VEYA INVESTMENTS LTD.

CATALOGUE

Gas-Turbine Units and Industrial Equipment on their Basis

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About Veya Investments Limited

Veya Investments Limited supplies a wide range of gas-pumping units (GPU) modifications for line and booster compressor stations (BCS), underground gas storages (UGS), both for newly constructed and reconstructed facilities. GPU are delivered as unified and functionally complete highly compatible assemblies or as modules to be mounted at the operating site using common lifting facilities and tools. As to their structure, GPU are made as easy-to-assemble panel hangars and as self-contained units. GPU are also supplied as items for reconstruction (upgrade) of units.

Veya Investments Limited performs the complete cycle of works which includes engineering and construction of gas-turbine power plants on a turnkey basis and offers reliable stand-alone gas-turbine units which are power plants manufactured in Russia, Europe, USA and Japan. The electrical capacity of the power plants varies from 1 up to 150 MW. The state-of-the-art gas thermal power plants are engineered and constructed on a turnkey basis in 14-24 months. Our company is independent regarding the equipment suppliers selection as it uses the machinery produced by the leading Russian and foreign manufacturers: **Dresser-Rand, Kawasaki Gas Turbines Co. Ltd., Mitsubishi Heavy Industries, OPRA Turbines, Alstom, Permskie Motory OJSC, Iskra OJSC, Nevsky Zavod CJSC, Ural Turbine Plant CJSC, Zorya-Mashproekt, Iskra SPA, Motor Sich and others**. The detailed specification, promotional material and equipment description are available upon the request.

The modern gas thermal power stations supplied by **Veya Investments Limited** are based on the most technology-intensive and economically viable ways of electric power generation. Gas-turbine power plants can be equipped with heat recovery unit (optional). The surplus power may be used for cost-free workshop conditioning and for equipment cooling during the production operation.

Environmentally-friendly modular stations supplied by our company are able to operate in different branches of economy for decades. Gas thermal power plants are in service at oil and gas industry processing the associated petroleum gas (APG). The reliable and high-power gas-turbine power plants which we construct on a turnkey basis have an optimal price/quality balance.

As the charge rates are constantly growing, an independent generation of electric power and cheap and available heat at high-power and modern cogeneration plants is a right and economically sound solution for different branches of industry, small and medium-sized businesses, housing and public organizations.

List of works performed by the company:

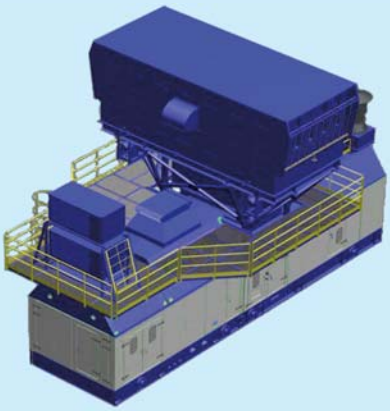
- All kinds of design and engineering works ranging from energy audit to designer supervision;
- Development and selection of gas-pumping gas-turbine power units, gas-turbine electric power plants, boosters, turbine-type generators, modular electric power plants etc. according to the Customer's demands;
- Engineering consulting;
- Generation facilities construction on a turnkey basis;
- Power facilities construction project management;
- Equipment delivery and OEM parts supply within the warranty and post-guarantee periods;
- Installation supervision, commissioning and start-up, facility handover to the Customer on a turnkey basis;
- Customer's equipment upgrade. Reliability and performance improvement. Maintenance costs reduction.
- Overall equipment diagnostics;
- Customer's staff training, skill development, periodic training which takes place either at the manufacturing plant or at the Customer's site;
- The supplied equipment working state monitoring during the post-guarantee period, working out the recommendations on repair and maintenance upon the demand of the Customer. Overall planning and total overhaul term defining;
- Permanent structures and temporary assembly shelters for machinery building;
- Power generation projects development and financing assistance;
- Performing of the project feasibility study.

General information

Gas-turbine electric power unit
with the capacity of 2,5 MW

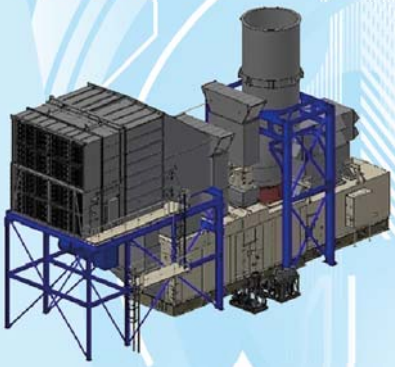
Gas-turbine electric power unit
with the capacity of 6 MW

Gas-turbine electric power unit
with the capacity of 10 MW



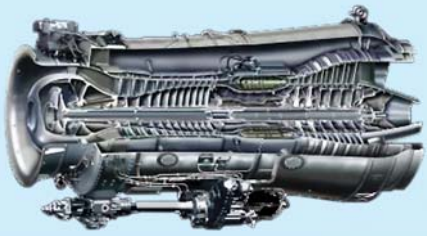
Gas-turbine unit
with the capacity of 6/8/10 MW.
Self-contained unit modification

Gas-turbine unit
with the capacity of 16 MW

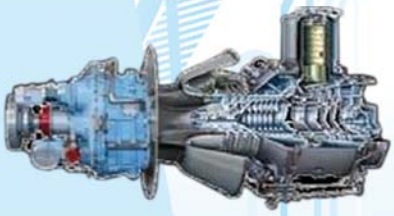


Gas-turbine unit
with the capacity of 2,5 MW.
Self-contained unit modification

Mechanical gas-turbine engine
with the capacity of 16 MW



Power-driven gas-turbine engine,
6, 8 MW



Power-driven gas-turbine engine
2,5 MW

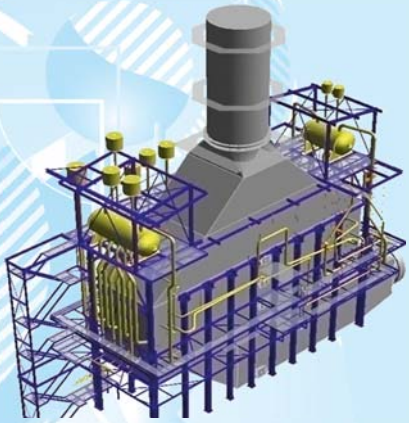
Gas-turbine units use natural gas, associated petroleum gas, synthetic natural gas, diesel, kerosene.

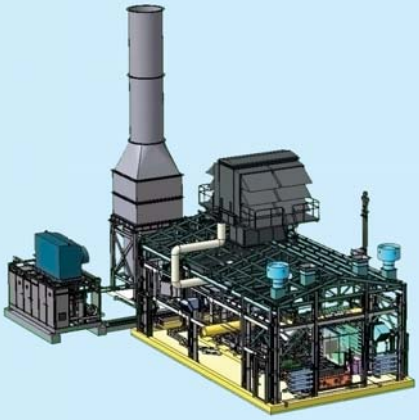
General information

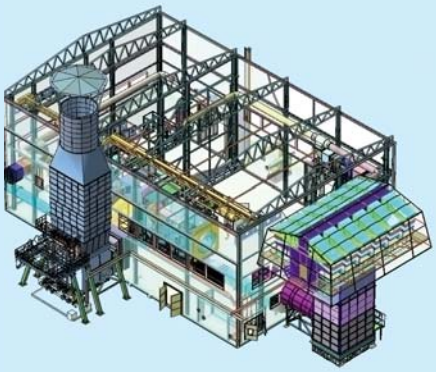
Gas-pumping unit
with the capacity of 2 MW

Gas-pumping unit
with the capacity of 4 MW

Gas-pumping unit
with the capacity of 6,3 MW







AL-31ST engine for gas-pumping
Units with the capacity of 16 MW

GTD-10RM engine for the automatic
gas-pumping unit GPA-10RM

GTD-6,3RM engine for the automatic
gas-pumping unit GPA-6,3RM

Gas-turbine unit with the capacity of 13,7 MW

Unit technical data:

- Electric power, MW — 13,7;
- Turbine generator terminal voltage, kV — 6,3/13,8;
- Thermal output, Gcal/h — 17,71;
- Performance coefficient, %:
  - without heat recovery — 33,3;
  - with heat recovery — 84,3.
- Hazardous emissions content in the exhaust gas of the GTE, mg/m^3 — up to 50;
- Overhaul period, hour — 40 000;
- Specified life, hour — 200 000;
- Integrated lubrication system for GTE and reduction gear, oil type — TP-22.

Gas-turbine units based on this engine are used in gas-turbine thermal power plants and combined-cycle power installations building.

These units can operate in conventional cycle and also in combined (performance coefficient>50%) and cogeneration (performance coefficient >80%) cycles with combined power and heat generation.

Gas-turbine unit with the capacity of 22,5 MW

Unit technical data:

- Electric power, MW — 22,5
- Turbine generator terminal voltage, kV — 6,3/13,8
- Thermal output, Gcal/h — 24,3
- Performance coefficient, %:
  - without heat recovery — 38,5
  - with heat recovery — 85,1
- Hazardous emissions content in the exhaust gas of the GTE, mg/m^3 — up to 50
- Overhaul period, hour — 40 000
- Specified life, hour — 200 000
- Integrated lubrication system for GTE and reduction gear, oil type — TP-22.

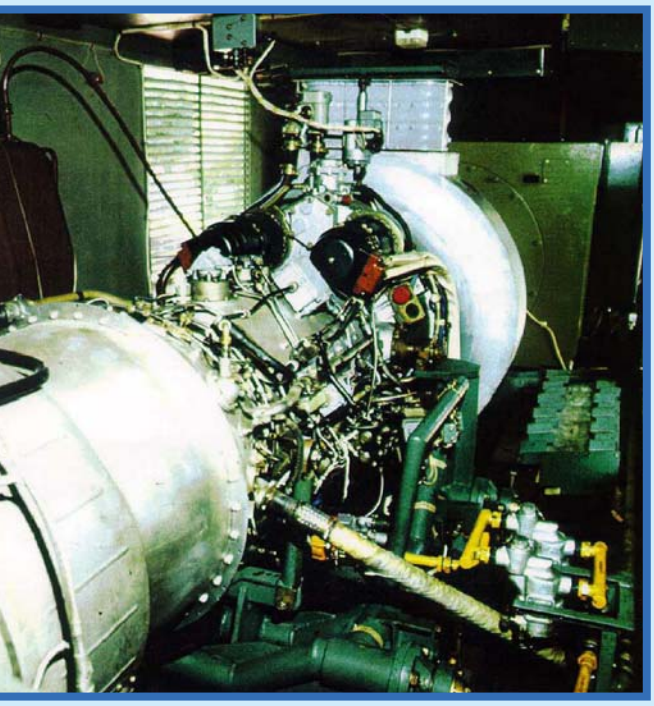
Gas-turbine units based on this engine are used in gas-turbine thermal power plants and combined-cycle power installations building.

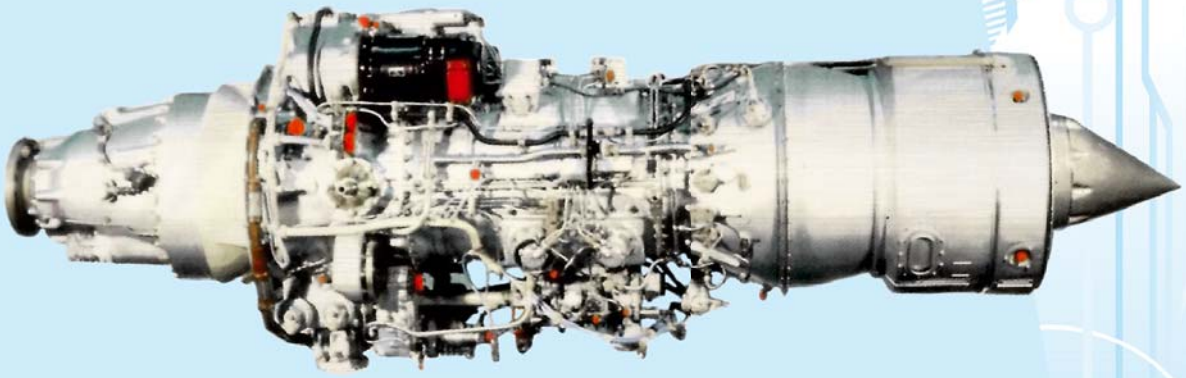
These units can operate in conventional cycle and also in combined (performance coefficient>55%) and cogeneration (performance coefficient >85%) cycles with combined power and heat generation.

