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The State Concern





GAS TURBINE ENGINES FOR GAS PIPELINES

ZORYA–MASHPROEKT

IN THE MARINE, POWER AND GAS INDUSTRY

The State Enterprise “ZORYA”-“MASHPROEKT” Gas Turbine Research & Production Complex has a 60-years experience in designing & production gas turbines for Navies, commercial and passenger vessels, power plants and gas piping units and drivers for production equipments. Since 1953 over 4500 marine & industrial gas turbines have been produced and supplied.

Ships of 20 countries worldwide, over 60 power plants, more than 150 gas pipelines compressor stations in Ukraine, China, Kazakhstan, Belarus, Czechia, Canada, Azerbaijan, Iran, Russia, USA, Ghana and other countries are equipped with “ZORYA”-“MASHPROEKT” gas turbines. The total power of the turbines exceeds 500 million kW and total firing time over 110 million hours.

According to gas companies statistics, the gas pumping units (GPU) driven by our gas turbines have been acknowledged most reliable comparing to driven by another companies. They have highest mean value of technical utilization coefficient, maximum time between failure and the highest availability factor.

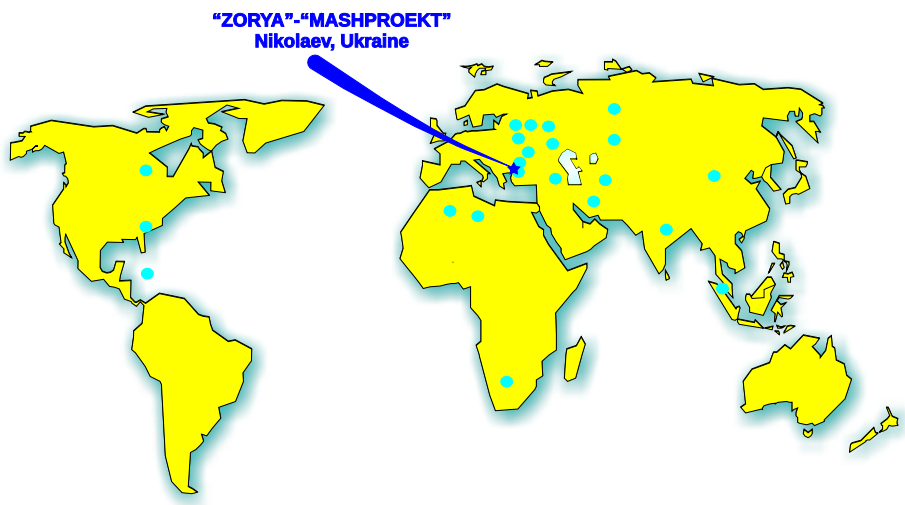
Owing to the constant work on support and upgrade of the technical level, many turbines exceeded 80000 firing hours without factory repair. UGT16000 second generation leading turbines have accumulated over 100000 hours. UGT15000 third generation leading turbines have accumulated over 85000 hours, UGT25000 fourth generation turbine - over 60000 hours, UGT10000 fourth generation turbine has been put in to trial-commercial operation at Kirovogradskaya compressor station (Ukraine) in 2002 and already have accumulated 35000 working hours.

“ZORYA”-“MASHPROEKT” gas turbines were created for naval applications; they are also adjusted for working off-shore, on floating & stationary oil & gas platforms.

The specialist of “Mashproekt” (Scientific Research & Experimental-Design Works Center) is constantly working at creating new & upgrading early-developed gas turbines widely using modern sophisticated CAD\CAM systems.

