



INDUSTRIAL GAS TURBINES FOR POWER GENERATION



ZORYA-MASHPROEKT

GAS TURBINE UNITS FOR EFFECTIVE POWER GENERATION

Over fifty years SE GTR&PC «Zorya» - «Mashproekt» has been engaged in delivery of gas turbine units for marine application, gas pipeline systems and power generation. Quality, proven by sea, provides high reliable and efficient engine operation during power generation.

Total number of gas turbine units exceeds 4,000 units, with total power – more than 50, 000 MW and accumulated operating time – over 110 million firing hours.

Being in operation in power sector since 1969, «Zorya»-«Mashproekt» has a park of engines of more than 450 units with overall power more than 6,000 MW with accumulated operating time over 36 million hours.

Purchasing equipment produced by our enterprise, the Customer with the help of specialists from our enterprise shall obtain the following:

- optimum set of equipment taking into account specific features of the project;
- timely delivery of equipment;
- supervision during the equipment assembly and commissioning, training of personnel;
- warranty and post-warranty support within entire life time of the equipment;
- optimum modernization of equipment with expired life time.

In the interest of the Customer our enterprise all the time is engaged in the development and improvement of services. Satisfaction of technical requirements of the Customer is main task of maintenance department.

1. China National Offshore Oil Corporation (CNOOC).
6 MW simple cycle Gas Turbine Generator units with UGT 6000 for Weizhou terminal of CNOOC.

2. JSC «Belarusian Cement Works».
UGT 16000 combined heat and power plant for electrical power generation and drying process of raw materials during cement production at Kostukovich, Belarus.



3. Qeshm Island power and desalination plant.
UGT 25000 combined cycle gas turbine plant for electrical power generation and steam supply for desalination plant on Qeshm Island, Middle East.

4. China National Petroleum Corporation (CNPC).
16 MW simple cycle Gas Turbine Generator units for North Azadegan oil field power plant, Middle East.

5. JSC «Mozyr Oil Refinery».
UGT 16000 combined heat and power plant for electrical power generation and steam supply for process applications at Mozyr, Belarus.



Automatic control system

Automatic control system (ACS) is one of the most important parts of GTU that offers all functions of control, governing, protection and monitoring of GTU itself and its auxiliary equipment.

Our gas turbine power generating units are equipped with microprocessor based automatic control systems on the base of software and hardware of leading world manufacturers: «Allen Bradley», «Siemens», «GE Fanuk», «Woodward».

«Zorya»–«Mashproekt» is engaged in development, manufacture, delivery and commissioning of ACS of its own make, as well as provides after-sales support during operation.

ACS delivered by us guarantees flexibility of software and has a possibility to integrate into upper level control system.

ACS is easy to maintain - Customer's trained staff performs work on ACS by himself.

By Customer's request ACS is able to provide remote monitoring that makes possible to evaluate condition of equipment without visit of power plant by specialists, to obtain consultations if contingency situations occur.

Applied fuel

Our enterprise improves its Products all the time to run on various grades of fuel. Power generating units running on various types of fuels with transition from one type fuel to another on operating unit have been developed and delivered.

Natural gas is the most cost efficient fuel per generation of 1 kW hr of energy. Meanwhile, in some cases to provide trouble-free operation of power generating sets during natural gas pressure reduction, turbogenerator's operation on liquid fuel shall be provided.

For this purpose at the enterprise dual fuel design has been developed.

Dual fuel technology allows transfer from natural gas to technological gas or diesel fuel or another type of liquid fuel without engine stoppage.

Reliable and efficient operation of dual fuel engines serves as evidence of effectiveness of applied technology.

Use of natural gas for power generation is widely spread. Furthermore, many regions remain without gas supply.

Dual fuel technology allows the Customer to generate power running on liquid fuel at the first stage of operation and then to transfer to natural gas when it becomes available.

All the time SE GTR&PC «Zorya»–«Mashproekt» has been working on improvement of ecological indexes of gas turbine power plants.

