



T32 Gas Turbine Unit



Package supply of power equipment

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REP Holding, a joint-stock company, is a leading Russian power machine building enterprise, a designer, manufacturer and supplier of new generation power machines.

Since 2019 REP Holding is incorporated in Gazprom Energoholding Group.

We design, manufacture and provide packaged supplies of power and electrical equipment for Oil&Gas, metallurgical and chemical industries, power generation and distribution facilities. Our products are widely used for gas transportation system modernization, construction of advanced power units and power stations, in small-scale power generation, on the LNG market and in other industries.

REP Holding offers manufacturing and supply of packaged equipment based on gas turbines rated at 32 MW.



MS5002E Gas Turbine Unit

GTU is produced by REP Holding under the license of GE Oil & Gas (Nuovo Pignone S.p.A.).

Cooperation between REP Holding and General Electric started in 2008, when turbine production license with complete technology transfer was purchased from GE Oil & Gas (the license photo is enclosed).

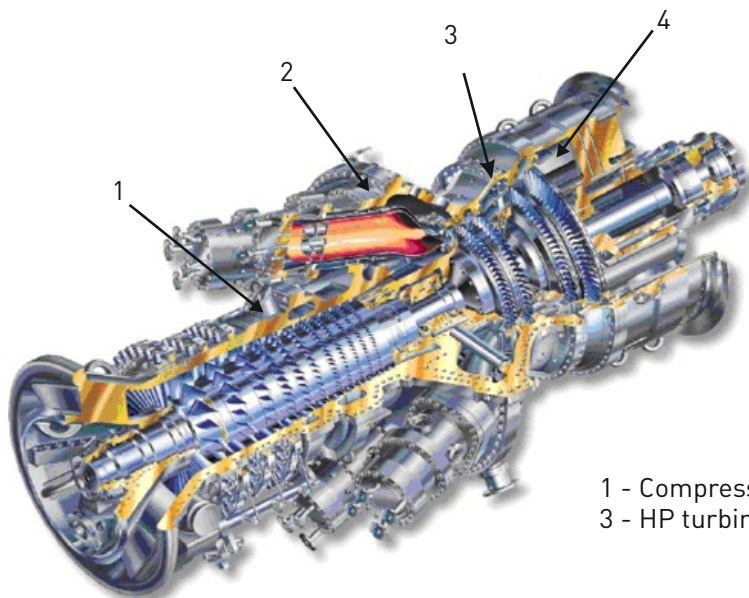
The GTU is a multipurpose machine – it can be used both in the gas transportation system and the power generation industry. The unit has been produced at REP Holding enterprises since 2009, manufactured as per the API standards.



**Gas turbine engine main technical characteristics
at nominal load under ISO conditions**

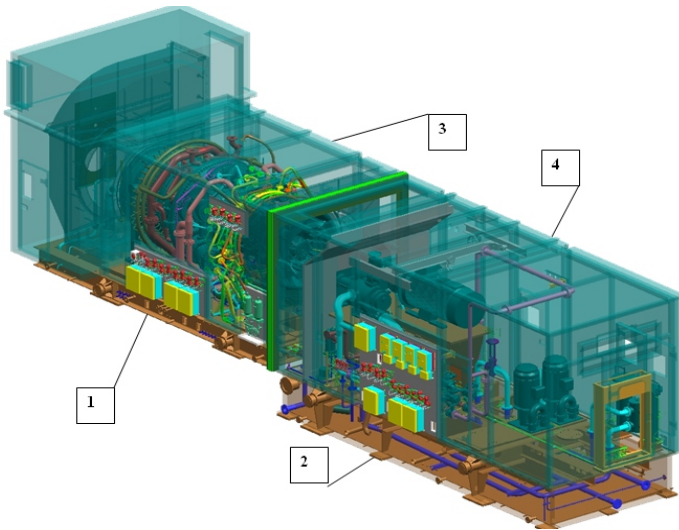
Shaft power, no less than	32,0 MW
Turbine efficiency, no less than	36,0%
Exhaust gas flow	102,3 kg/s
Temperature of exhaust gases	508 °C
Compression rate	17,0
Fuel gas flow rate (natural gas, Qph=50 MJ/kg)	1,78 kg/s
Gas generator rotor speed, maximum	7500 rpm
Output shaft rotor speed, nominal	5714 rpm
Emission (at 15% O ₂ in dry combustion products):	
— nitrogen oxides	≤40 mg/m ³
— carbon monoxide	≤38 mg/m ³
Engine dimensions (without piping)	17,5*4,4*4,7 m
Weight of the gas turbine unit on the base plate	70 t
Assigned service life	200000 h
Time between overhauls	48000 h

