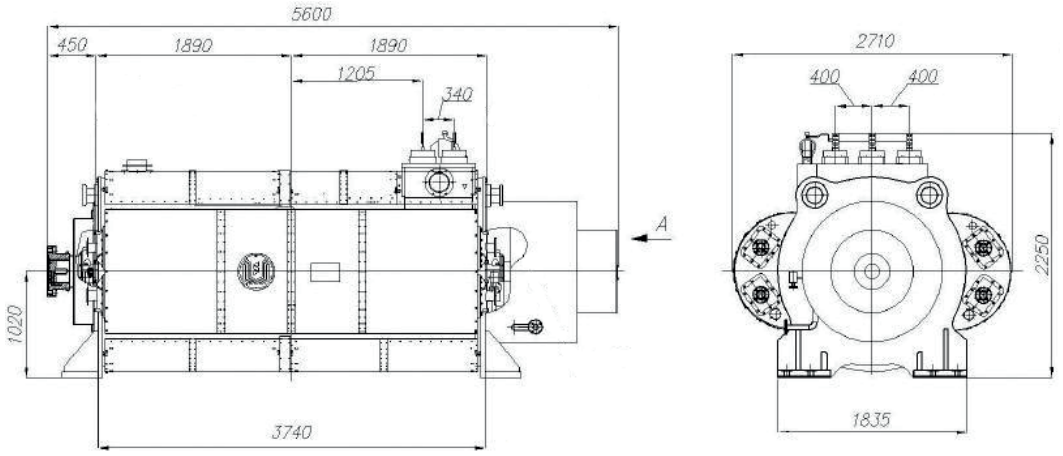


Generator

A synchronous two-pole three-phase turbo-generator, made in Russia, is used as the generator in GTE-16. It is designed to generate electric power when coupled with the gas turbine and connected directly to the electric network or through a transformer.

Nominal power of the generator is 16 MW, total power is 20 MVA, speed - 3000 rpm, efficiency at nominal conditions – 98.1%. The cooling systems is two – loop: the inner loop (air), and the outer one (liquid).

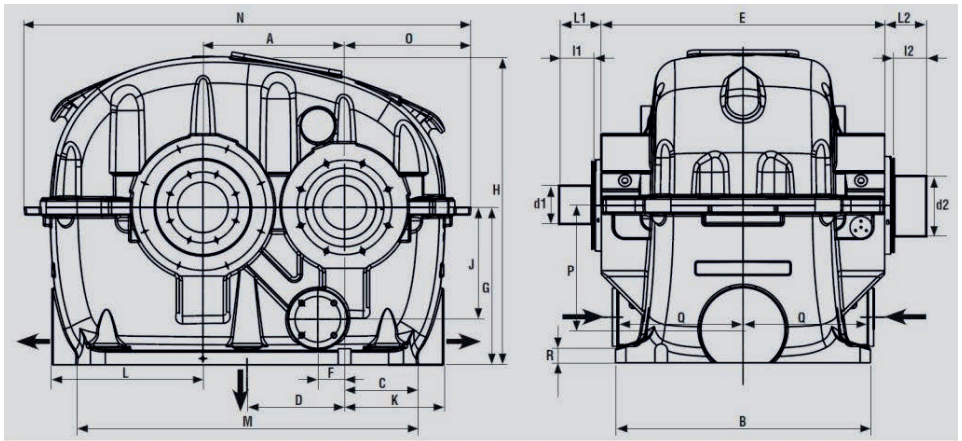
In accordance with the IEC standards the generator operates successfully at all normal operating conditions, including unstable condition, such as systemic failures, load shedding and synchronization failure.



As agreed with the Customer, other turbo-generators rated at 16 MW with air or liquid cooling can be applied as turbo-generators.

Gearbox

GTE-16 employs one-stage gearbox with parallel arrangement of shafts to transmit power from the gas turbine shaft with 7800 rpm to the generator shaft with 3000 rpm.



Size	A	B	C	D	E	F	G	H	H-G	J	K	L	M	N	O	P	Q	R	
56	560	1018	295	380	1140	105	630	1245	615	445	395	595	1350	1743	488	486	475	67	6000

Gearboxes from any other companies can be employed as agreed with the Customer.

Automatic Control System of the Gas Turbine Power Plant (GTE ACS)

The GTE ACS is designed to perform functions of automatic control, governing, monitoring and protection providing prolonged trouble-free operation of the power plant and auxiliary systems.

The GTE ACS is supplied packaged with the turbo-generator and represents an independent , functionally complete distributed system the main components of which are based on the common soft-and hardware made by General Electric.