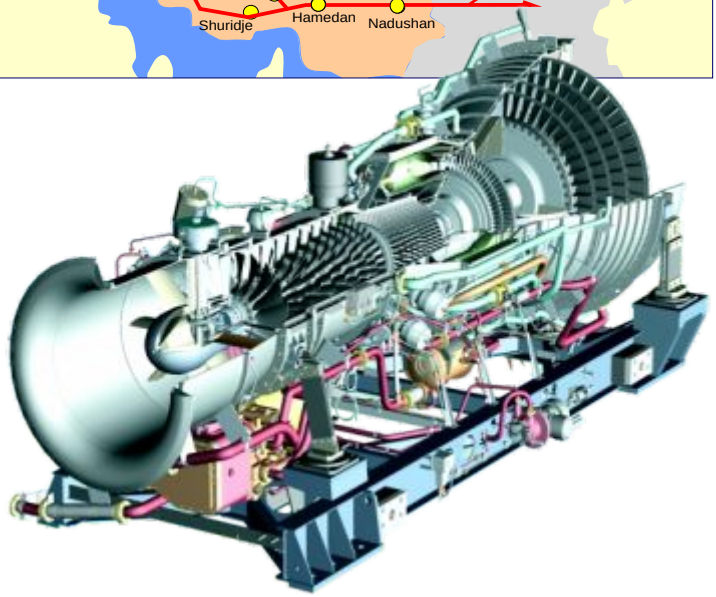
“ZORYA”-“MASHPROEKT” facilities & laboratories have been equipped with up-to-date tools, equipment & technologies, the personnel there is well trained. High-temperature steel & alloy precision casting, precise isothermal & impulse extrusion, electro-beam welding, electro-beam & plasma coatings, laser cutting, electric methods of metal treatment-these make an incomplete list of advanced technologies applied at the enterprise.

The specialist of the complex perform contract supervision, adjustment & alignment, guaranteed maintenance of prototype & stock-produced items on-site of the customer, and also after-sale maintenance through the whole service life.

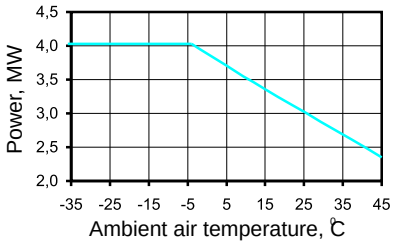


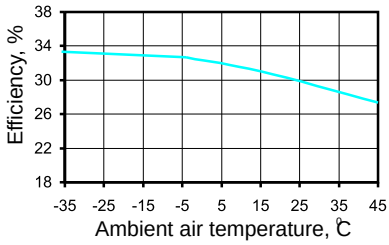
GAS PIPELINE COMPRESSOR STATIONS EQUIPPED WITH "ZORYA"-"MASHPROEKT" GAS TURBINE ENGINES

DR59	GPU-10	364 units
UGT 16000		
DJ59	GPU-16	116 units
DJ59	Modern. GPA 25/76	12 units
DJ59	Modern. GTK-10-4	16 units
UGT 3000		
DE76		1 units
UGT 6000		
D"71	GPA-C-6,3S	18 units
DT71	GPA-C-6,3	22 units
UGT 10000		
DN70	Modern. GPU-10	1 units
DN70	Modern. GTK-10-4	1 units
D"70	GPA-8-S	8 units
DU70	GPU-16K (Aquarius)	1 unit
UGT 15000		
DG90	GPA-C-16S	304 units
DG90	Modern. GTK-10-4	22 units
DG90	Modern. Coberra-182	10 units
DG90	Replacement Avon	2 units
UGT 25000		
DU80	GPA-C-25S	135 units
DN80	GPA-25/76	117 units



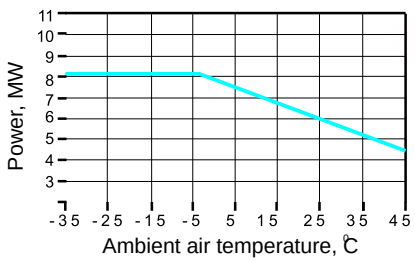
UGT 3000
(DE76)

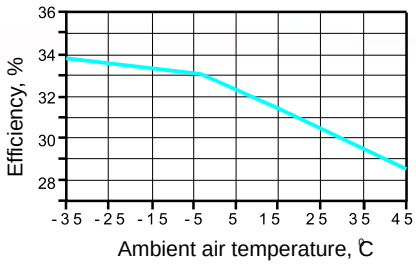




Power, kW	**3360**	Exhaust gas temperature, ℃	**420**
Efficiency, %	**31,0**	Dimensions (LxWxH), m	**2,5x1,3x1,25**
Fuel gas consumption, nm³/kW-h	**0,324**	Weight, ton	**2,5**
Exhaust gas mass flow, kg/sec	**15,5**	Produced	1 unit