T32 (MS5002E) Gas turbine engine



1 - Compressor; 2 - Combustion chamber;
3 - HP turbine; 4 - Free turbine (LPT)

Gas turbine engine main systems



- 1 – MS5002E turbo-unit on its own base plate
- 2 – Auxiliary base plate (ABP) with all the GTU operation support systems mounted on it: starting system, oil supply system and fuel system
- 3 – GTU heat-and-noise insulating enclosure (HNE)
- 4 – ABP heat-and-noise insulating enclosure (HNE)

Gas turbine engine configuration

MS 5002E engine structure comprises two units: the gas turbine unit itself on its own base plate and the auxiliary base plate (ABP) with all the GTE operation support systems.

Compressor

- Axial, 11-staged, with variable inlet guide vane and variable guide vanes of 2 stages
- Casing with vertical and horizontal splits
- Compression ratio - 17

Combustion chamber

- Sectional, with 6 liners
- Dry low emission system DLN-2
- 5 fuel burners in each liner with a pre-mix system
- Equipped with flame detectors and ignition devices

Gas generator turbine

- Axial, two-staged, with 3D-optimized profiling
- Cooled nozzles and blades with protective coating

Free turbine

- Axial, two-staged, without cooling
- Uncooled shrouded nozzles and bucket

Basic parameters

- Rated power – 32 MW
- Life cycle – 200,000 hours
- Efficiency – 36 %
- NO_x emission ≤ 18 ppm