The GTE ACS is built with due regard to the requirements of RD 153-34.1-35.127-2002. The GTE ACS provides performance of a complete complex of control, information functions, as well as governing and control functions required for the power unit functioning in all operation conditions.

GTE-16 Electric Equipment

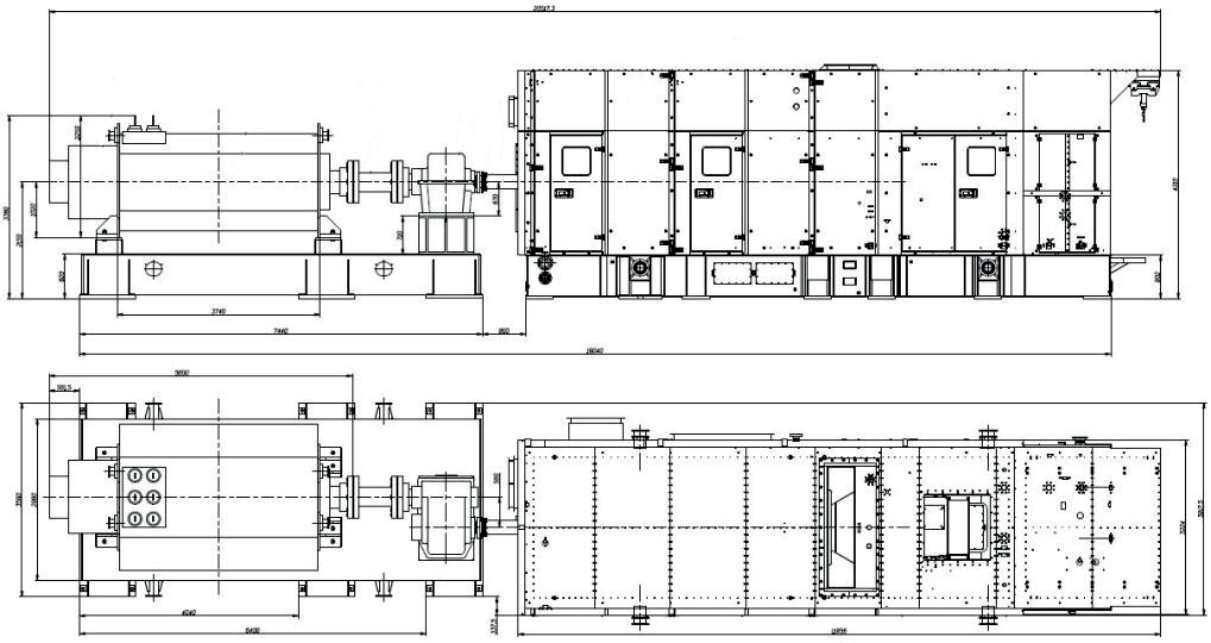
The GTE-16 electric equipment includes equipment of the following electric systems:

- power generation and power output into the mains;
- auxiliary power supply system;
- monitoring and control system for the electric parts and relay protection;
- lighting system;
- grounding and lightning protection systems.