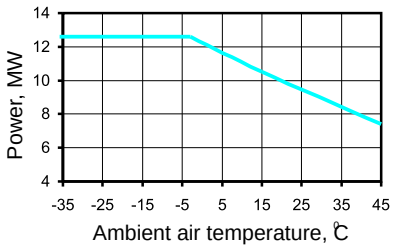
UGT 6000
(DT71)

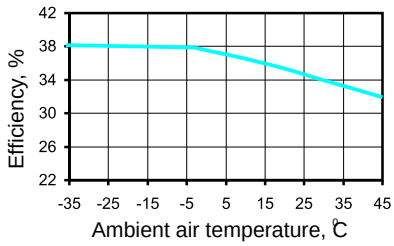




Power, kW	**6700**	Exhaust gas temperature, ℃	**428**
Efficiency, %	**31,5**	Dimensions (LxWxH), m	**4,6x1,8x1,8**
Fuel gas consumption, nm³/kW-h	**0,319**	Weight, ton	**4,5**
Exhaust gas mass flow, kg/sec	**31,0**	Produced	37 units

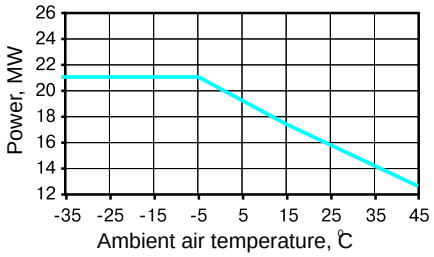
UGT 10000
(DN70, DI70, DU70, DT70)

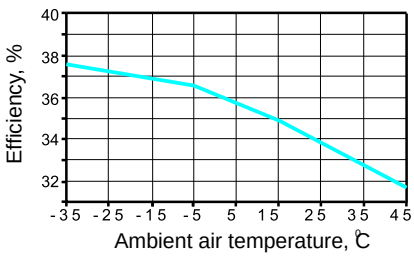




Power, kW	**10500**	Exhaust gas temperature, ℃	**420**
Efficiency, %	**36,0**	Dimensions (LxWxH), m	**4,0x1,8x1,7**
Fuel gas consumption, nm³/kW-h	**0,279**	Weight, ton	**5,0**
Exhaust gas mass flow, kg/sec	**36,8**	Produced	11 units

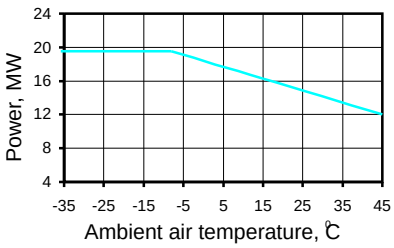
UGT 15000
(DG90)

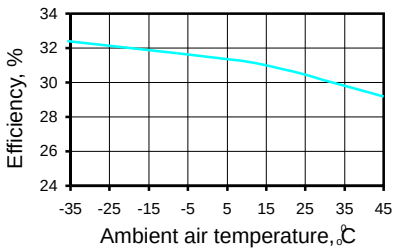




Power, kW	**16700**	Exhaust gas temperature, ℃	**414**
Efficiency, %	**35,0**	Dimensions (LxWxH), m	**4,7x2,1x2,2**
Fuel gas consumption, nm³/kW-h	**0,287**	Weight, ton	**9,0**
Exhaust gas mass flow, kg/sec	**72,2**	Produced	3 48 units

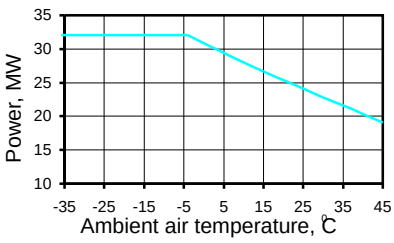
UGT 16000
(DJ59)