Gas-turbine engine with the capacity of 2,5 MW

Engine family for power plant generator driving with the capacity of 2,5 MW with the electric frequency of:

Current frequency, Hz	**50**	**60**
Rotary speed, minute^{-1}	12300^{+90}	12300_{-90}
Rotational speed of the output shaft, minute^{-1}	1000	1000



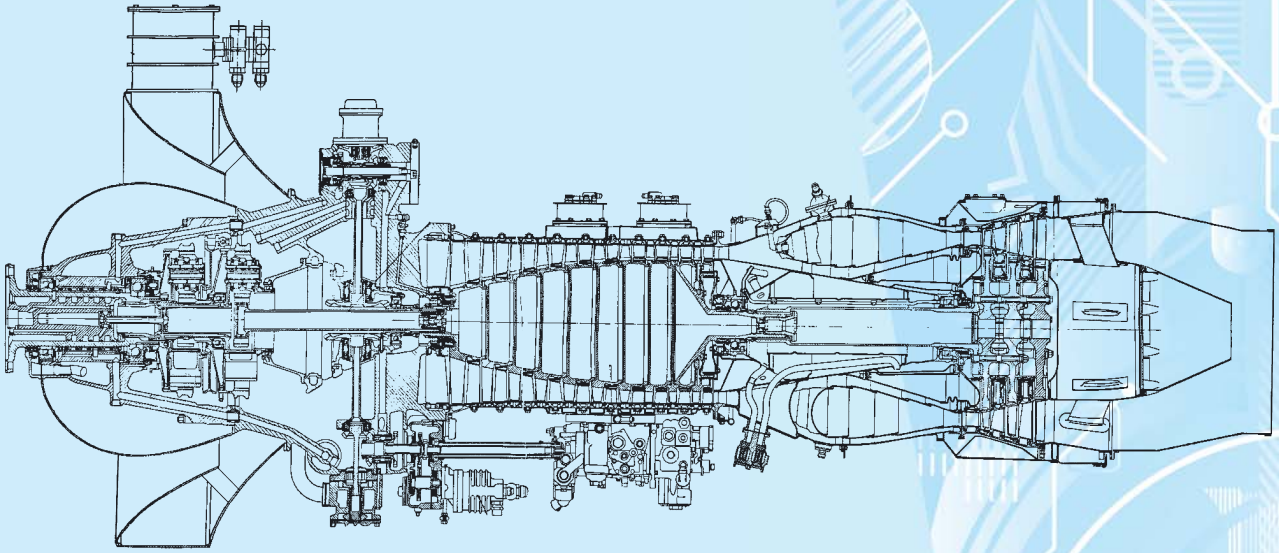


Technical data

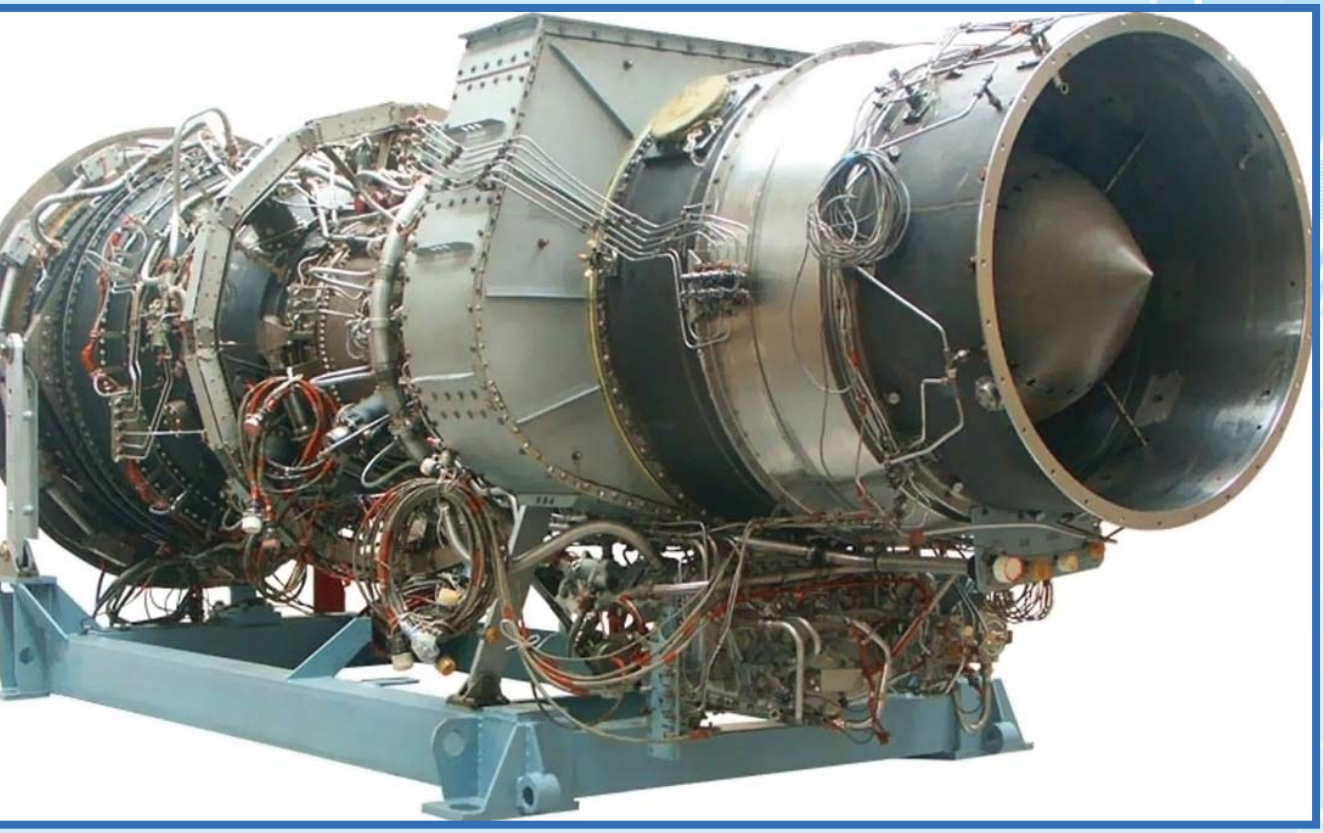
Type of engine	**Gas-turbine**	
Version	General climate	
Fuel type	kerosene, diesel	natural or associated gas
Lubricant type	flood lubrication	
Capacity of engine power settings with generator load, kW:		
- no-load conditions	0	
- 0,5 of the rated power	1250	
- rated power	2500	
- overload	2750	
Fuel consumption with rated power setting up to , kg/h	995	836
Specific fuel consumption with rated power setting, up to , kg/kW/h	0,398	0,334
Gas temperature behind the turbine, up to, °C		
- at the start-up	750	
- at the rated power	520	
Total dimensions, mm		
- length	3500	
- width	890	
- height	1180	
Operational conditions:		
- air temperature at the inlet of the engine, °C	from–50 up to +55	
- relative humidity, up to, %	85	
Delivery weight of the engine, up to, kg	1200	

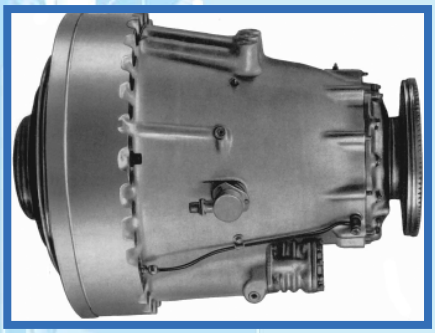
Engine assemblies' configuration

Driving engine axial section



Driving engine physical configuration



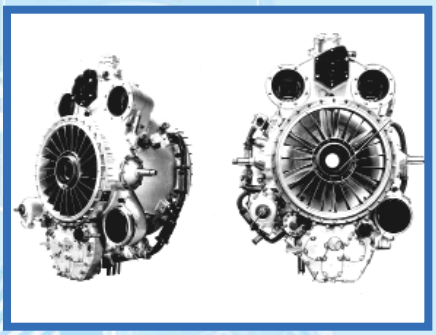


Reduction gear

Reduction gear situated at the front part of the engine is used for rotary speed reduction and power transfer from gas turbine for synchronous generator shaft rotation.

The reduction gear consists of: planetary assembly, stationary ring gear, output shaft and engine torque meter mechanism mounted in reduction gear casing cast in magnesium alloy.

Engine rotary drive to the reduction gear mechanism is provided by the drive shaft spring.

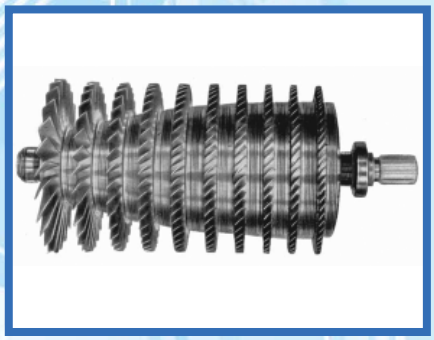


Front casing

The front casing is used for the transmission between compressor and engine reduction gear.

The flanges located at the outside face of the front casing are attached to the engine main systems units and trunnions which mount the engine to the engine bed of the plant.

The crank chamber contains units' drive components, compressor rotary table front support and the inlet guide vanes.



Compressor

A 10-stage axial subsonic compressor is intended for air suction, compression and feeding to the combustion chamber.

The compressor drum disc rotor consists of ten separate discs which bear the rotating blades on their rims.

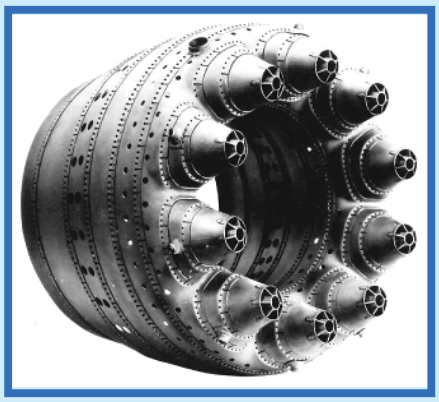
Discs, rear shaft and rotating blades of the compressor rotary are made of high-quality stainless steel.

The compressor casing is a welded structure with a plug and socket unit in the horizontal plane. The rear flange of the compressor casing is attached to the combustion chamber mount.

Setting the operating speed of the compressor avoiding compressor stalls and shifting it to the reduced speed is made by bleeding of a part of the air into the atmosphere through special valves.

Labyrinth seals between rotor and stator suppress non-productive air leaks increasing the compressor's efficiency.

Constant speed of the compressor rotor at different power settings, moderate rotational velocity and special structural features guarantee high reliability of the compressor.



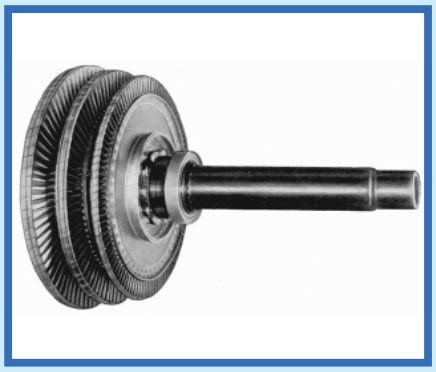
Combustion chamber assembly

The combustion chamber assembly is a power pack of the engine which takes up the turbine's weight as well as forces and torques generated in the combustion chamber and turbine while the engine is being run.

It consists of casing, combustion chamber, fuel-injection nozzles (burners), ignition, fuel fold and several minor mounts. The casing is a welded structure made of stainless steel.

Annular-type combustion chamber is made of refractory plate material and has ten injection nozzles welded to the ring liner. Its design permits ignition and fast flame transference as the engine is started.

The well-organized burning process combined with efficient layered cooling of the chamber walls guarantee the combustion chamber stable performance at all power settings, a uniform thermal field at the turbine inlet as well as high service reliability of the combustion chamber during the whole operating life.



Turbine

The axial reaction turbine is used for converting the thermal power of hot gasses into the engine rotor mechanical work. It drives the compressor, engine units and transmits the surplus power to the generator shaft.

The overhung turbine rotor consists of three runner wheels and a shaft joined by screws. The turbine rotating blades are shrouded and mounted pairwise in fir-tree slots of the discs.

The fail-safe performance is guaranteed, as the discs, blades and other high-heat parts are made of refractory materials and are well-cooled by compressor air-bleeding.

The high performance coefficient is obtained by using labyrinth seals which minimize air leaks through gaps between the rotor and the stator.

Engine lubrication and breather systems

Engine receives a close-circuit lubrication which means that the injected and scavenge oils are constantly circulating in the closed system. The oil from the oil tank is transferred into the lubrication system as consumed oil compensation is required during the engine operation.

All the inner chambers of the engine receive breathing in order to ensure the normal performance of the lubrication system and the seals.