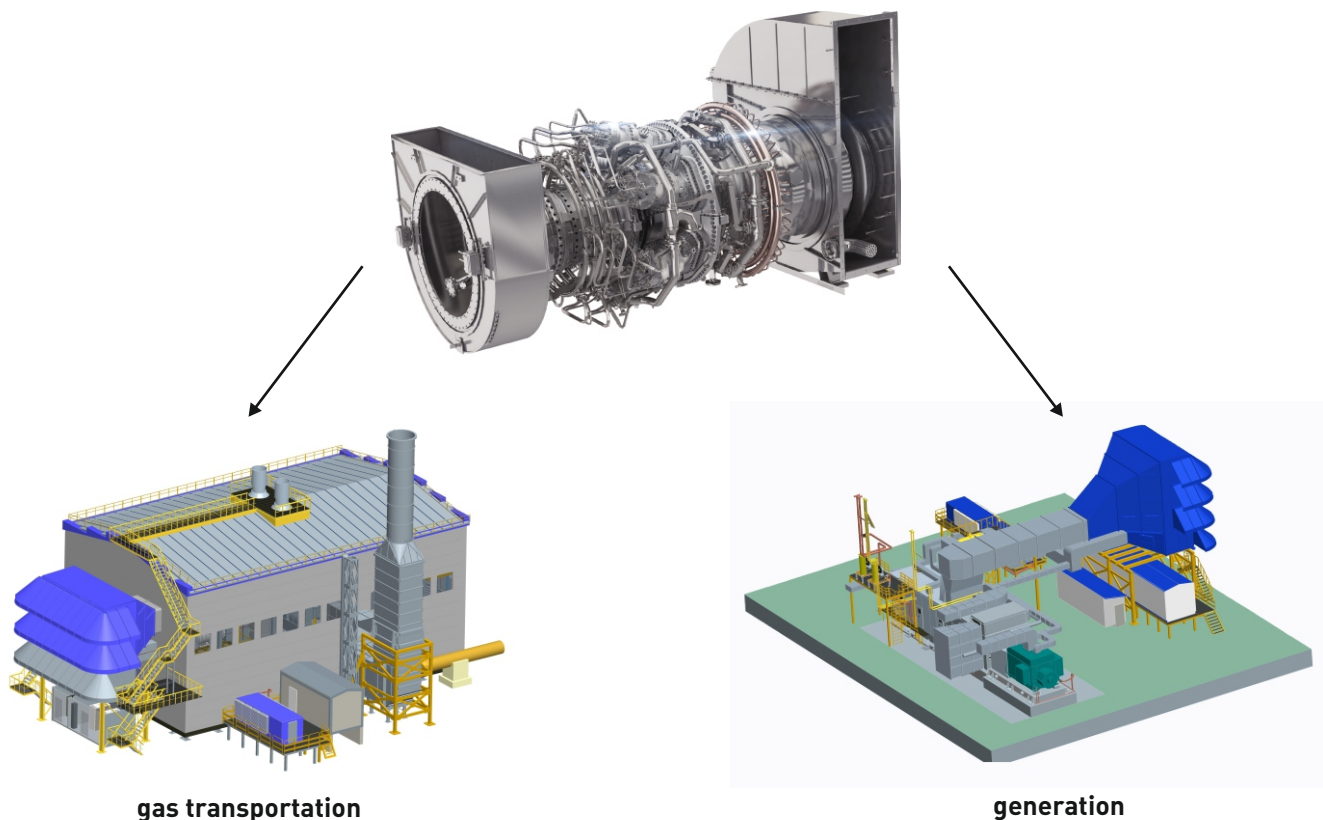
Advantages

- high efficiency and reliability
- high economic effectiveness in various operating modes
- wide range of operating conditions (t from $-60\text{ }^{\circ}\text{C}$ to $+45\text{ }^{\circ}\text{C}$, designed for boreal climate as per GOST)
- unique environmental characteristics
- long service life, high level of repairability;
- multipurpose application
- transportation convenience
- field service maintenance availability

T32 can be used both as a compressor mechanical drive and as a turbogenerator drive.

PERFORMANCE (at ISO conditions)	LADOGA 32	
	Generator Drive	Mechanical Drive
Output	31100 kW	32000 kW
SC Efficiency (%)	35.0	36.0
Pressure Ratio	17:1	17:1
Heat Rate (kJ/kWh)	10285	10000
Nox (ppm) Exh.	18	18
Gas Flow (kg/s)	101	101
Exh. Gas Temp. ($^{\circ}\text{C}$)	5103000/3600 (both geared)	510
Load Rated Speed (rpm)		5714

Application



- as part of gas-pumping units at main gas pipeline compressor stations;
- as part of gas turbine and combined-cycle units at combined heat and power stations and Central Heating and Power Plants;
- in ship-building as the main propulsion plant for ships and vessels.

Gas transportation

T32 is best suited for modern compressor stations when gas transportation via main gas pipeline system with operating pressure from 5.5 to 12.0 MPa, due to the optimal rated power (32 MW) and the output shaft speed (5714 rpm).

GPU-32 "Ladoga"



REP Holding produces a high-tech gas-pumping unit "Ladoga-32" on the basis of T32 industrial gas turbine. GPU is designed for operating conditions of any complexity, features high efficiency (36 %), low emissions ($\text{NO}_x \leq 18$ ppm) and prolonged service life (200,000 hours).

It is designed for transmission of natural gas via the main gas pipelines.

It can be used both for reconstruction of existing and construction of new gas-pumping stations.

T32 is supplied as part of the GPU in the individual hangar-type building, in complete ready-to-use modules.