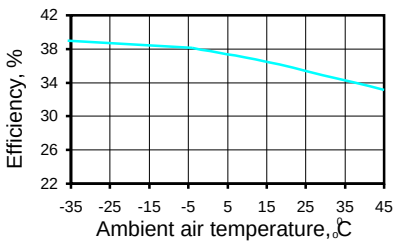




Power, kW	**16300**	Exhaust gas temperature, ℃	**354**
Efficiency, %	**31,0**	Dimensions (LxWxH), m	**5,9x2,1x2,4**
Fuel gas consumption, nm³/kW-h	**0,324**	Weight, ton	**13,5**
Exhaust gas mass flow, kg/sec	**98,5**	Produced	144 units

UGT 25000
(DI80, DN80, DU80)





Power, kW	**26700**	Exhaust gas temperature, ℃	**484**
Efficiency, %	**36,5**	Dimensions (LxWxH), m	**6,4x2,5x2,7**
Fuel gas consumption, nm³/kW-h	**0,275**	Weight, ton	**16,0**
Exhaust gas mass flow, kg/sec	**89,0**	Produced	232 units

“ZORYA”-“MASHPROEKT” GAS TURBINES FOR NEW & MODERNIZED GAS PUMPING UNITS

Experience of using “ZORYA”-“MASHPROEKT” gas turbines as integrated parts of gas pumping units achieves over 30 years. To date most of the gas pumping units based on the DR59 gas turbine has exhausted their service life. The specialists of the company have developed the concept of using the third & fourth generation gas turbines in gas pumping units of compressor stations under construction & modernization for drive replacement, both domestic & foreign ones.

34 modernization projects have been developed for gas pumping units in operation. They include replacement of out-of-date drives with exhausted life by modern, more economical “ZORYA”-“MASHPROEKT” gas turbines. As a result of such reconstruction, at the working compressor station the modern technical level is being provided something nonstop. The greatest economical effect attributes to the upgrading of the working compressor shops in the conditions, when the new shop construction is either impossible or extremely difficult (in the mountainous pipeline sections, frozen grounds of the Extreme North, in the swamped territories when there are problems with land a purchasing).

“ZORYA”-“MASHPROEKT” performs projects of on-site drive adjustment in the units under upgrading. It also prepares equipment sets document necessary for gas pumping units upgrading. They include field changing of the equipment available on site (blowers, supports, air intake devises, exhausters, serving the auxiliary equipment). By the customer's desire, the experts of the company can perform automatic control system engineer's project of the units under upgrading.

To increase independence of the compressor stations work when the outer power source is off & with the purpose to decrease cost on buying electric power, “ZORYA”-“MASHPROEKT” suggests using free space after out-of-date engines removed for construction own power station for providing compressor station uninterruptible power supply. “ZORYA”- “MASHPROEKT” offers power stations with rated power 2.5, 6, 16, 25 MW as well as turbo-expander generating sets.

UGT 3000

The **UGT3000** gas turbine modification **DE76** with speed 9700 rpm was developed for the direct drive “Prague Energo” 3RSC56/3RSD56 centrifugal compressor without gearbox. This unit is used for gas pumping in and out at underground gas storage in Czech.

The turbine has absolutely new two channel burners for NO_x reduction and a special cage design with many layer sound isolation.

Gas pumping unit driven by DE76E at Stramberk underground gas storage engine room

UGT 6000

Gas pumping unit GPA-C-6,3S with DT71 gas turbine

The **UGT6000** gas turbine modification **DT71** is used in GPA-C-6,3S unit produced by the “FRUNZE” company as serial production. It is also used to replace NK-12ST aeroderivated engine while upgrading GT-750-6 gas pumping units.

This gas turbine is possible to be used for upgrading GTN-6 and GT-6-750 units produced by Russian company “Turbomotorworks”.

GPA-C-6,3 with DT71 gas turbine at Dikanka compressor station, Ukraine.

UGT 10000

The **UGT10000** fourth generation gas turbine has been developed with several modifications:

DN70L with 4-stage left-rotated power turbine and rated speed **4800 rpm** for GTK-10-2, GT -10-4 and G–U-10 gas pumping units upgrading;

DI70P with 3-stage right-rotated power turbine and rated speed **6500 rpm** for GT -10-I gas pumping units upgrading;

DI70L with 3-stage left-rotated power turbine and rated speed **6500 rpm** for GT-750-6 gas pumping units upgrading;

Dt70 with 3-stage right-rotated power turbine and rated power **8 MW** at speed **8200 rpm** and ambient temperature 25 C;

DU70L gas turbine with modernized flowing part to the power of 16MW by means of steam injection with 4-stage left-rotated power turbine and rated speed **4800 rpm** is used in “Aquarius” GPU-16K unit.