Starting system

Automatically sets the no-load conditions for the engine rotor. The rotation is made by two starter-generators. For providing the

reliable compressor performance at the start the air is bled into the atmosphere. Rotation speed and the corresponding fuel flow are adjusted by the fuel-control unit.

Anti-icing system

A special unit signals when there is ice detected at the engine inlet. The electric mechanism starts hot air feeding through the traction system in order to preheat the inlet guide vanes of the compressor and other parts located at the engine inlet line.

The front casing fins cavities are being constantly preheated by the hot oil circulation.

Engine mounting to the power plant engine bed

Made by four trunnions: two are located on the front casing in horizontal plane, two are situated on the compressor and combustor joint flange at the horizontal axis angle of 7°.

Delivery package:

- a single set of spare parts;
- a set of engine operational documentation.

Maintenance:

- service maintenance by the manufacturer;
- low operational costs;
- low maintenance expenses;
- high operational reliability;
- mobility and promptness in fault repair;
- service in any place of the world;
- on-condition maintenance;
- the manufacturer assigns his experts for the period of the start-up and, if necessary, for any operational period;
- theoretic and practical training of the Customer's staff at the manufacturing plant or at the operational site in any place of the world.

The Customer is provided with information which prevents from errors in the course of engine operation. Our experts have decades of experience in technical support of engines..

Repaire service

- the repair service rendering is monitored by the manufacturer;
- the manufacturer guarantee the supply of necessary parts, assemblies and other products for local repair during operation;
- the overhaul engine repair is performed by the manufacturer with the initial life recovery and initial settings (main data) reset;
- the manufacturer is ready to cooperate with companies willing to organize their own maintenance department.

Gas-turbine engine with the capacity of 10 MW

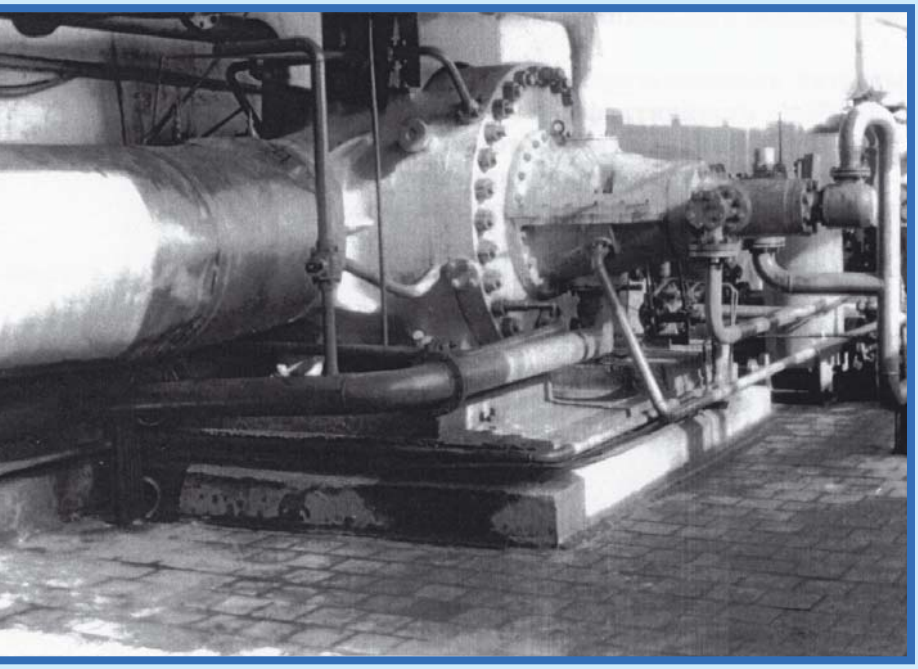
This is a modern gas-turbine engine for centrifugal air blower drive.

Scope of application:

For driving gas-pumping units centrifugal air blowers with the rated power of 10 MW.

Design criterion:

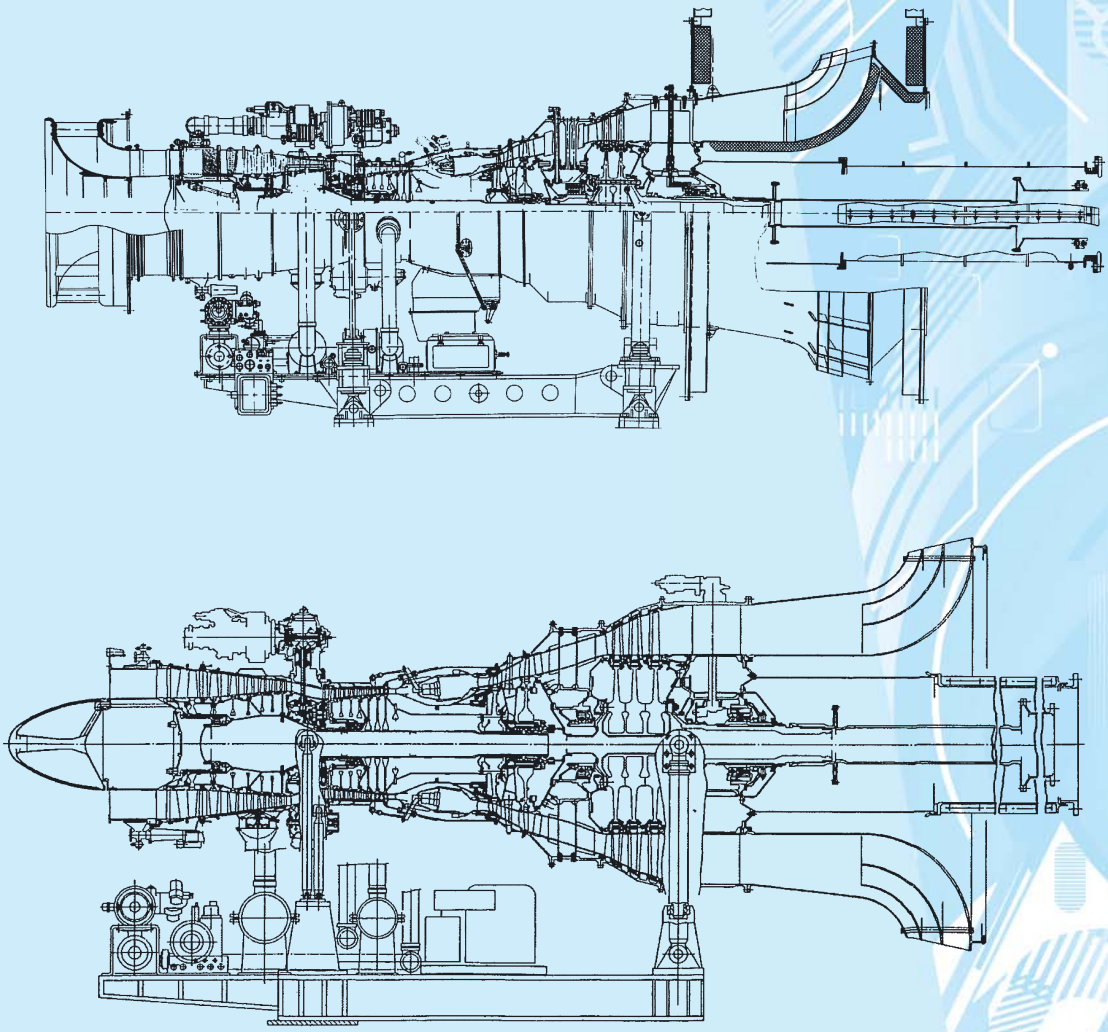
- low operational expenses;
- high productivity;
- easy maintenance and repair;
- high reliability;
- high environmental performance indicators.



Technical data of gas-turbine drive

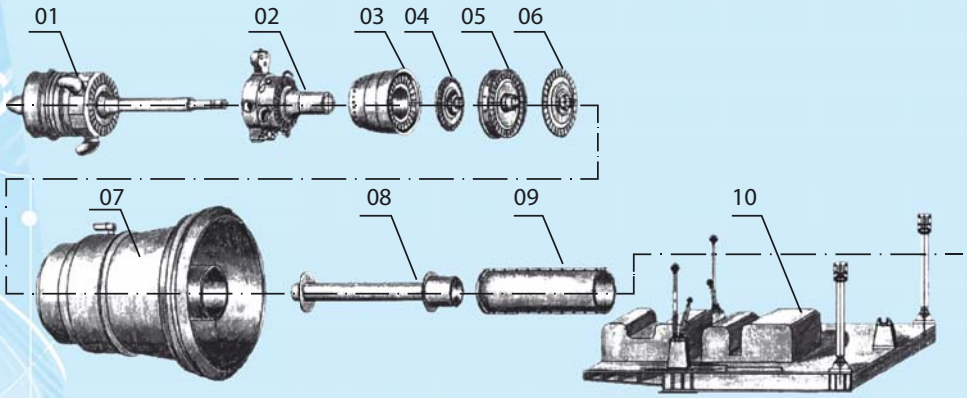
Parameter	Declared measure	Conditions
Rated power, kW/h	10000	
Fuel gas flow-rate, kg/h	2085	at H= 11950 kkl/kg
Absolute thermal efficiency, %	34,5	
Power turbine rotary speed, minute^{-1}		
AI-336-1-10	4800 – counter-clock-wise	from exhaust outlet
AI-336-2-10	6500 – clockwise	from exhaust outlet
Continuous work period at the main power settings, min	Unlimited	within operation life limits with negative values at sea level
Maximum capacity, kW/h	12000	
Start System	pneumatic, turbine starter	
Average number of starts in 1000 engine operational hours	15	with 0°C, 760 mm Hg content of O_2=15%
Time for reaching the rated power minutes, up to	10	
Exhaust gas has a content:		
– nitrogen oxides, mg/m^3	50	
– carbon, mg/m^3	80	
Sound pressure level, dB	145	
Drive operating life:		
till overhaul, h rated, h, not less than service life, years	25 000 100 000 12	
Drive weight, kg, up to	5200	

Drive configuration



Drive modules:

- three-shaft scheme with minimized bearing supports number;
- configuration made to provide modular (block) assembly;
- the drive is divided into 10 main modules.



1. Low-pressure compressor (LPC);
2. LP-turbine rotor;
3. Intermediate casing and high-pressure compressor (HPC) (main module);
4. Free power turbine with an output element;
5. Combustor and high-pressure turbine (HPT) nozzle diaphragm;
6. Driving shaft;
7. HPT rotor;
8. Driving shaft housing;
9. HPT and LPT support housing;
10. Frame.

Structure description

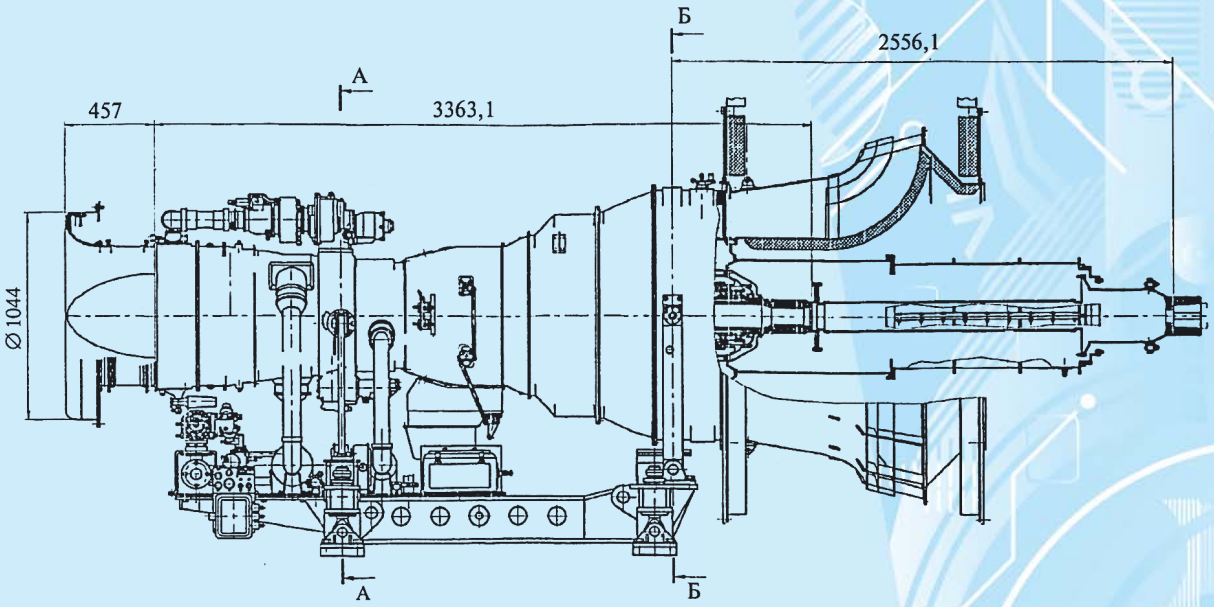
The engine: three-shaft, with axial two-stage 14-step compressor, intermediate casing, annular-type combustion chamber, two stages of compressor turbines, free power turbine and output element.