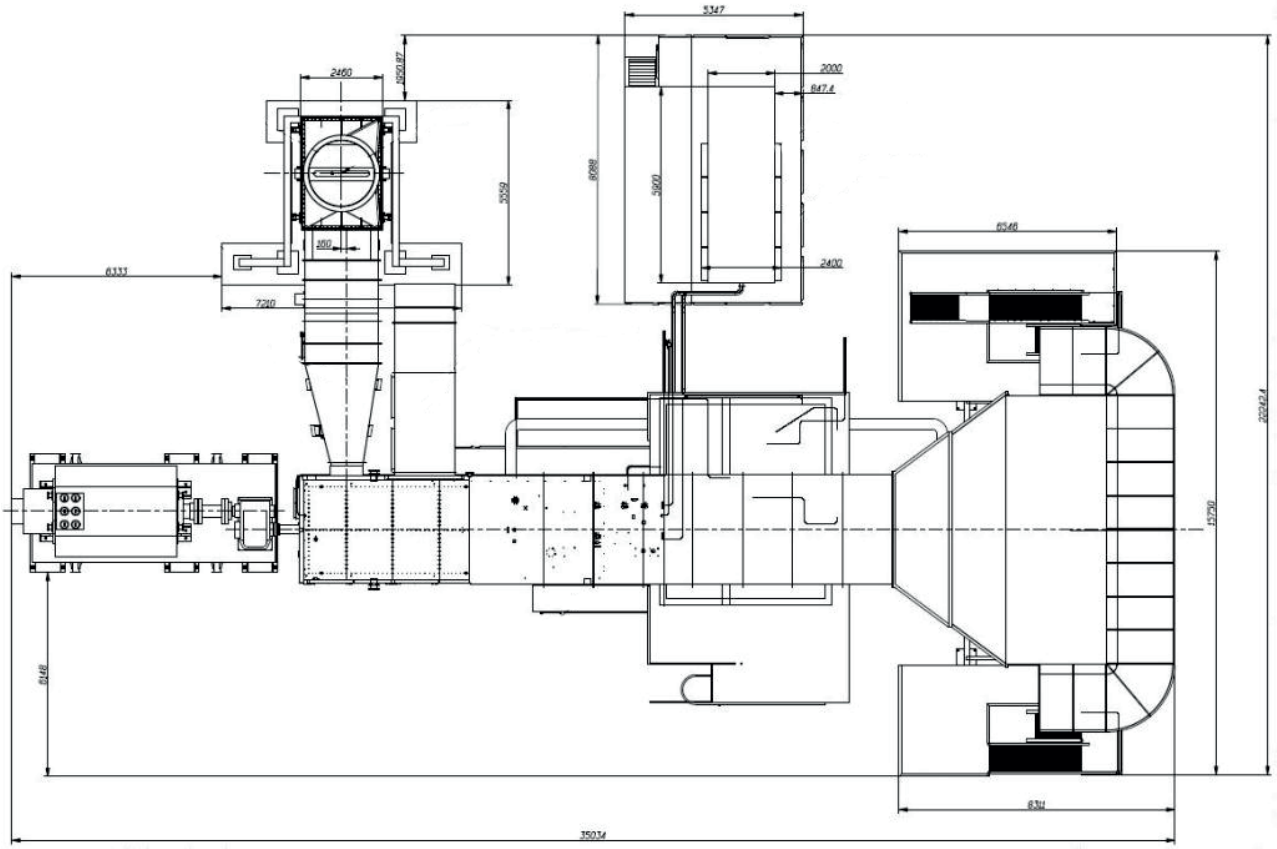
The GTE-16 automatic control system equipment and the electric equipment are placed into block-boxes that can be made both for outdoor and indoor installation inside the power building.

Power Unit Arrangement

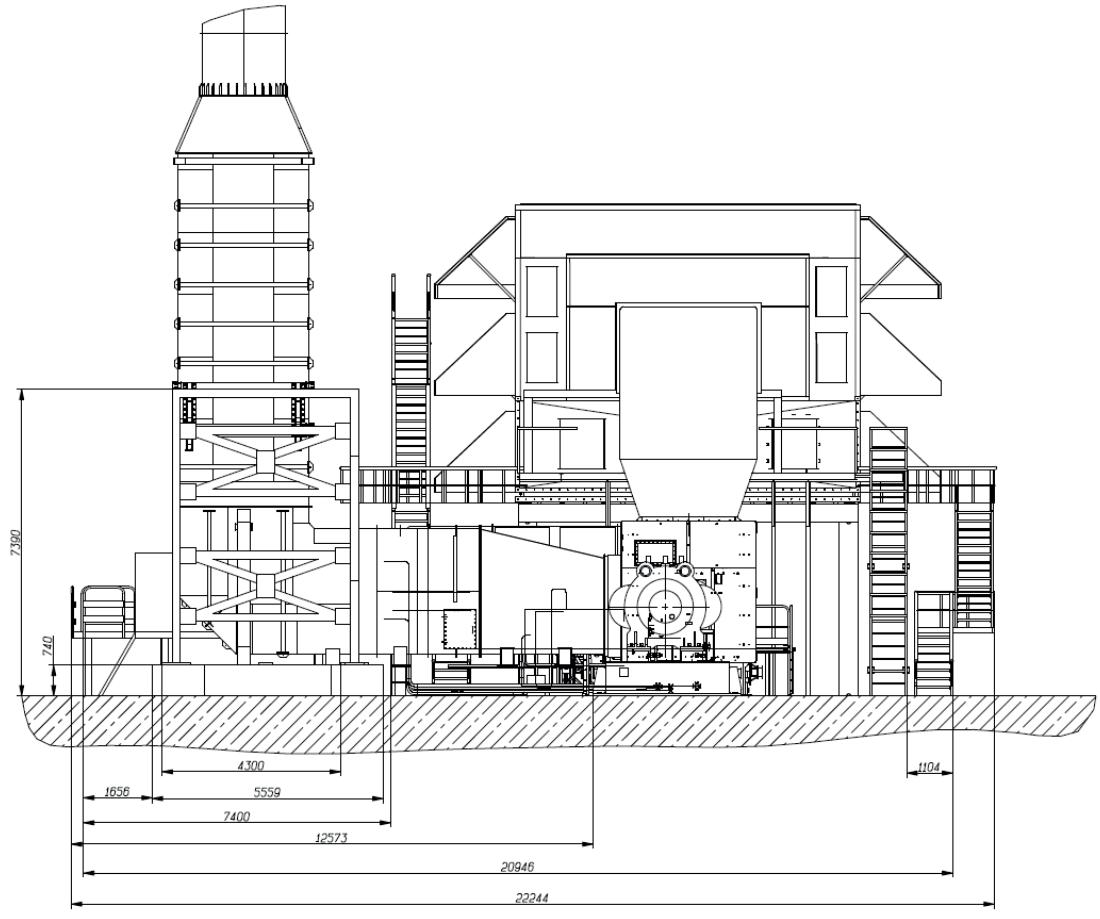
The GTE-16 design makes it possible to perform service maintenance and partial repair on site without dismantling and dispatch to the Works - Manufacturer.