DN70L gas turbine in the modernized GTK-10-4 gas pumping unit at compressor station Kirovogradskaya, Ukraine

DN70L gas turbine unit for modernization GPU-10 at compressor station Romnenskaya, Ukraine

Container with gas turbine is manufactured with highest noise insulation degree. Turboblock and air inlet unit integral design gives opportunity to reduce building and assembly jobs period.

Gas compressor lubricating is integrated with gas turbine lubricating oil system, this design gives opportunity to exclude electrically driven pump.

One of the features of this upgrading is the new gas turbine мbuilding ino the acting design scheme of the original unit maintaining all of its functions including house generating drive & united lubricating oil system.

Frequency converter provides constancy of the frequency of the electrical energy produced by the house generator. This converter is used also for gas turbine starter control and provides smooth gas pumping unit starting.

UGT 15000

The UGT 15000 gas turbine engine has the following modifications:

DG90L, DG90L2 with power turbine frequency **5300 rpm** of left rotation to be used in new GPUs of compressor shops:

GPA-C-16S - developed by "Frunze" company (Sumy, Ukraine);
GPA-16 "Ural" - developed by "Iskra" company (Perm, Russia);
GPA-16 "Volga" (Kazan, Russia);
GPA-16 "Neva" (St. Peterburg, Russia);
while upgrading GPUs increasing the drive power:
GTK-10-4 (GTK-10-2) developed by NZL (St. Peterburg, Russia)
GPU-10 developed by "ZORYA”-“MASHPROEKT" (Nikolaev, Ukraine),
GPU-16S developed by "Frunze" company (Sumy, Ukraine).

GPU-10 (GPU10-01) upgrading is held by means replacing DR59L second generation engine rating at 10 MW & efficiency of 27% with DG90L rating at 16 MW.

While upgrading new DG90L installation provided housed in the finished serial block from the reserve recourse stock.

They perform upgrading or replacement of the blower supercharger, complex air cleaner, gas exhaust path, automatic control system, as well as ventilation, fuel & lubrication systems changes.

At Vyngapurovskaya compressor station there's also a shop equipped with upgraded GPA-C-16S units powered by DG90L2.

DG90L2 engines as part of new gas pumping units are used by gas transportation & production companies of Ukraine, Russia, Belarus, Turkmenistan (over 150 engines, as well as to power ammonia compressors at Odessa Port Plant (two engines).

"ZORYA”-“MASHPROEKT" has totally produced over 350 UGT15000 engines in different modifications. The leading engines at Surgutgasprom compressor station have accumulated over 75000 fire hours.

GPA-C-16S with UGT 15000 gas turbine at Novopetrovskaya compressor station, Yamburg, Russia

GPA-C-16S with UGT 15000 gas turbine at Slonim compressor station, Belarus

UGT 16000

By their design & parameters turbines of **UGT16000** family (DR59, DJ59) are of the second generation, but they have proved themselves as the most reliable at the gas pumping stations.

10MW **DR59** with efficiency of 28% is used in GPU-10 & GPU-10-01. "Zorya"-"Mashproekt" and "KRTZ VOSKHOD" have produced 536 turbines totally. The leading DR59 turbines have accumulated over 100000 firing hours.

DJ59 with efficiency 30% and rated power 16MW is used in GPU-16 developed by Ukrainian company "FRUNZE". Totally over 120 units like this have been manufactured.

Beginning in 1992, DJ59L2 have been widely used for replacing out-of-date drives while upgrading GT -10-4 & GPU-25/76 units developed by "Nevskiy Zavod" from St. Petersburg, Russia, and replacing COBERRA-182 gas generator from Cooper-Rolls company. 33 DJ59L2 turbines are working in the upgraded units at 9 compressor stations.