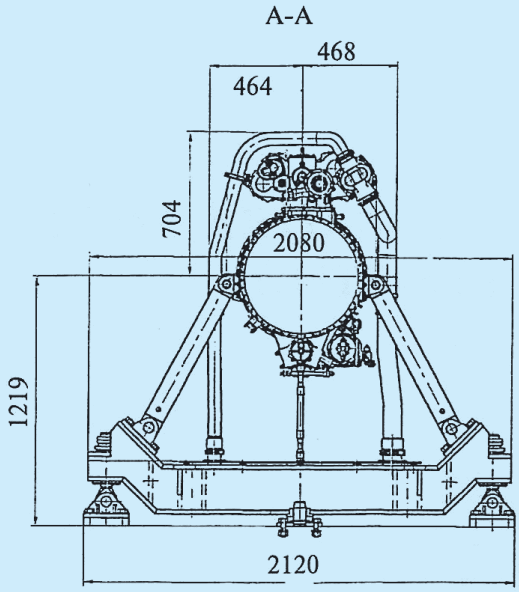
The engine is mounted on the frame where a part of its units is located and attached to the frame by two flanges.

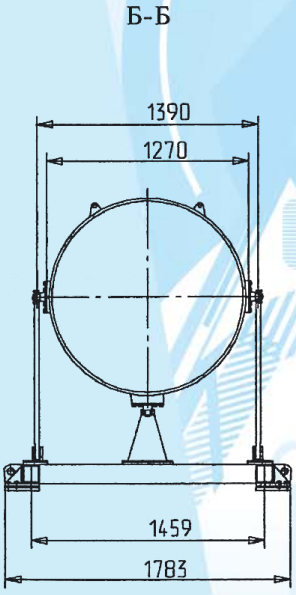
The engine rotary direction is left, (from exhaust outlet). A unit with right-direction rotation can be supplied on request.

The engine configuration is made to provide for modular assemblage.

Engine support diagram







Electronic automation system

Electronic automation system (EAS):

- developed on the base of general purpose industrial building blocks;
- working conditions data are displayed on the PC screen;
- the engine's EAS is integrated with GPU ACS at the standard traffic channels level;
- has the structure of a stand-alone assembly mounted on the frame;
- improves GTE and GPU performance characteristics by means of engine monitoring and protection and by:
  - increasing the accuracy of set-up parameters keeping with the help of efficient control algorithms implemented by the electronic controller;
  - GTE and EAS monitoring which increases the failure-free operation period, improves engine endurance, permits to perform on-condition maintenance;
  - placing the units in the GPU and not on the engine in order to provide optimal thermal and vibration conditions.
- can be run both in automatic mode by the GPU ACS and by operator.

The maintenance and repair service guarantees drives operation in any place of the world:

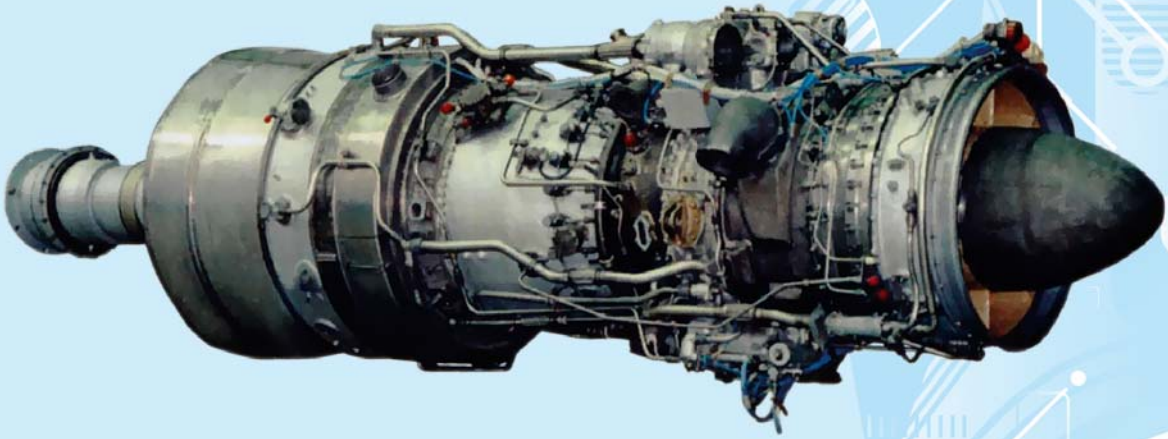
- service maintenance by the manufacturer;
- low operational costs;
- low maintenance expenses;
- high operational reliability;
- mobility and promptness in fault repair;
- service in any place of the world.

Our experts have decades of experience in technical support of engines.

Specific tasks:

- timely replacement of used assemblies and units;
- on-condition maintenance;
- theoretic and practical training of the Customer's staff at the manufacturing plant or at the operational site in any place of the world. The Customer is provided with information which prevents from errors in the course of engine operation. The Customer is provided with information which prevents from errors in the course of engine operation.

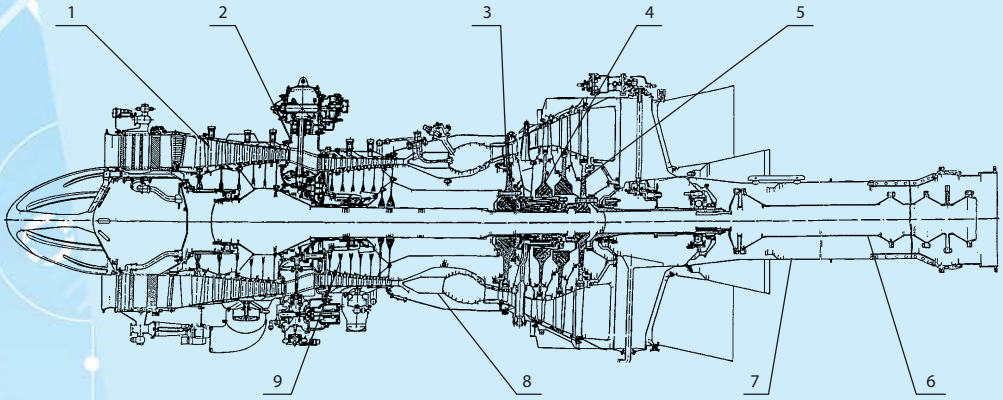
Engines used in industrial plants



Gas-turbine engine with the capacity of 8 MW

Gas-pumping unit based in the 8 MW engine

Driving engine axial section



1. LPC;
2. Intermediate casing;
3. HPT;
4. LP-turbine;
5. Power turbine;
6. HPC;
7. Combustion Chamber
8. Cone-shaped beam;
9. Power shaft train.

Main technical data of the driving engine:

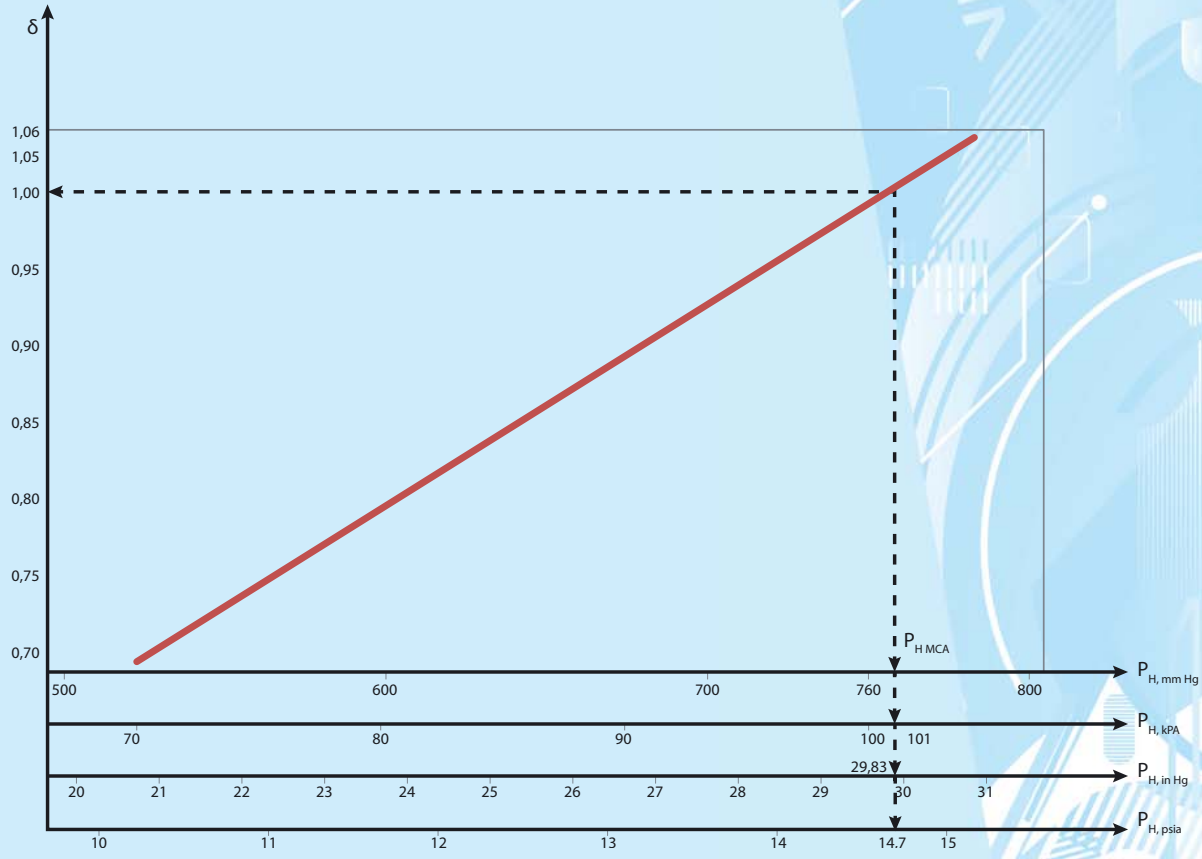
- Rated power setting (H=O, MCA):
  - capacity, kW (hp) — 8000 (10720);
  - absolute thermal efficiency, % — 32,5.
- Off-peak conditions (H = 0, MCA):
  - capacity, kW (hp) — 3000 (4020).
- Exhaust gas temperature, K(°C) — 725 (452);
- Power turbine rotary speed, min^{-1} (s^{-1}) — 8200 (136,67);
- Power turbine rated speed adjustment range — 0,70... 1,05;
- Weight, kg (/,) — 1470^{+30} (3240^{+65}).

Gas-turbine drive performance data

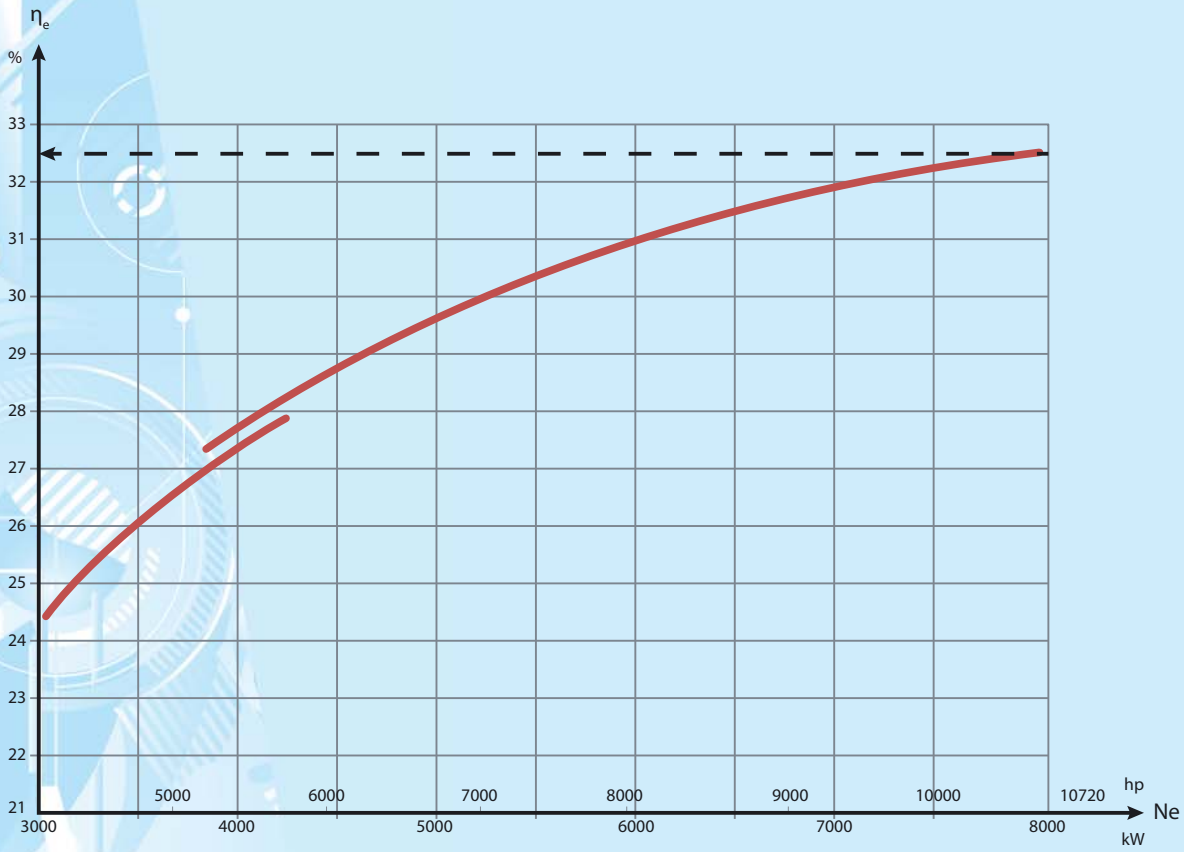
Height compensational factor for defining the available capacity,