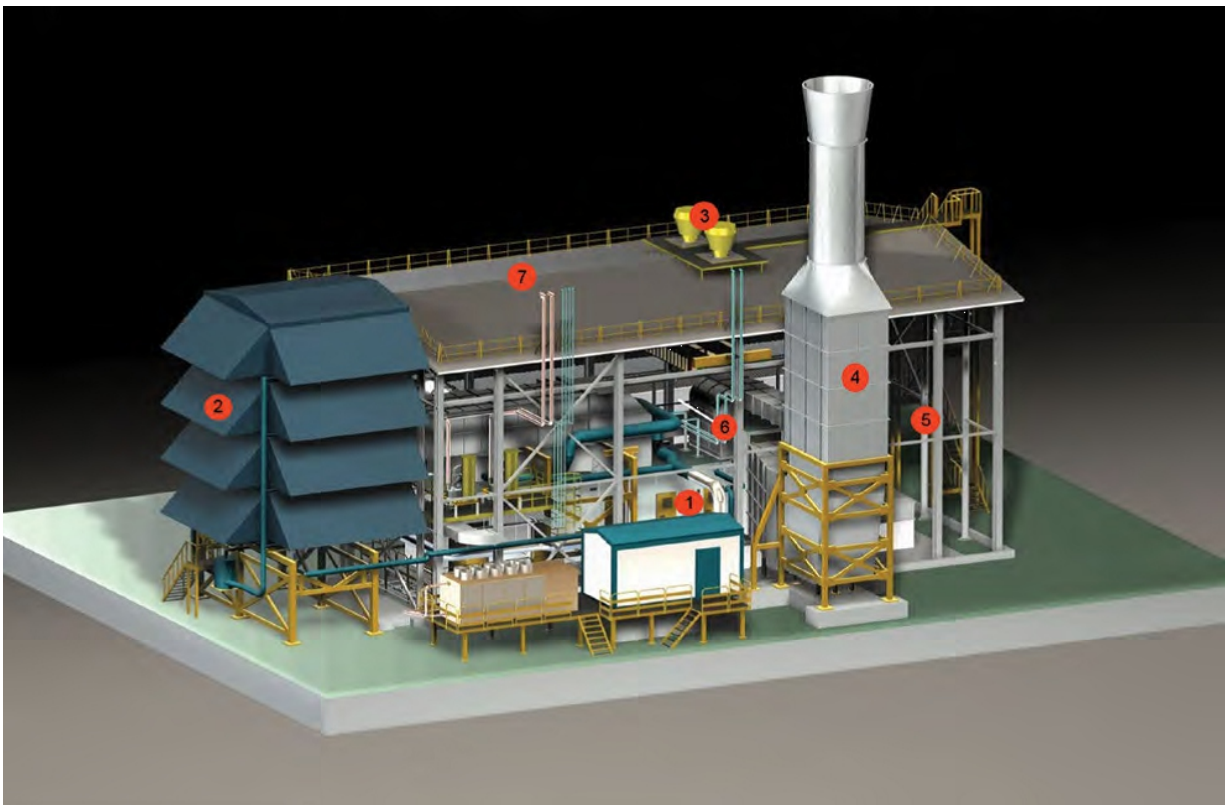
Advantages

- high reliability and availability;
- high efficiency;
- low level of harmful emissions meeting the up-to-date environmental requirements;
- turn-key packaged supply



Unit configuration

- MS5002E gas turbine unit rated at 32 MW:
 - MS5002E turbo-unit
 - MS5002E GTU auxiliary base plate
 - heat-and-noise insulating enclosure of MS5002E GTU auxiliary base plate
 - heat-and-noise insulating enclosure of MS5002E gas turbine compartment
- Natural gas compressor 400-21-1C and its upgrades
- Integrated automatic control system
- Filter house (FH)
- Power supply system
- Instrumentation (control and measuring devices)
- Turbo-unit cooling system
- Exhaust system
- Fuel conditioning system
- Oil system with oil cooler
- Individual hangar-type building with ventilation, heating, gas detection, and video surveillance systems
- Fire-fighting system
- Axial compressor flushing system