Compressor station with UGT 16000 gas turbines construction in Iran

UGT 25000

UGT25000 fourth generation gas turbine also has several versions of power turbines in speed & rotation direction:

DN80L with speed of **3300 rpm** is used for upgrading GPA-25/76 at Ukrainian & Russian gas pipelines as well as at underground gas storages in Gasly (Uzbekistan).

DI80P with speed of **4850 rpm** & right rotation is intended to replace MS5003 engines (manufactured by General Electric) in GT-25I units produced Nuovo Pignone.

DU80L with speed **4850 rpm** and left rotation is intended for "URAL GPA-25S" and GPA-25S gas pumping units manufactured by Russian company "ISKRA" and Ukrainian company "FRUNZE".

Over 110 DN80L and over 150 DU80L gas turbines have been produced and leading turbine has been accumulated over 60000 firing hours.

URAL GPA-25S with UGT 25000 gas turbine at Tayozhnaya compressor station, Yamburg, Russia

GPA-C-25S with UGT 25000 gas turbine at Potaveh compressor station, Iran

Modernized gas pumping unit GPA-25/76 in the engine room of Sofievskya compressor station, Ukraine

MAIN SET OF DELIVERY

Gas turbine unit is suitable for out-of-door installation, has modular design and consists of several complete modules
The modules are shipped pre-assembled at the factory and the set consists of the following modules:

Gas Turbine Engine Module, comprising:
- Heat and noise attenuating enclosure on module base frame;
- Gas Turbine Engine;
- Adapter supports for engine installation on the base frame;
- Rubber diaphragm;
- Exhaust duct (upward elbow with cone nozzle peace, telescopic joint with GTE, supports, heat insulation and lining);
- Lubricating oil skid;
- Engine module internal piping and wiring;
- Engine module electric equipment units;
- Vibration sensors cables and signal conditioner/amplifier;
- Pulsation sensors cables and signal conditioner/amplifier;
- Engine and lubricating oil skid compartments electric heaters;
- Lubricating oil skid compartment ventilation fan;
- Supply fans unit of engine module forced ventilation system (with silencers, inlet air filter, service platform);
Exhaust duct to enclosure penetration assembly (with compensator, silencers and cooling air outlet duct);
- Engine inlet air silencer.

- Engine lubricating oil cooler air-type Module.
- Fuel control / Fire-fighting Module.
- Electric Equipment Module.
- Self-cleaning Inlet Air Filtration Module.
- Exhaust stack with heat insulation and lining Module.
- Power shaft between engine and centrifugal gas compressor with coupling.
- Set of installation parts.
- Inter-module connections.
- GTU set of spare parts for start-up and commissioning.
- GTU individual set of spare parts for two years operation.
- GTU group (capital) set of spare parts for two years operation of group of Units.
- Group set of tools and fixtures.

Set of Operation and Maintenance Manuals.

GAS TURBINE ENGINE MAIN SYSTEMS

Lubrication system

Lub-oil system provides lubrication of all gas turbine and auxiliary bearings and gears. The lub-oil system is of forced circulating type supplies oil in and pumps it out from bearing units due mechanically driven built-in auxiliary pumps. When starting the engine, electrically driven pumps provide oil until sufficient parameters exist for the built-in pumps to take over.

The following lubricating oils can be used in the engine:

- MS-8P as per OST 38.01163, Shell Turbo Oil ISO 3448 or equivalent.

Fuel system

Fuel system provides controllable fuel supply to atomizers of combustion chamber, fuel ignition while start process and sustain the desired operational rate. Fuel - natural gas with Hu=8,555 kcal/Nm.

Starting system

Starting system of electrical type provides initial rotation of assemblies, fuel initial ignition in the firing tubes and disconnects after fulfilment the start process.

Pneumatic system

Pneumatic system provides control of gas turbine built-in auxiliary gears during start & stop process, turbine normal working, gears blocking and protection during abnormal conditions. All systems developed by “ZORYA”-”MASHPROEKT” and adopted for operation with automatic control and monitoring system.

Automatic control and monitoring system

Automatic control and monitoring system is microprocessor type, has state-of-the-art-design and based on best marine system equipment suppliers.