$$\delta = \frac{P_H}{P_{H\ MCA}}$$

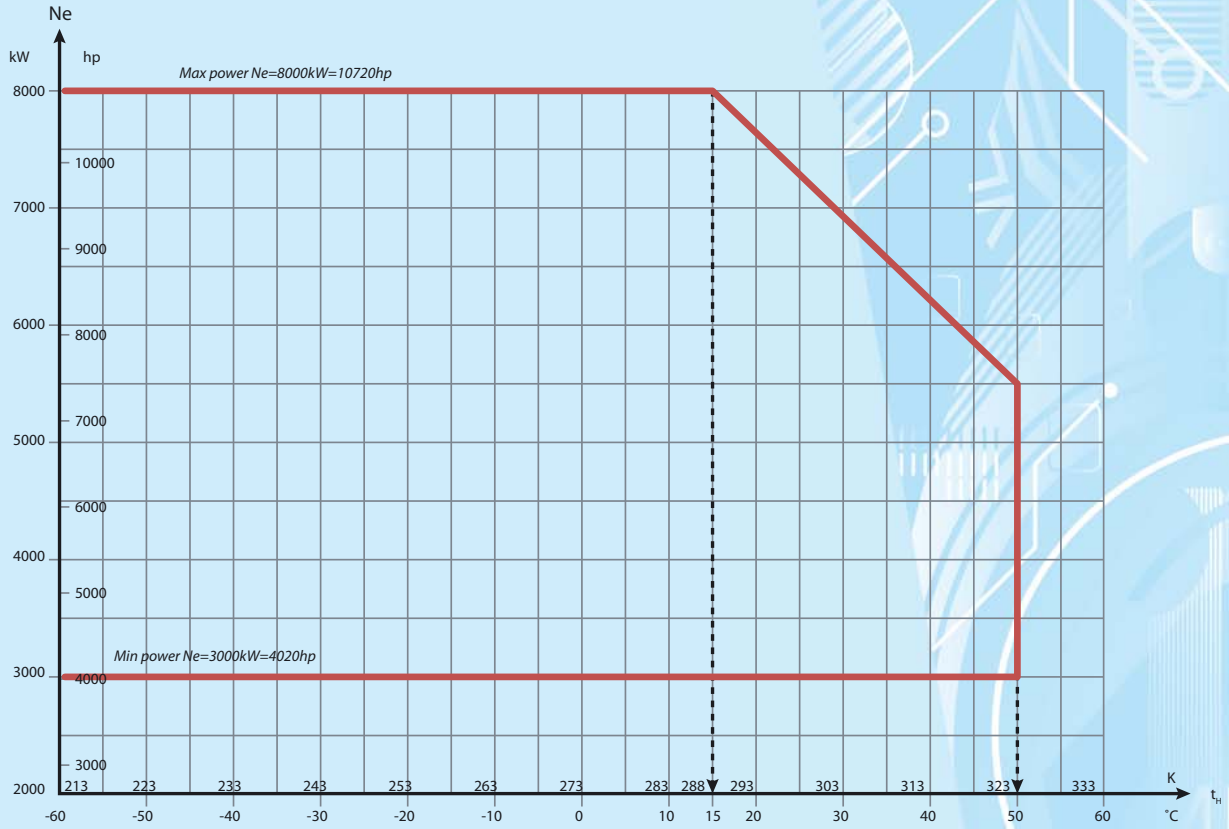
where is δ — compensational factor;
P_H — ambient air pressure at the specific height, mm Hg (kPa, in Hg, psia);
$P_{H\ MCA}$ — 760 mm Hg. (101 kPa; 29,83 in Hg; 4,7 psia)



Absolute thermal efficiency in relation to the capacity with $P_{H\ MCA}$,
t_H=15°C (288 K) and n_{CT} =8200 min^{-1} (136,67c^{-1})



GTD power characteristics with $P_{H\ MCA}$ 1hp=0,7457 kW



The design concept of a gas-turbine drive with the capacity of 8 MW

This drive is specially designed for mounting on gas-pumping, gas-lift and oil-pumping units.

Engineering was based on our long experience in designing, operation and development of gas-turbine engines and electric power plants.

The drive is equipped with a newly designed automatic control system which includes the following: GTD electronic controller, fuel gas feed controller, power turbine speed-limit device, isolation valve, power-supply unit.

The engine meets the requirements for gas-turbine plants used in gas-pumping, gas-lift and oil-pumping units.

The drive has two configuration variants as to the power turbine rotation direction and industrial use:

Power turbine rotation	Use	Configaration
Counter-clockwise	Oil-pumping and gas-lift units	Variant 1
Clockwise	Gas-pumping and gas-lift units	Variant 2

Upon the request it is possible to produce unit variants with power turbine rotation speed of 5000 of 3000 (3600) min-1 (83,33 or 50(60) s-1).

As an option, the engines can be adapted for liquid fuel such as kerosene RT, TS-1 or equal foreign-produced fuel.

The engine can be used for keeping the power of 6,3 MW (8442 hp) with the ambient air temperature up to 312 K (+39 °C).

Drive short description

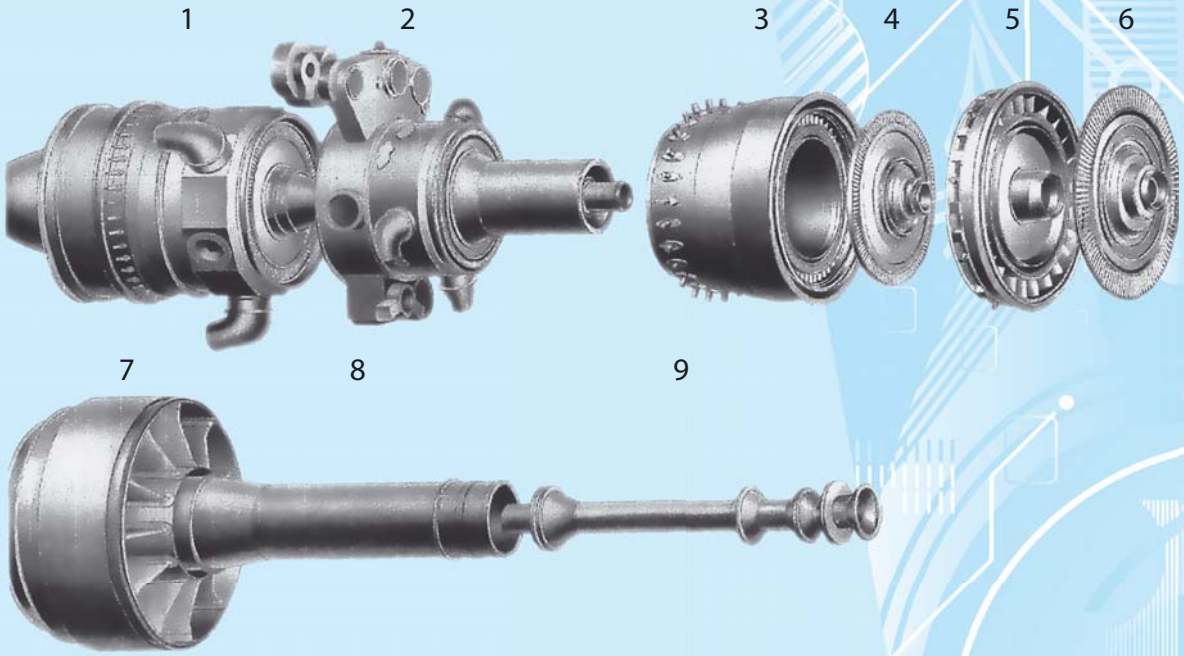
This is a three-shaft drive with an axial two-stage 13-step compressor (LPC and HPC), intermediate casing, annular-type combustion chamber, two compressor turbine stages (HPT and LPT), two-staged power turbine and exhaust unit.

The AI-336-8 also includes: input device; attachment fittings and centering control on the bed frame; starting, control, feeding, lubrication and breathing systems, settings control and condition testing.

Operation: the air coming through the GTD input device is compressed by low-pressure and high-pressure compressors and is fed to the combustion chamber, where it is mixed with natural gas coming through the nozzles and transforms into the fuel-air mixture. As the mixture burns, the gas flow temperature is rising. Then the gas is fed to the turbine where the air flow energy is converted into mechanical work used for driving the low-pressure and high-pressure compressors and centrifugal blower.

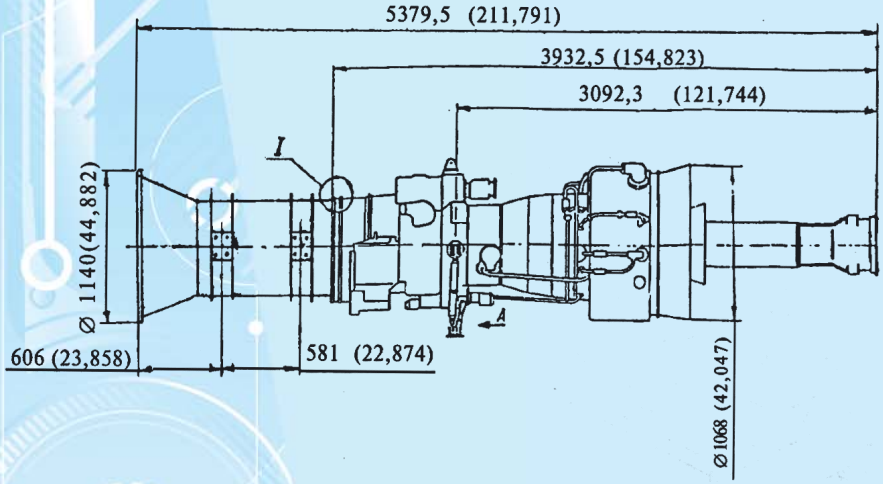
In order to guarantee the reliability of the drive and enhance its durability we are working through the possibility to develop LPC by assembling to it an additional so-called “zero” stage which will increase the pressure of the two-staged compressor and the temperature of the gas at the inlet of the turbine.

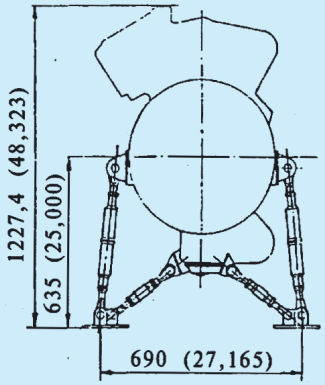
Modules of the drive



1. Low-pressure compressor;
2. Intermediate casing with the high-pressure compressor — the main module
3. Combustion chamber
4. High-pressure turbine rotor;
5. High-pressure and low-pressure turbines body frame;
6. Low-pressure turbine;
7. Power turbine;
8. Cone-shaped beam;
9. Power shaft train.