INDUSTRIAL GAS TURBINES FOR ELECTRIC GENERATORS' DRIVE

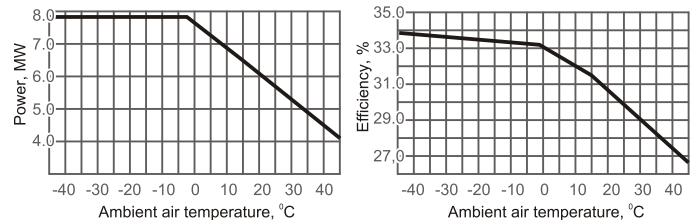
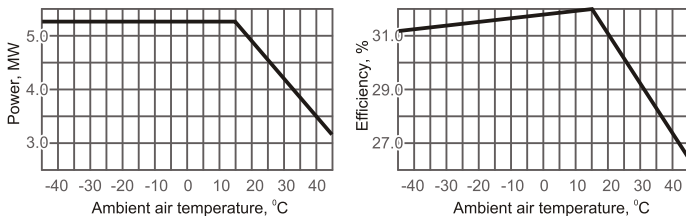
UGT 5000 DGT-5 model

- Single-shaft gas turbine with integrated gearbox
- Compressor – axial-centrifugal, 10 axial, 1 centrifugal stage
- Combustion chamber – silo-type 8 combustion liners
- Turbine – axial, 3 stages, turbine speed - 12,840 rpm
- Gearbox output shaft speed - 3,000 rpm
- Start – turbocompressor rotor spinning by two AC electric motors with continuous power of 132 kW each



UGT 6000 DT71 model

- Three-shaft gas turbine combines with two-spool turbocompressor and free power turbine
- Compressors - axial, 8 stages LPC, 9 stages HPC
- Combustion chamber – can-annular, reverse flow with 10 combustion liners
- 1 stage gas generator turbines
- 6, 4, 3 and 2 stages power turbine
- Start – LPTC rotor spinning by one AC electric motor with continuous power 30 kW



Engine technical data (ISO 2314)

	DGT-5	DT71
GTE power, kW	5,250	6,500
GTE efficiency, %	32.0	31.5
Specific fuel gas consumption (Hu = 8555 kcal/Nm ³), Nm ³ /kW h	0.314	0.319
Specific diesel fuel consumption (Hu = 10200 kcal/kg), kg/kW h	-	0.268
Total compressor pressure ratio	14.0	13.5
GTE exhaust gas mass flow, kg/s	21.5	30.5
GTE exhaust gas temperature, °C	480	430
GTE output shaft speed, rpm	12,840	7,200
Gearbox output shaft speed, rpm	1,500; 1,800; 3,000; 3,600	3,000

Characteristics of power plants in operating conditions

Installation	Cycle	Power, MW		Efficiency (FUF - fuel utilization factor)		Fuel consumption	
		electr. (e)	thermal	%	BTU / (kW·h)	natural gas, (Nm ³ /h) Hu=8,555 kcal /Nm ³	liquid, (kg/h) Hu=10200 kcal/kg
UGT 5000	Simple	4.87	-	30.3	11,260	1,620	
UGT 5000S	Co-generation	4.87	7.41	30.3(e) / 76.4(FUF)	11,260	1,620	
UGT 6000	Simple	6.0	-	29.5	11,560	2,045	1,715
UGT 6000S	Co-generation	6.0	11.0	29.5(e) / 83.6(FUF)	11,560	2,045	1,715

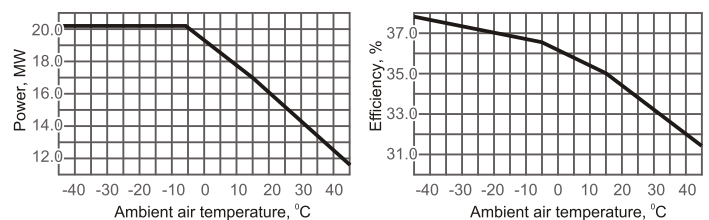
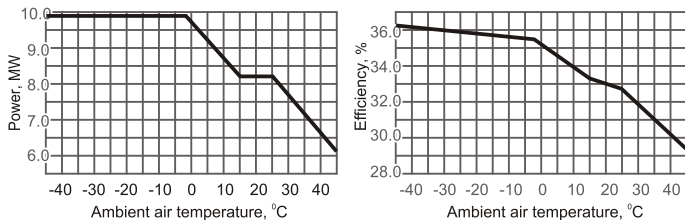
UGT 8000 DT70 model