- 1 – Gas turbine unit MS5002E
- 2 – Filter house
- 3 – GTU cooling and ventilation system
- 4 – Exhaust system
- 5 – H-400-21-1C compressor
- 6 – Integrated automatic control system consisting of two units – ACS unit and electrical unit
- 7 – Individual hangar-type building

Main technical characteristics of GPU-32 «Ladoga»

Nominal coupling power in the station conditions, MW, no less than	31,2
Volume capacity referred to the nominal conditions (0,1013 MPa, 20°C), mln m ³ /day	62,0
Polytropic efficiency of the centrifugal compressor, no less than, %	80
GTU effective efficiency when operating at rated power in the station conditions, %, no less than	36,0
Nominal gas working pressure, abs., at the centrifugal compressor outlet, MPa	7,45
Compression rate	1,44
Nominal speed of the GTU power turbine rotor	5714
Temperature downstream of the turbine, °C (nom./max.)	510/600
Fuel gas flow	1,78

GPU-32 "Ladoga" test bench



REP Holding production site is equipped with a high-tech test bench to perform GTU mechanical, thermotechnical and research tests aimed to complete GTU shipment and operational readiness comprehensive assessment. The annual testing program comprises 20 units per year.

Generation

T32 GTU can be used for the construction and modernization of power generation and fuel companies as part of combined-cycle plants and gas turbine power stations.

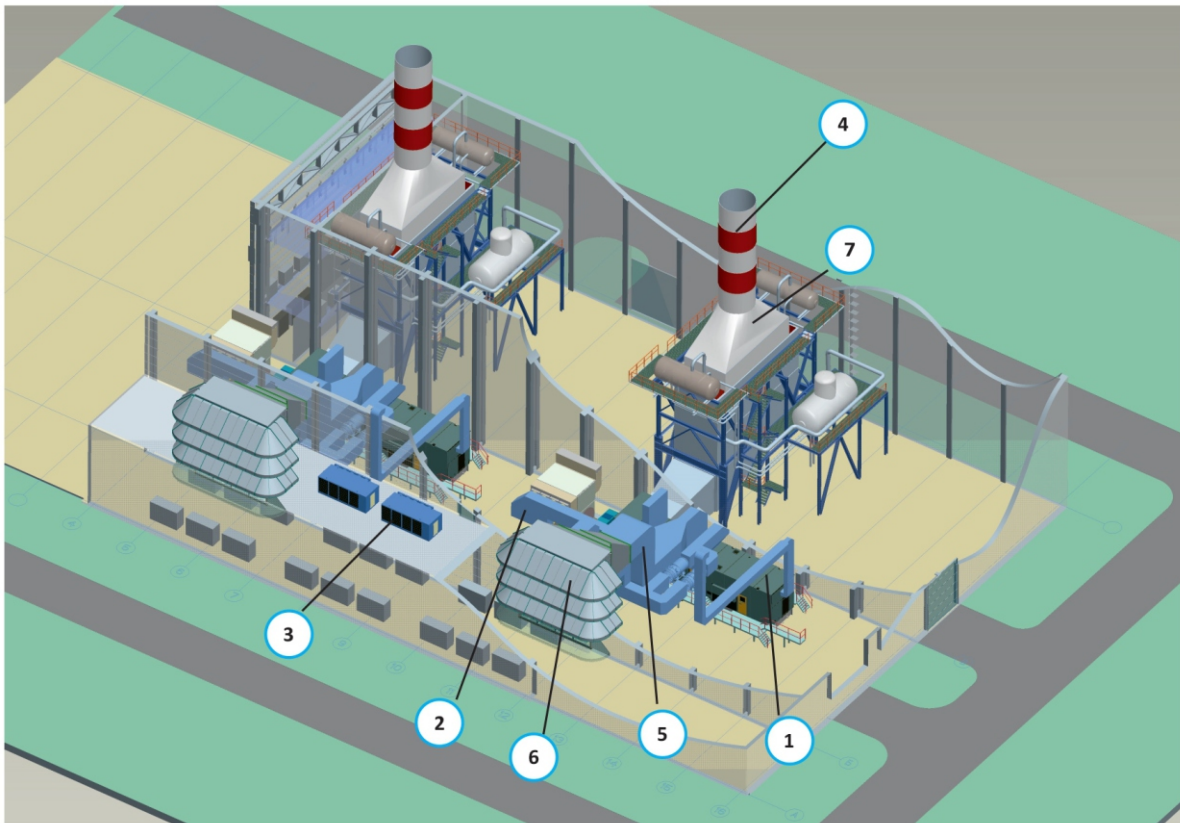
The 32 MW gas turbine power station is a high-technology power generation package designed and produced by REP Holding for operating conditions of any complexity. It is designed to generate electrical and thermal energy at power plants, operating both in a simple and combined cycle.