Main dimensions and drive anchor points

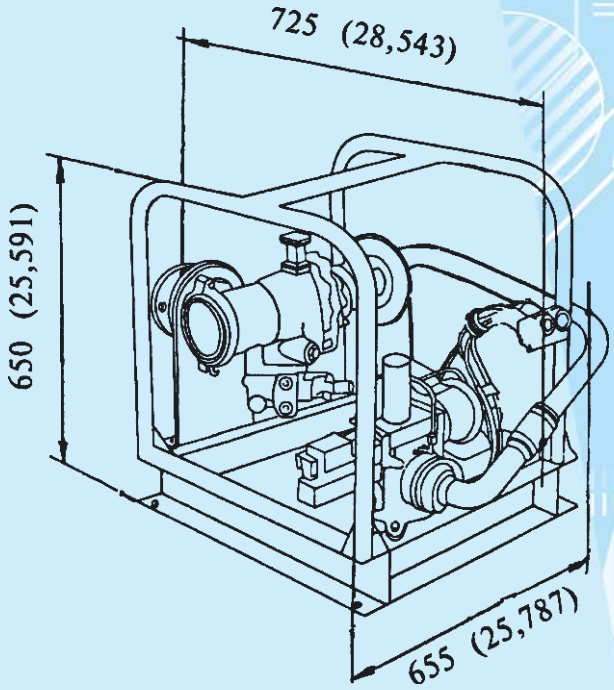




Retainer

Dimensions, mm (inches):
- length: 5379,5 (211,79);
- width: 1068,0 (42,05);
- height: 1227,4 (48,32)

Overall view and dimensions of gas-regulating system assembly



Reliability and durability index, warranty:

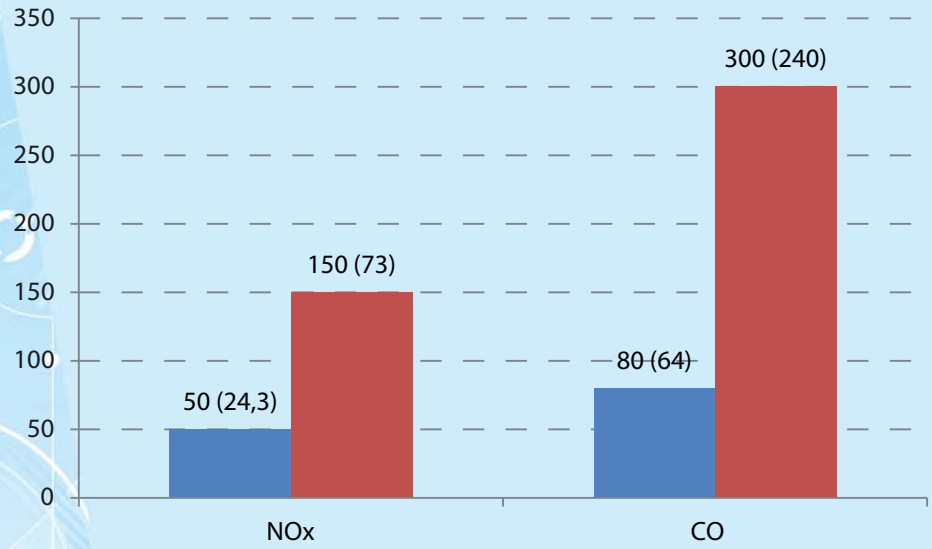
- No-failure operating time (time between failures), h — not less than 4000;
- Overhaul life (TBO), h — not less than 25000;
- Service life limit, h — not less than 100000;
- Drive overhaul life — 12 years, storageability time included.

The supplier guarantees that the unit meets the requirements of TOR if the consumer follows the terms of operation, transportation and storage.

The warranty lifetime and storageability time is 7 years in warehouse from the acceptance data including 4 years of storage at open platforms without shelter or 5 years — at a site with a shelter in areas of moderate and cold climate. In regions with tropical climate the guaranteed storageability period of the product in the supplier's package is 2 years in sheltered warehouses.

The indicated warranty is valid for the supplied spare parts of a single package, board instruments and component parts of the GTD.

Environmental performance



Hazardous emissions content (mg/nm^3) in the exhaust gasses with the rated capacity (ppm).

Controllability

The high level of controllability provides an efficient and safe on-condition operation of the drive.

Current monitoring is carried out using 15 status check parameters and 50 GTD status check messages. The automatic control system helps to immediately obtain the data of condition and parameter-trends of GTD and its systems as well as to forecast their technical condition basing on the collected information.

The GTD configuration permits to perform periodic examination of the parts and assemblies of the gas-air flow duct (rotating blades of all compressors' and turbines' stages, inner surface of the combustion chamber) through special openings using an optical device in order to estimate its technical condition. There are oil sampling points at the GTD designed for periodic oil tests for wear products content detection and also swarf analyzer and three high-temperature swarf indicators.

Unit operation technical support

Engines and GTD operation technical support is performed by a developed network of Maintenance and repair department (MRD) experts. The MRD is the main link between the plant and operating entities:

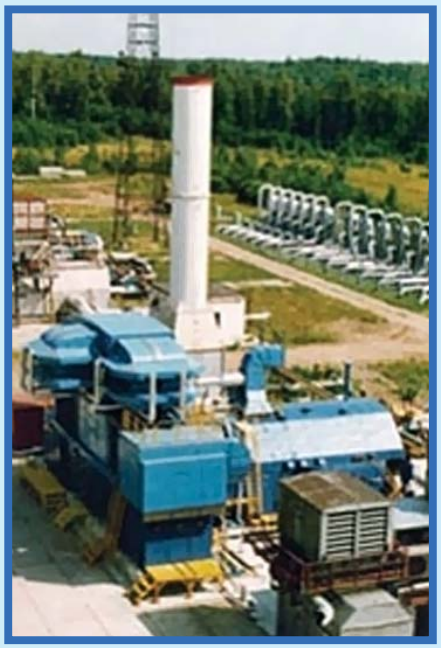
- has its representatives in more than 100 places in the world;
- assigns its experts to the operating entity as it supplies engines to be used in aircrafts, helicopters or GTD;
- asseblies to be installed in ground industrial plants;
- provides comprehensive 24-hour/7-day cooperation with operating entities representatives.

MRD ensures:

- warranty and service maintenance of the engines and GTD in any region;
- mobility and promptness in fault repair;
- immediate and efficient reaction to operating entities requests;
- collection and processing of the engine and GTD operation data for their further development;
- performing works in operating entities on order to enhance reliability and improve the performance of engines and GTD;
- engines and GTD reconstruction under field conditions by assemblies and modules replacement;
- preparing and rendering services such as engineering;
- engines and GTD on-condition operation;
- qualified consulting on all issues regarding engines and GTD operation;
- theoretic and practical training of the operating entities's staff at the manufacturing plant or at the operational site in any place of the world.

General information

We supply over 50 modifications of gas-pumping units (GPU) for line and booster compressor stations (BCS), underground gas storages (UGS), both for newly constructed and reconstructed facilities. GPU are delivered as unified and functionally complete highly compatible assemblies or as modules to be mounted at the operating site using common lifting facilities and tools. As to their structure, GPU are made as easy-to-assemble panel hangars and as self-contained units. GPU are also supplied as items for reconstruction (upgrade) of different types of units.



Gas-pumping unit consisting of self-contained assemblies with the capacity of 12 MW

Gas-pumping unit with the capacity of 16 MW

Gas-pumping units

Main features of gas-pumping units:

- delivered as highly compatible assemblies to the mounting site;
- use up-to-date Russian and foreign automatic control systems with modern Micro-PC element base manufactured by SIEMENS (Germany);
- has air-cleaning equipment with cyclone and accumulative
- filters which ensure air cleaning according to the European standard EN-779-94-F7-F9 with 99,7% efficiency;
- using oil-free centrifugal compressors with magnetic rotor suspension and dry gas seals;
- using NVH casing for gas-turbine engine which also provides high level of fire and explosion safety of the power drive (assembly);
- using plate-fin oil air coolers (OAC) with frequency regulation of fans' rotation speed;
- using axial fans in GTU cooling systems which are reliable and have low noise level;
- can be furnished with a modular assembly of fuel gas treatment;
- can be refilled by portable oil filling unit;
- design and fabrication of GPU are performed according to the quality control system which conforms with the international ISO 9000 standards.

Gas-pumping unit at the Igrinskaya compressor station

Gas-pumping unit at the Permskaya compressor station

Gas-pumping units for line compressor stations

Used for equipping the line compressor stations both operating and under construction which transport natural gas by transfer pipelines.

As to their structure, GPU are made as easy-to-assemble panel hangars and as self-contained units.

GPU are equipped with centrifugal compressors (CC) manufactured in Russia and abroad and gas-turbine units (GTU) built basing on aircraft engines.

GPU are compatible with different drives which may be any of existing GTU and compressors resulting in uniform units with capability ranging from 4 up to 25 MW depending on the existing compressor stations.

Gas-pumping unit with the capacity of 16 MW at the Smolenskaya compressor station

Gas-pumping unit with the capacity of 12 MW at the Krasnodarskaya compressor station

Main technical data

Parameter	GPU-6,3	GPU-12	GPU-16	GPU-25
Rated power, MW	6,3	12	16	25
Commercial output, mln. nm^3/day	11,5	20,4...32,6	22,0...35,0	44,5...57,0
Compressor pressure, MPa	5,49	5,45...9,61	5,45...8,33	7,45
Compression ratio	1,44	1,32...1,7	1,44...1,61	1,37...1,5
Polytropic thermal efficiency of the compressor	0,84	0,85-0,86	0,85-0,86	0,85-0,86
Power turbine rotation speed, rpm	8200	6500	5300	5000
GTU absolute thermal efficiency (station conditions)	0,30	0,34	0,363	0,395
GTU fuel gas specific flow rate, kg/kW/h	0,239	0,208	0,192	0,177
Gas pressure (max), MPa: - start - fuel	 0,294 0.49	 0,6 3,0	 0,6 3,2	 0,6 4,5
Oil type: - engine - compressor	 MS-8P TP-22S	 MS-8P TP-22S	 MS-8P TP-22S	 MS-8P TP-22S
Weight, tons	-	170	220	310
Total resource, thousand hours	100	100	100	100

GPU modification for line compressor stations

Modification	Configuration
Power rating 6 MW	
Variant 1	Self-contained units
Power rating 12 MW	
Variant 1	Self-contained units
Variant 2	In hangar
Power rating 16 MW	
Variant 1	Factory-assembled
Variant 2	In hangar
Power rating 25 MW	
Variant 1	In hangar

Gas-pumping units for booster compressor stations

Used for equipping operating and newly built booster compressor stations which maintain the set up fuel gas pressure when reservoir energy is depleted.

Main technical data

Parameter	GPU-6 BCS	GPU-10 BCS	GPU-16 BCS
Rated power, MW	6	10	16
Commercial output, mln. nm³/day	6,0...8,3	5,0...24,0	8,0...29,0
Compressor pressure MPa	7,45	12,3	7,45
Compression ratio	1,1...4	1,25...3	1,45...3
Polytropic compressor thermal efficiency	0,8	0,78...0,83	0,78...0,83
Power turbine rotation speed, rpm	7000	9000	5300
GTU absolute thermal efficiency (station condition)	0,262	0,34	0,363
GTU fuel gas specific flow rate, kgr/kW•h	0,274	0,212	0,192
Gas pressure (max), MPa: - start - fuel	 0,6 1,8	 0,6 3,0	 0,6 3,2
Oil type: - engine - compressor	 MS-8P TP-22S	 MS-8P TP-22S	 MS-8P TP-22S
Weight, tons	147	185	225
Total resource, thousand hours	100	100	100

GPU for booster compressor stations

Modification	Variant
Power rating 6 MW	
Version 1	In hangar
10 and 16 MW power ratings	
Version 1	Self-contained units
Version 2	In hangar

Booster gas-pumping unit with the capacity of 16 MW at the Zapadno-Tarkosalinskaya compressor station

Booster gas-pumping unit with the capacity of 16 MW at the compressor station of Yamburggazdobycha Production Association

Gas-pumping units for underground gas storages

Used for equipping operating and newly built underground gas storages which collect and use natural gas reserves destined to cover peak consumption.

Main technical data

Parameter	GPU-4 UGS	GPU-10 UGS
Rated power, MW	4	10
Commercial output, mln. nm³/day	1,8...2,5	4,0...11,3
Compressor pressure MPa	9,92...14,4	7,45...14,4
Compression ratio	2,2...3	1,57...3,26
Polyptropic compressor thermal efficiency	0,76...0,80	0,76...0,83
Power turbine rotation speed, rpm	14000	9000
GTU absolute thermal efficiency (station conditions)	0,24	0,34
GTU fuel gas specific flow rate, kg/kW•h	0,303	0,212
Gas pressure (max), MPa: - start - fuel	 0,6 1,5	 0,6 3,0
Oil type: - engine - compressor	 MS-8P TP-22S	 MS-8P TP-22S
Weight, tons	98	185
Total resouce, thousand hours	100	100

Gas-pumping unit at the Permskaya compressor station

GPU modification for underground gas storages:

Modification	Variant
Power rating 4 MW	
Variant 1	Self-contained units
Power rating 10 MW	
Variant 1	Self-contained units

Gas-pumping unit for underground gas storages with capacity of 10 MW at the Karashurskaya compressor station

Electric power plants based on gas-turbine engines.