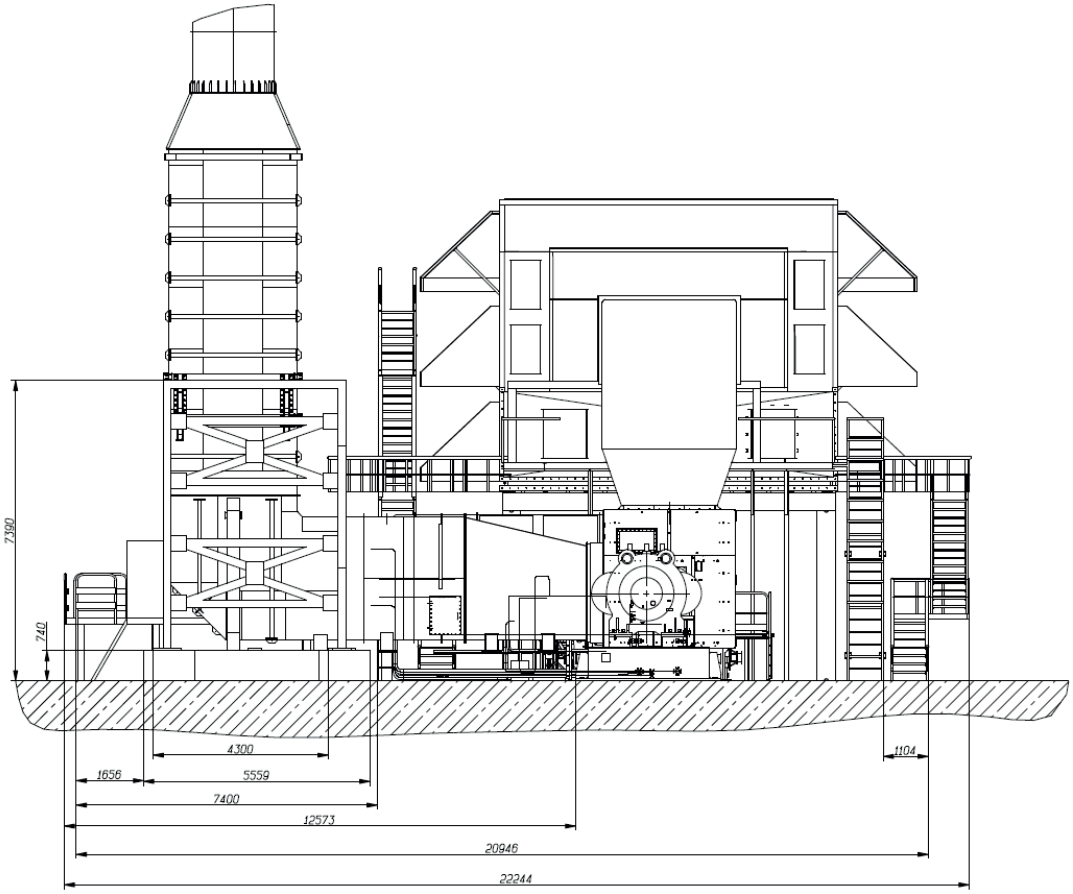
Outline drawing of the plant (gas turbine engine and turbo-generator)



GTE-16 equipment layout



GTE-16 plant (side view, the walls of the hangar are not shown).



GTE-16 plant (view from the generator, the walls of the hangar are not shown).

The power unit is designed in accordance with standards, norms, rules and technical specifications adopted in the RF and technical requirements specification agreed upon with the Customer and General Designer.

GTU Production, including assembly and testing, are carried out on production sites of "REP Holding" in St. Petersburg.

Complete units, including all auxiliary systems and controls, are planned for commercial manufacture in the beginning of 2016.

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