The main unit equipment is unified to the fullest extent possible and is completed with module units.

Purpose and field of application

- The power unit is designed to generate electrical and thermal energy;
- It can be used at combined heat and power stations (CHPs) or central heating and power plants (CHPPs);
- As an option, it can be equipped with a steam recovery boiler (SRB) or hot-water recovery boiler (HWRB) for the simultaneous generation of electrical and thermal energy (cogeneration);
- GTPS-32 is installed in the main building of the power plant or in the individual easy-to-assemble hangar-type building. The option of setting up the unit in an existing building may be considered if required (during reconstruction).

GTPS-32 configuration



The layout of the main equipment of a two-unit GTU-CHPP with SRB

1. GTU (power gas turbine unit);
2. Generator with the air cooling system;
3. Oil air-cooler;
4. Exhaust pipe;
5. Air ducts of cycle air and air cooling system;
6. FH (filter house);
7. SRB (steam recovery boiler)

The GTPS-32 includes a gas turbine engine MS 5002E, as well as a package of main and auxiliary equipment.

- MS5002E gas turbine (GT) (under the license of GE);
- Turbo-generator (TG) for GT;
- Gear box to transmit power from the GT to TG;
- Filter house (FH);
- Heat-recovery boiler (SRB or HWRB, if required);
- Fuel gas booster compressor (if required);
- Air and gas ductwork;
- Automatic process control system (APCS);
- Electric equipment.

GTPS-32 parameters (at nominal load under ISO conditions)

Output at generator terminals	31,0 MW
Electric efficiency	35,0%
Exhaust gas flow	102,3 kg/s
Temperature of exhaust gases	508 °C
Fuel gas flow rate (natural gas, $Q_{ph}=50\text{MJ/kg}$)	1,77 kg/s

GTPS-32 advantages

- high reliability due to advanced technologies application and up-to-date approach to gas turbine engine design (turbine core component).
- service life – no less than 200 thousand EOH;
- extended time between overhauls – no less than 48 thousand EOH (when operating at base load on standard gas fuel);
- highest electric efficiency in its class;
- high economic effectiveness of the unit in various operating modes;
- use of components mainly produced by Russian manufacturers with a large share of REP Holding (general completion, licensed GTE, electric equipment, automation, supply systems, piping, metal structures, engineering, service maintenance);
- possibility of repair at the Customer's site. The GTU allows for service maintenance on site, without dismantling and shipment to the Manufacturer's facility;
- quick replacement of the GTE owing to lateral roll-out from under the casing.