- Three-shaft gas turbine combines with two-spool turbocompressor and free power turbine
- Compressors – axial, 9 stages LPC, 9 stages HPC
- Combustion chamber – can-annular, reverse flow, 10 combustion liners
- 1 stage gas generator turbines
- 3 stages power turbine
- Start – LPTC rotor spinning by one AC current electric motor with continuous power of 30 kW



UGT 15000 DB90 model

- Three-shaft gas turbine combines with two-spool turbocompressor and free power turbine
- Compressors – axial, 9 stages LPC, 10 stages HPC
- Combustion chamber – can-annular, reverse, flow, 16 combustion liners
- 1 stage gas generator turbines
- 4 and 3 stages power turbine
- Start – LPTC rotor spinning by two AC electric motors with continuous power of 30 kW each



Engine technical data (ISO 2314)

	DT70	DB90
GTE power, kW	8,300	16,900
GTE efficiency, %	33.2	35.0
Specific fuel gas consumption (Hu = 8555 kcal/Nm ³), Nm ³ /kW h	0.303	0.287
Specific diesel fuel consumption (Hu = 10200 kcal/kg), kg/kW h	-	0.241
Total compressor pressure ratio	16.6	19.5
GTE exhaust gas mass flow, kg/s	33.0	71.0
GTE exhaust gas temperature, °C	470	420
GTE output shaft speed, rpm	7,200	3,000
Gearbox output shaft speed, rpm	3,000	-

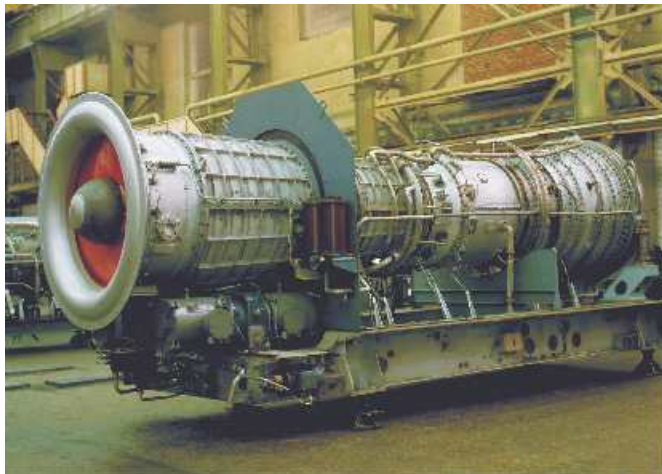
Characteristics of power plants in operating conditions

Installation	Cycle	Power, MW		Efficiency		Fuel consumption	
		electr. (e)	thermal	(FUF - fuel utilization factor)		natural gas, (Nm ³ /h) Hu=8,555 kcal /Nm ³	liquid, (kg/h) Hu=10200 kcal/kg
				%	BTU / (kW·h)		
UGT 8000	Simple	7.6	-	31.0	11,010	2,465	-
UGT 15000	Simple	16.0	-	33.5	10,190	4,800	4,030
UGT 15000S	Co-generation	16.0	25.0	33.5(e) / 85.8(FUF)	10,190	4,800	4,030
UGT 15000S2	STIG (steam-in-gas)	25.0	-	42.0	8,130	5,980	5,020
UGT 15000SS1	Combined	20.6	-	43.1	7,920	4,800	4,030
UGT 15000SS2	Combined	41.5	-	43.4	7,860	9,600	8,060