The world leading manufacturers produce a wide range of electric power plants based on gas-turbine engines, both specially designed for this purpose and used in other branches of industry (aircraft engineering, shipbuilding industry, oil and gas industry, etc.). Units of different types are produced in order to meet the demand for power supply in industry, housing and public utilities, research and scientific institutions, defense facilities, etc.

The main parameter for defining the class of power generation units and their purpose are the output characteristics of the generated electric power.

Low-powered electric power plants — up to 10 MW

Used for power supply of industrial and household facilities, compensate lack of power at peak loads, work as emergency and standby power sources, operated in backup mode.

Quite often building the new electric power facilities, reconstruction of out-dated equipment in power stations and boiler houses is implemented by using modular gas-turbine power plants (GTPP) based on gas-turbine units (GTU) as the best solution to the problem of obtaining cheap power supply. Recoupment period for these projects varies from 3 to 5 years.

Description

The main assemblies of the electric power plant are the gas-turbine unit and the generator located in soundproof and insulated container.

Electric power stations are equipped with all the necessary support systems (fuel, starting, lubrication, etc.) and utilities.

Units and systems of the power plant are manufactured as highly compatible assemblies which can be transported by train, car or ship.

Standard technical specifications of a gas-turbine power plant with the capacity of 2,5 MW

Rated terminal power of the generator, MW	2,55
Exhaust heat power with exhaust t.=110 °C, Gcal/h	5,82
Gas temperature behind the turbine (exhaust), °C	361
Gas flow behind the turbine (exhaust), kg/s	25,6
Equivalent operation sound level, not exceeding, dBA	80
Operating life, h: - till overhaul - specified	 30 000 120 000

Fuel:

- natural gas (other type as agreed).

Advantages of GTPP:

- Do not require neither expensive facilities building nor large groups of maintenance staff;
- Highly compatible assemblies are supplied which reduces the time for mounting, commissioning and start-up of the facilities;
- All equipment fully complies with environmental requirements regarding emissions and noise.
- The equipment can operate both in parallel circuit and in standalone mode, which increases significantly the facilities' energy safety level. It means that in case of emergency disconnection of the consumers from the supply network it can automatically shift to the local load thus preventing negative effects of failures in the power network;
- Short period of recoupment of GTPP: from 3 to 5 years;
- Self-contained units;
- Reliability;
- Maintenance works are not time-consuming;
- High performance

The unit can be equipped with additional power modules in order to increase its capacity.

Standard technical specifications of a gas-turbine power plant with the capacity of 1,8 MW

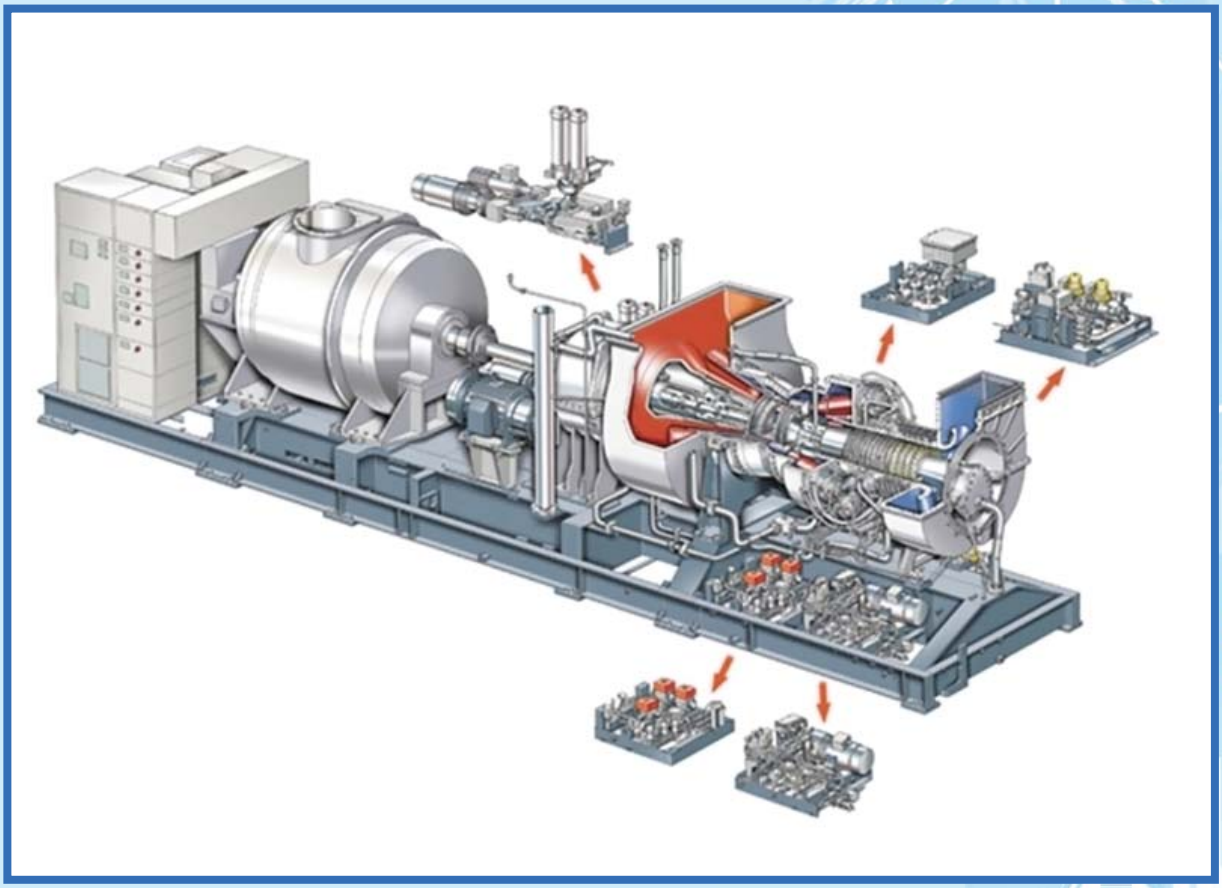
Gas-turbine engine serves as power-supply unit.

- Output shaft speed — 1500 rpm.
- Rated power 1800 kW.
- Peak capacity up to 2000 kW
- Power plant electrical efficiency — 26%
- Generator terminal voltage 6,3 — 10,5 kV
- Frequency 50 Hz

Main engineering data

Rated electrical power	1860	1730
Electrical efficiency	26,2%	25,7%
Net efficiency with heat recovery	90%	89%
Electrical voltage, kV	0,4 or 6,3	0,4 or 6,3
Current frequency, Hz	50	50
Time for shifting to the rated power settings, minutes	2	2
Weight, tons	14,3	14,3
Dimensions, mm	6000×2100×2600	6000×2100×2600
Fuel	Gas	Diesel
Fuel supply pressure, atm	10	10
Fuel comsumption with rated load	712 m^3/hour	670 l/hour
Exhaust gas temperature, °C	559	542
Heat/steam output with cogeneration	4000 kJ 3,44 Gcal/hour 6 tons/hour	4000 kJ 3,44 Gcal/hour 6 tons/hour
Steam pressure with cogeneration	9 kg/cm^2	9 kg/cm^2
Hazardous emissions content in exhaust gas	6 ppm NOx 6 ppm CO 5 ppm UHC	25 ppm NOx 25 ppm CO 10 ppm UHC
Noise level per 1 m, dBA	85	85
Overhaul life, h	60 000	60 000

Standard layout of low-powered electric power plant by the example of a gas-turbine unit manufactured in Europe



High-capacity power plants from 10 up to 50 MW

Used for power and heat supply of single industrial and household facilities as well as of areas and small populated localities:

- oil and gas fields infrastructure;
- metallurgical complexes;
- desalination plants;
- plants and factories;
- trade centres;
- hotels and restaurants;
- remote settlements and industrial facilities which lack centralized power supply, etc.

Gas-turbine units have two/three-way feed, and thermal power plants of different configuration and purposes have fuel efficiency over 80%. Gas-turbine units are designed and engineered so that the required maintenance is minimized reducing the expensive downtimes. Gas-turbine units suppose low maintenance expenses and the possibility of fast mounting and start-up at the Customer's site. Their electrical efficiency reaches 35%. If the unit is combined with a steam turbine this index increases up to 48%.

The ignition and start-up systems has a high efficiency and ensures start reliability of 99,5% in different climate conditions.

Standard technical data of a gas-turbine electric power plant by the example of a unit with the capacity of 16 MW

The unit is equipped with a turbine with the rotational speed of 3000 rpm. By reducing the rotational speed the turbine can be used as a generator drive without reduction gear, which helps to increase gas-turbine unit reliability and cut total operational costs.

GTPP serve as main or standby power source, either autonomously or along with other power supply units. It is possible to recover waste heat in recovery boiler which can be hot-water type or steam boiler.

Description

Gas-turbine electric power plant is distinguished by:

- optimal engineering factors and endurance characteristics;
- minimum quantity of maintenance staff;
- minimum production areas;
- minimum fuel consumption per 1 kW/h of the generated power among the competition in this power class;
- minimized maintenance and repair costs which ensure the lowest possible power and heat production costs.

Main technical data:

- Rated terminal power of the generator, MW — 16,3;
- Exhaust heat power with exhaust t =110 °C, Gcal/h — 19,48;
- Gas temperature behind the turbine (exhaust) — 481 °C;
- Gas flow behind the turbine (exhaust) — 56,26 kg/s;
- Equivalent operation sound level — not exceeding 80 dBA.

Fuel:

- natural gas;
- other type of fuel as agreed.

Advantages:

- Do not require neither expensive facilities building nor large groups of maintenance staff.
- Highly compatible assemblies are supplied which reduces the time for mounting, commissioning and start-up of the facilities.
- All equipment fully complies with environmental requirements regarding emissions and noise.
- The equipment can operate both in parallel circuit and in standalone mode, which increases significantly the facilities' energy safety level. It means that in case of emergency disconnection of the consumers from the supply network it can automatically shift to the local load thus preventing negative effects of failures in the power network.
- Short recoupment period — 3–5 years.
- Reliability.
- Maintenance is not time-consuming.
- High efficiency.

Standard technical data of a gas-turbine electric power plant by the example of a unit with the capacity of 22 MW

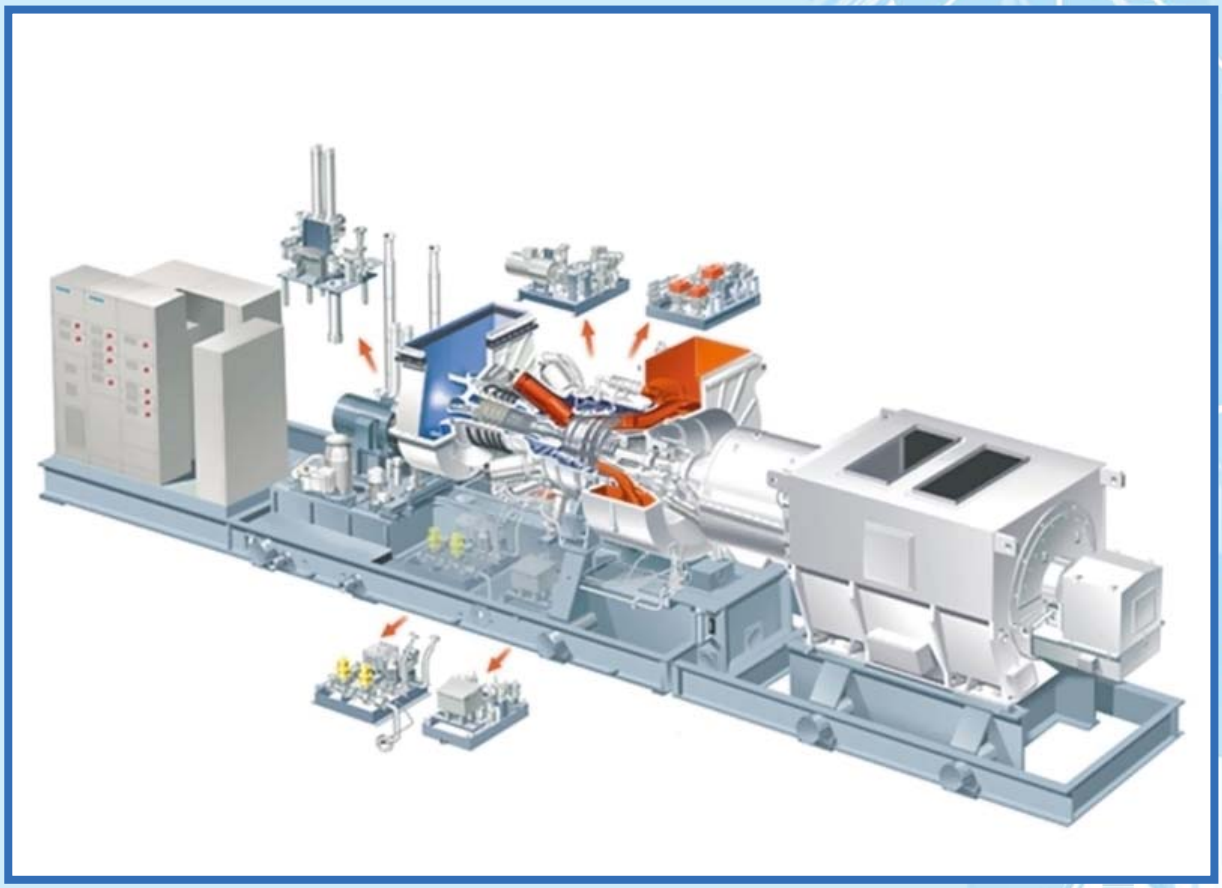
Gas-turbine units based on this engine are used in gas-turbine thermal power plants and combined-cycle power installations building. These units can operate in conventional cycle and also in combined (performance coefficient>50%) and cogeneration (performance coefficient >80%) cycles with combined power and heat generation.