REP Holding equipment packaged supply provides:

- optimal layout solutions
- application of modern technical solutions
- operating cost reduction
- maximum operational reliability of all GTPS parts
- equipment supply lead time reduction
- full package of service

GPU-32 "Ladoga" on the basis of MS5002E GTU supply reference*

GPUs-32 "Ladoga" are widely used in Oil&Gas reconstruction and new construction projects. To date, 71 units have been manufactured at REP Holding production facilities. They are being successfully operated at Russian compressor stations: on the gas trunk line from Yamal Bovanenkovo field to Ukhta, on reconstruction sites - the "Gryazovets" and "Vavozhskaya" stations, in particular. Within the frame of existing contracts the units are being utilized in the following construction projects: "Power of Siberia" gas trunk line and Amur GPP, the "Sakhalin-2" project, "Turkish Stream", "Novy Port", CS "Portovaya" LNG, etc.

Type of equipment	Client	Delivery site	Qty, units	Year of manufacture
GPU-32 "Ladoga"	Gazprom	Reconstruction of Pilot Compressor Station at the CS "Gryazovets"	1	2009
GPU-32 "Ladoga"	Gazprom	Reconstruction of the CS "Vavozhskaya"	1	2010
GPU-32 "Ladoga"	Gazprom	Gas trunk line Bovanenkovo-Ukhta, CS-8 "Chikshinskaya", compressor department 1	1	2010
GPU-32 "Ladoga"	Gazprom	Reconstruction of the CS "Vavozhskaya", department No. 1, gas pipeline Yamburg-Tula-1	1	2011
GPU-32 "Ladoga"	Gazprom	Gas trunk line Bovanenkovo-Ukhta, CS-8 "Chikshinskaya", compressor department 1	3	2011
GPU-32 "Ladoga"	Gazprom	Gas trunk line Bovanenkovo-Ukhta, CS-9 "Maloperanskaya", compressor department 1	4	2011
GPU-32 "Ladoga"	Gazprom	Gas trunk line Bovanenkovo-Ukhta, CS-6 "Intinskaya", compressor department 1	2	2011
GPU-32 "Ladoga"	Gazprom	Gas trunk line Bovanenkovo-Ukhta, CS-6 "Intinskaya", compressor department 1	2	2012
GPU-32 "Ladoga"	Gazprom	Gas trunk line Bovanenkovo-Ukhta, CS-7 "Syninskaya", compressor department 1	4	2012
GPU-32 "Ladoga"	Gazprom	Gas trunk line Bovanenkovo-Ukhta, CS-6 "Intinskaya", compressor department 2	3	2013
GPU-32 "Ladoga"	Gazprom	CS "Russkaya", "South Stream" gas pipeline	5	2013
GPU-32 "Ladoga"	Gazprom	Gas trunk line Bovanenkovo-Ukhta, CS-7 "Syninskaya", compressor department 2	3	2014
GPU-32 "Ladoga"	Gazprom	Gas trunk line Bovanenkovo-Ukhta, CS-9 "Maloperanskaya", compressor department 2	3	2014
GPU-32 "Ladoga"	Gazprom	Gas trunk line Bovanenkovo-Ukhta, CS-8 "Chikshinskaya", compressor department 2	3	2014
GPU-32 "Ladoga"	Gazprom	CS "Russkaya", South Stream gas pipeline	2	2014
GPU-32 "Ladoga"	Gazpromneft	CS "Novy Port"	4	2015
GPU-32 "Ladoga"	Gazprom	CS "Russkaya", "South Stream" gas pipeline	7	2015
GPU-32 "Ladoga"	Gazpromneft	CS "Novy Port"	4	2016
GPU-32 "Ladoga"	Gazprom	CS-7-A "Zeyskaya", the "Power of Siberia" project	3	2017
GPU-32 "Ladoga"	Sakhalin Energy Investment Company	Sakhalin-2	3	2018
GPU-32 "Ladoga"	NIPI NG Peton	LNG production, storage and shipment Complex, CS "Portovaya"	2	2018
GPU-32 "Ladoga"	Gazprom	Nord Stream 2 gas pipeline, Slavyanskaya CS	4	2019
GPU-32 "Ladoga"	CPECC	Amursky GPP	6	2019
Total			71	

*As of January 2020

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