INDUSTRIAL GAS TURBINES FOR ELECTRIC GENERATORS' DRIVE

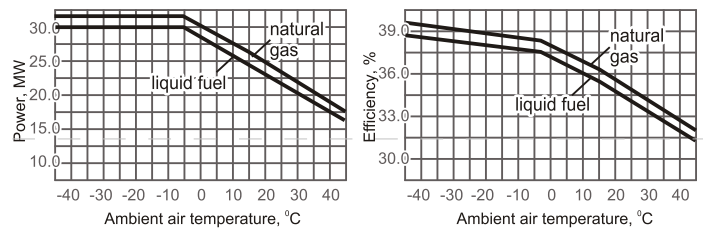
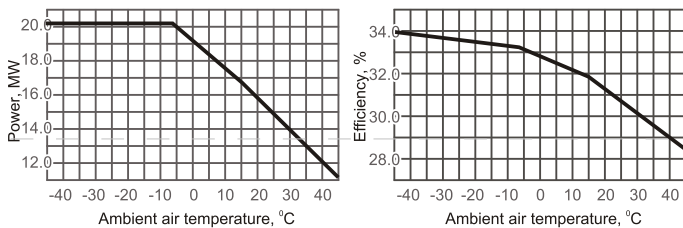
UGT 16000 **DJ59L3 model** has dual-fuel design

- Three-shaft gas turbine combines with two-spool turbocompressor and free power turbine
- Compressors – axial, 7 stages LPC, 9 stages HPC
- Combustion chamber – can-annular, straight-flow, 10 combustion liners
- 2 stages gas generator turbines
- 3 stages and 2 stages power turbine
- Start – LPTC rotor spinning by three AC electric motors with continuous power of 30 kW each



UGT 25000 **DG80 model** has dual-fuel design

- Three-shaft gas turbine combines with two-spool turbocompressor and free power turbine
- Compressors – axial, 9 stages LPC, 9 stages HPC
- Combustion chamber – can-annular, reverse flow, 16 combustion liners
- 1 stage gas generator turbines
- 4 stage and 2 stage power turbine
- Start – LPTC rotor spinning by two AC electric motors with continuous power of 45 kW each



Engine technical data (ISO 2314)

GJ59L3

DG80

GTE power, kW	15,900	26,200
GTE efficiency, %	31.4	36.3
Specific fuel gas consumption (Hu = 8555 kcal/Nm ³), Nm ³ /kW h	0.320	0.277
Specific diesel fuel consumption (Hu = 10200 kcal/kg), kg/kW h	0.269	0.232
Total compressor pressure ratio	12.5	21.5
GTE exhaust gas mass flow, kg/s	96.0	89.0
GTE exhaust gas temperature, °C	350	485
Power turbine speed, rpm	3,000	3,000

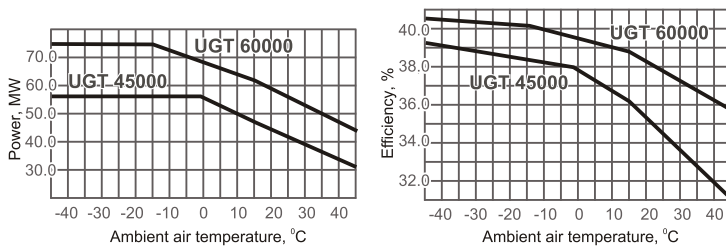
Characteristics of power plants in operating conditions

Installation	Cycle	Power, MW		Efficiency (FUF - fuel utilization factor)		Fuel consumption	
		electr. (e)	thermal	%		natural gas, (Nm ³ /h) Hu=8,555 kcal /Nm ³	liquid, (kg/h) Hu=10200 kcal/kg
					BTU / (kW·h)		
UGT 16000	Simple	15.0	-	30.0	11,380	5,030	4,220
UGT 16000S	Co-generation	15.0	26.0	30.0(e) / 82.0(FUF)	11,380	5,030	4,220
UGT 16000SS1	Combined	18.5	-	37.0	9,220	5,030	4,220
UGT 25000	Simple	25.0	-	35.0	9,750	7,180	6,020
UGT 25000S	Co-generation	25.0	37.0	35.0(e) / 86.8(FUF)	9,750	7,180	6,020
UGT 25000SS1	Combined	33.3	-	46.6	7,320	7,180	6,020
UGT 25000SS2	Combined	67.0	-	46.9	7,280	14,360	12,040