Automatic control and monitoring system main purposes are:
- performing all the algorithms of gas turbine and other components of the unit;
- monitoring of all the parameters of the unit;
- information of operating staff on current status of the unit, including the emergency governing, alarms, records and diagnosis.

This valuable information can then be used for trend analysis and maintenance planning.

SOPHISTICATED CYCLE INSTALLATIONS FOR GAS PUMPING

It increases efficiency & power of the units, decreasing contaminant emission in combustion products. Thus, 16MW gas pumping unit GPU-16K driven by UGT10000 gas turbine working in a heat recovery unit of “Aquarius” type with energetic & ecological steam injections and water recovery from combustion products. First GPU-16K is in service at Stavishchenskaya compressor station, “Cherkassytransgas”, Ukraine.

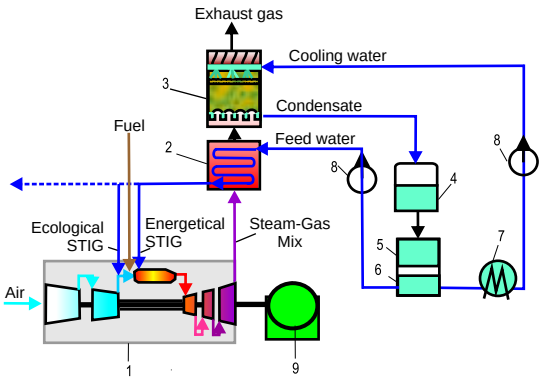
The merits of the “Aquarius” are high efficiency up to 43% in ISO condition and low emission. The NO_x emission levels for 25MW installation equal to 25 ppm at rated power and for 16MW installation they are 35 ppm. CO emissions amount to 30 ppm.

The steam generated in the waste heat recovery boiler is used for generating additional power and for NO_x/ CO suppression down to 25/30 ppm.

In the contact condenser, which is installed at the top of the waste heat recovery boiler water condensation and recovery out of the steam and gas mixture occur. The “Aquarius” type installations are capable of generating additional fresh water as a result of chemical reaction by fuel burning in the gas turbine when the cooling water in the installation inlet is lower than 30 centigrade.

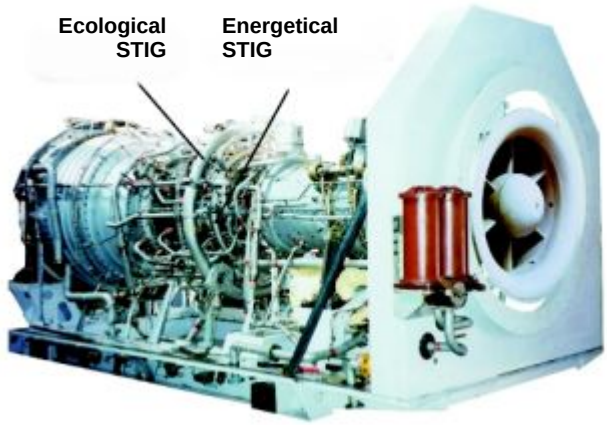
An experimental 25 MW “Aquarius” installation has been successfully operates since 1995 and has accumulated over 20000 working hours at the test facility.

“AQUARIUS” Installation Diagram



1 - gas turbine
2 - waste heat recovery boiler
3 - contact condenser
4 - condensate collector
5 - condensate cleaning unit
6 - feed water tank
7 - water cooler
8 - pump
9 - gas compressor

Gas pumping unit GPU-16K at Stavishchenskaya compressor station, Ukraine



UGT10000 (DU70L) gas turbine with STIG

■ AFTER-SALES SUPPORT

Guarantee and after-sales support is an important part of reliable and long-term operation of our equipment.

Services consist of engineering services and consultations during Customer's fulfillment of work as below:

- installation of GTE and auxiliary systems;
- commissioning and putting into operation;
- GTE operation (during a guarantee period and then during any period of time);
- GTE maintenance;
- routine repair of separate components of GTE and auxiliary equipment;
- GTE disassembly during the delivery for repair.

After-sales support:

- selection and delivery of spare parts and consumables;
- training of maintenance personnel in equipment operating procedure and service regulations.

We are constantly are constantly developing and improving our services.





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