Electrical efficiency, MW	22,5
Heat generator terminal voltage, kV	6,3/13,8
Thermal output, Gcal/h	24,3
Thermal efficiency (%): - without heat recovery - with heat recovery	 38,5 85,1
Hazardous emissions content in exhaust gases of GTE, not exceeding, mg/m^3	50
Overhaul period, hours	40 000
Service life limit, hours	200 000

Scope of application:

- Centrifugal compressors driving in oil and gas industry.
- Power generation.
- Combined heat and power generation (cogeneration).
- Power generation for oil and gas fields development, offshore production platforms and FPSO platforms.
- Power generation for oil transportation and refining complexes.

Standard layout of high-powered electric power plant by the example of a gas-turbine unit manufactured in Europe



Extra-high capacity power plants — over 50 MW

Serve for centralized power and heat supply of large industrial facilities, separate areas in big cities and whole populated localities. Generally, this type of units is used for combined power generation process (combined heat and electric power production, CHP).

CHP-plants are used as main heat and power supply sources. Extra-high capacity CHP-plants are equipped with turbines fed with heavy fuel and gas.

Main CHP-plant assemblies:

- engines as CHP-plant power units;
- electric power generators;
- CHP-plant heat exchangers;
- cooling towers with catalyzers;
- oil-circulating system;
- air duct system;
- firefighting systems;
- switchboards;
- CHP-plant transformers;
- network control device;
- control boxes.

Special features of extra-high capacity CHP-plants:

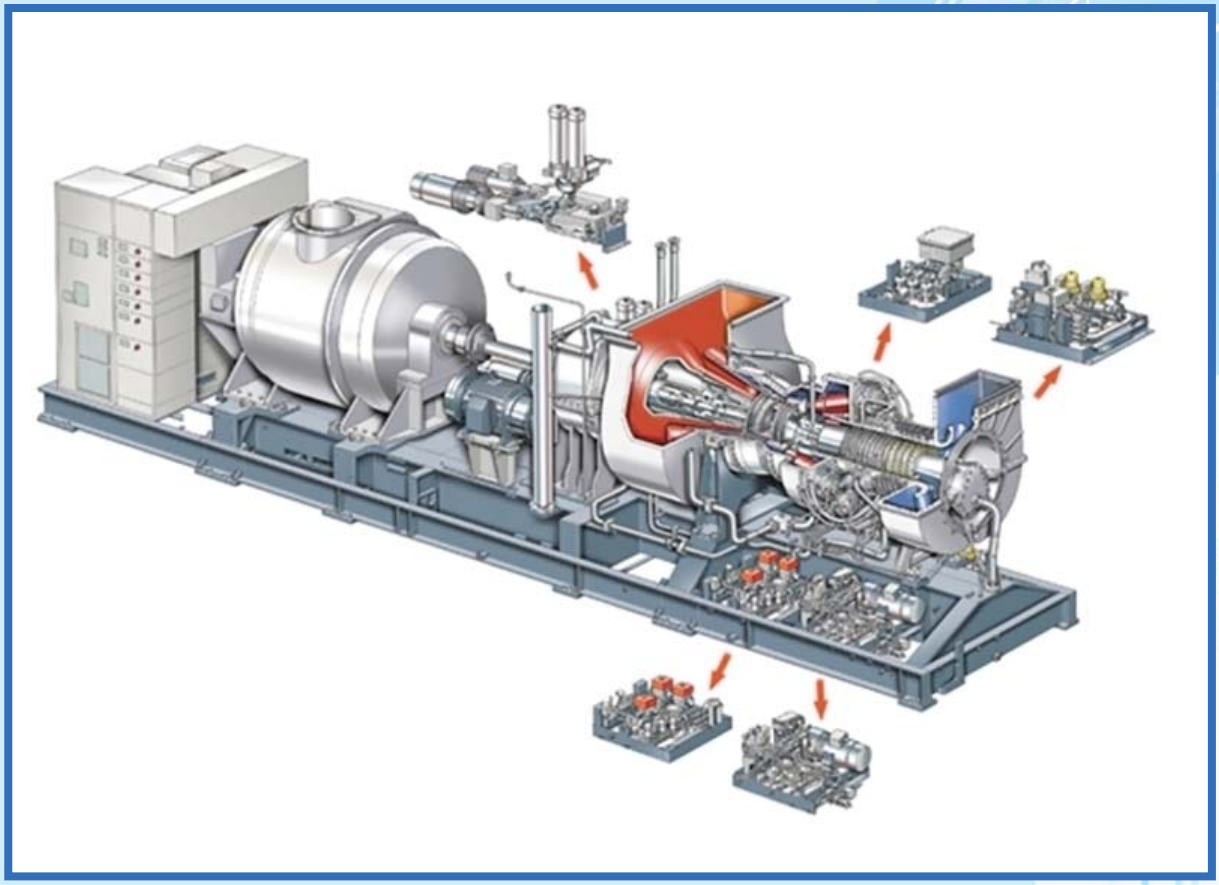
- Low cost of generation of 1 kW, in relation to the overall operational period;
- Best performance regarding hazardous emissions among power generating equipment with the capacity of 35 – 60 MW, at load 50 – 100%.
- Shifting from one type of fuel to another disconnection;
- Immediate load dump is possible;
- Maintenance adjustability (replacement of turbine parts).

Standard gas-turbine engines used in turbine electric power plants

Standard technical data of a gas-turbine electric power plant with the capacity of 50 MW

- Fuel: natural gas, liquid fuel, dual-fuel system, using other types of fuel;
- Current frequency: 50 — 60 Hz;
- Electrical efficiency — 37,5%;
- Thermal output — 9 597 kJ/kW/h;
- Turbine rotation speed — 6 608 rpm;
- Compressor pressure ratio — 19:1;
- Exhaust gas flow/temperature — 131,5 kg/sec, 544°C;
- NOx emissions (15% O_2, dry emissions) — ≤15 ppm

Standard layout of extra-high powered electric power plant by the example of a gas-turbine unit manufactured in Europe



Standard gas-turbine engines used in low-powered units by the example of gas turbine with the capacity of 5,25 MW

This type of turbine is a simple and modern structure mounted in a compact casing. It is produced in one- and two-shaft variants.

Rated electrical power of the gas turbine: ISO 5,25 MW

Turbines of this type are high-performance power generating units and can be fed with a wide range of liquid and gas fuel.

Scope of application:

- power generation;
- combined heat and power generation (cogeneration).
- power generation for oil and gas fields development, offshore production platforms and FPSO platforms.

Advantages:

- reliable structure which ensures high load endurance and constant power generation;
- cost-efficient price/capacity balance;
- perfect characteristics of load acceptance and load dump which provide a reliable performance in different fields of application;
- low-emission fuel combustion system;
- simple maintenance;
- short disconnection time.

Technical data:

- output power of 5,25 MW;
- turbines with the capacity of 4,35 MW, 4,7 MW and 5,05 MW are also available;
- fuel: natural gas / liquid fuel / dual-fuel system; other types of fuel upon the request;
- automatic shift from one type of the fuel to another with any load;
- frequency — 50/60 Hz;
- electrical efficiency — 30,5%;
- thermal output — 11 815 kJ/kW • h;
- turbine rotational speed — 17 384 rpm;
- compressor pressure ratio — 14,6:1;
- NOx emissions (15% O_2, dry emissions) — <25 ppm

Standard gas-turbine engines used in high-powered units by the example of gas turbine with the capacity of 24,77 MW

This is a vigorous gas turbine with a long life cycle which is perfectly fit for operation in any ambient conditions. The gas turbine is a compact two-shaft unit, its electrical efficiency is 34,2%. The turbine can consume a wide range of fuel: gaseous and different types of liquid fuel.

Scope of application:

- Power generation.
- Combined heat and power generation (cogeneration).
- Power generation for oil and gas fields development, offshore production platforms and FPSO platforms.
- Power generation for oil transportation and refining complexes.

Advantages:

- low-emission fuel combustion system;
- high thermal efficiency;
- long working time;
- multipurpose application of the gas-turbine units;
- cycle and constant operation, as well as operating in peak-load conditions;
- maintenance or gas-turbine engine replacement directly at the operating site of the unit;
- wide range of fuel consumed, shift from one type of fuel to another is made without disconnecting;
- load dump is possible;
- all the components are supplied by the manufacturer after previous tests.

Technical characteristics:

- output power — 24,77 MW;
- fuel: natural gas / liquid fuel / dual-fuel system; other types of fuel upon the request;
- frequency — 50/60 Hz;
- electrical efficiency — 34,2 %;
- thermal output — 10522 kJ/kW • h;
- turbine rotational speed — 7700 rpm;
- compressor pressure ratio — 14,0:1;
- exhaust gas flow / temperature — 80,4 kg/sec, 543 °C;
- NOx emissions (15% O_2, dry emissions) — ≤ 25 ppm.

Standard gas-turbine engines used in extra-high powered units by the example of gas turbine with the capacity of 50 MW

This is an extra-high powered gas turbine with a long life cycle which is perfectly fit for operation in any ambient conditions and has low maintenance expenses. Electrical output power of the gas turbine is 50 MW. The turbine consumes a wide range of fuel. A large amount of generated heat used for combined generation process permits to employ this turbine in different branches of industry.

Scope of application:

- power generation;
- combined heat and power generation (cogeneration).

Advantages:

- low costs in relation to the complete operational period;
- the unit is manufactured according to international regulations, standards and rules;
- all the components are supplied by the manufacturer after previous tests;
- best performance regarding hazardous emissions among power generating equipment with the capacity of 35-60 MW, with the load of 50-100%;
- high production efficiency;
- one-shaft variant (with two segmental bearings), cold-end drive, third-generation emission reduction system;
- shift from one type of fuel to another is made without disconnecting;
- immediate load dump is possible;
- maintenance adjustability (replacement of turbine parts);
- software for monitoring and remote control of the system operation (E-Service Applications).

Technical data:

- output power — 50 MW;
- fuel: natural gas / liquid fuel / dual-fuel system; other types of fuel upon the request;
- current frequency — 50/60 Hz;
- electrical efficiency — 37,5%;
- thermal output — 9 597 kJ/kW•h;
- turbine rotational speed — 6 608 rpm;
- compressor pressure ratio — 19:1;
- exhaust gas flow / temperature — 131,5 kg/sec, 544°C;
- NOx emissions (15% O_2, dry emissions) — ≤15 ppm.

Services rendered by Veya Investments Limited:

1. Development, engineering, gas-pumping units and compressor stations selection according to the Customer's requirements, engineering consulting.
2. All kinds of engineering and design services including energy audit, designer supervision and project feasibility study.
3. Equipment delivery and OEM parts supply within the warranty and post-guarantee periods.
4. Ensuring reliability, safety and conformity with the required performance characteristics.
5. Installation supervision, commissioning and start-up, facility handover to the Customer on a turnkey basis.
6. Customer's equipment upgrade. Reliability and performance improvement. Maintenance costs reduction. Power generation projects development and financing assistance.
7. Overall equipment diagnostics. Mechanical section optimization and equipment power settings improvement.
8. Customer's staff training, skill development, periodic training which takes place either at the manufacturing plant or at the Customer's site.
9. The supplied equipment working state monitoring during the post-guarantee period, working out the recommendations on repair and maintenance upon the demand of the Customer. Overall planning and total overhaul term defining.
10. Permanent structures and temporary assembly shelters for machinery building, generation facilities construction on a turnkey basis.

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