UGT 45000 ГТЭ45 model
UGT 60000 ГТЭ60А model

- Single-shaft gas turbine with gearbox
- Compressor – axial, 15 stages
- Combustion chamber – can-annular, reverse flow, 20 combustion liners
- Turbine – 4 stages
- Start – standard electric generator via thyristor converter



Engine technical data (ISO 2314)

ГТЭ45

ГТЭ60

GTE power, kW	47,700	63,500
GTE efficiency, %	36.1	38.8
Specific fuel gas consumption (Hu = 8555 kcal/Nm ³), Nm ³ /kW h	0.278	0.259
Compressor pressure ratio	14.0	18.0
GTE exhaust gas mass flow, kg/s	138.5	174.5
GTE exhaust gas temperature, °C	550	520
GTE output shaft speed, rpm	3,960	4,320
Gearbox output shaft speed, rpm	3,000	3,000

Characteristics of power plants in operating conditions

Installation	Cycle	Power, MW	Efficiency		Fuel consumption natural gas, (Nm ³ /h) Hu=8,555 kcal /Nm ³	
			electr.	%		BTU / (kW·h)
UGT 45000	Simple	45.0		34.4	9,920	13,150
UGT 45000SS1	Combined	66.1		50.8	6,720	13,080
UGT 45000SS2	Combined	132.2		50.8	6,720	26,160
UGT 60000	Simple	60.0		37.0	9,220	16,300
UGT 60000SS1	Combined	83.8		52.1	6,550	16,150
UGT 60000SS2	Combined	167.6		52.1	6,550	32,300

Engine type	Power, MW	Year of supply	Customer, location	Q-ty, pcs
Д012, Д014, ДА14	4-10	1969-1990	Floating power plants	77
			Railroad power trains	134
			Power plants	60
ДЦ59	12	1982-2002	Russia, Kazakhstan, Turkmenistan, Azerbaijan	89
UGT 2500*	2,5	1994-2011	Russia, Czech Republic, Canada, Poland	7
UGT 5000	5	2012	South Korea	1
		2001	Tyumen region (Russia)	5
UGT 6000	6	2003	Poltava region (Ukraine)	2
		2008-2013	Dongfang (China)	2
		2012-2013	Weizhou field (China)	3
		2003-2010	Kostukovich (Belarus)	3
UGT 15000	16	2010	Novyi Rozdil, (Ukraine)	2
		2013	Yadavaran oil field (Middle East)	5
		2014	Azadegan oil field (Middle East)	4
		2001	Floating power plants (Russia)	2
UGT 16000	16	1996	Mozyr (Belarus)	2
		2005	Salekhard, Tyumen region (Russia)	1
		1998-2009	Shakhty, Rostov region (Russia)	4
		1992	Krasnodarsky region (Russia)	3
		2011	Saki, Crimea (Ukraine)	1
		2003	Rubezhnoye, Lugansk region (Ukraine)	2
		2005	Novoyavorovsk, Lviv region (Ukraine)	2
		2004-2014	Zhanazhol field, Aktobe region (Kazakhstan)	10
2005	Kyzylorda (Kazakhstan)	3		
UGT 25000	25	2003-2005	Beloozersk, Brest region (Belarus)	6
		2007	Gorlovka, Donetsk region (Ukraine)	1
		2011-2014	Harbin (China)	2
		2011-2014	Middle East	20
UGT 110000*	110	2011	Takoradi (Ghana)	4
			2001-2004	Russia, Ukraine

* Without taking into account engines produced by license

Total – 459 units
Total power – 6,170 MW
Total accumulated hours – 36,379,097 hr

State Enterprise Gas Turbine
Research & Production Complex



ZORYA-MASHPROEKT

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This leaflet describes technical possibilities. Therefore, desired technical characteristics and volume of fulfilled tasks are agreed in each specific case during the contract conclusion.