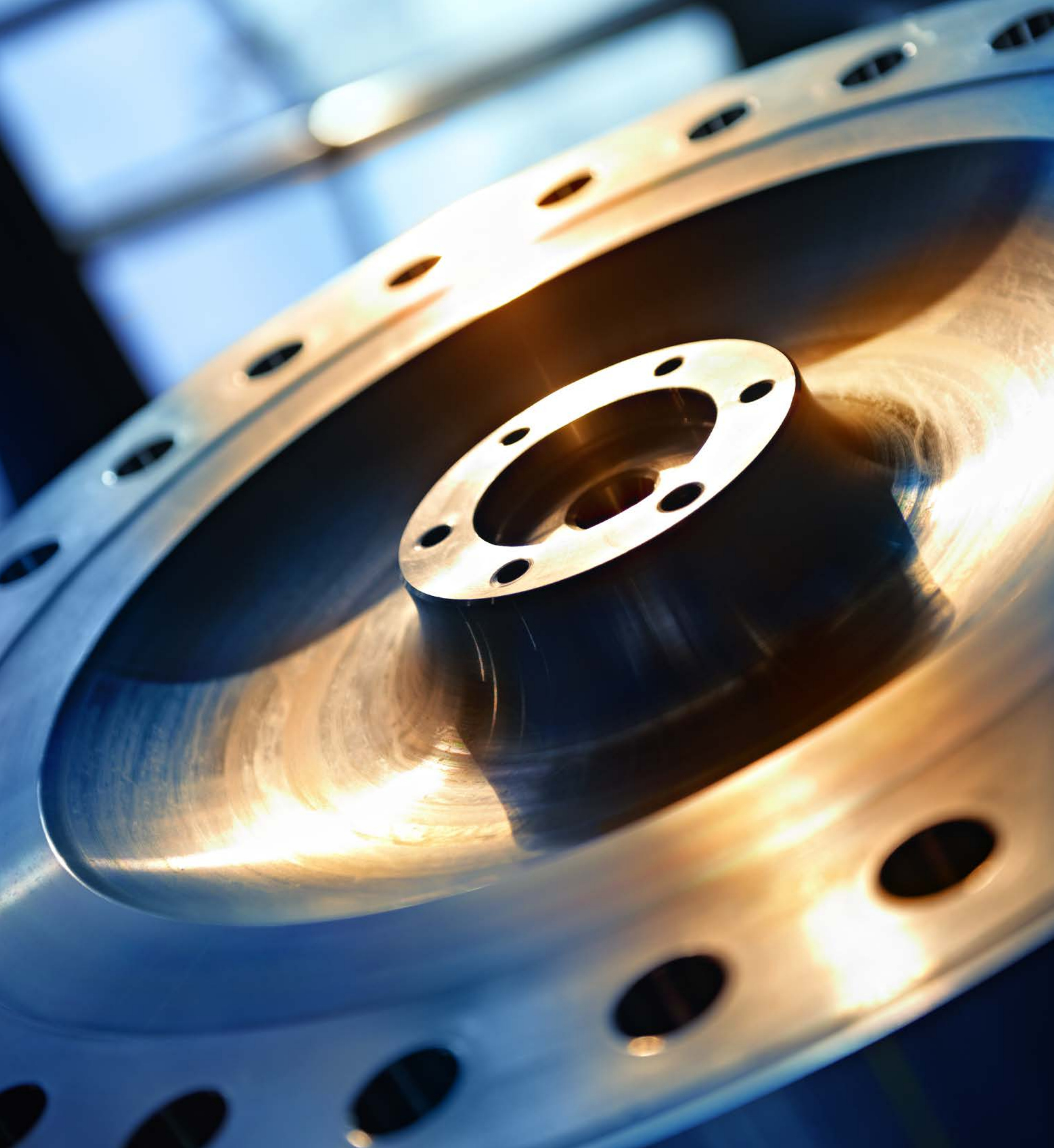


NEVSKIY ZAVOD

PRODUCT CATALOGUE



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**History.
Mission.
Values**

01

Brief history

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Development strategy

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Joint Stock Company “Nevskiy Zavod” (JSC “NZL”) (hereinafter referred to also as the Plant) is the oldest industrial enterprise of St. Petersburg, Russia’s leading power engineering company.



Head office building of Nevskiy Zavod, 1910

Founded in **1857**, Nevskiy Zavod has now more than 75 years experience in development and manufacturing of power engineering products: Gas and steam turbines, centrifugal and axial compressors).

Nevskiy Zavod was founded as a ship-building plant: more that 200 ships of various purpose, mainly for the Russian navy, were produced at the Plant. At the turn of **XXth century**, when the railroad construction was developing at a swift rate in Russia, the Plant mastered the production of locomotives and manufactured more than 4000 units. **In the twentieth** the Plant became actively involved into implementation of the State Plan of Electrification of Russia and changed its profile to that of power engineering, while **in the thirties** the Plant made itself known as a manufacturer of the first Russian centrifugal turbo-machine for air supply to the blast furnace. A new phase in the development of the Plant began and new complex machines - compressors, gas blowers, turbines, steam boilers - were brought to production at a fast pace. Nevskiy Zavod had manufactured about 130 compressor machines of 20 types by the year of **1941**.

In **1947**, the Soviet Union first gas turbine was built, and in 1958 the production of gas turbines and gas-pumping units for gas — main pipelines was started. This determined the main production profile of the Plant for the following years.

Shipbuilding

In **1857**, Major-General Petr Fyodorovich Semyannikov and Lieutenant-Colonel Vasily Apollonovich Poletyka acquired a small ironworks located on the Bank of the Neva river from an Englishman, Thomson.

At the end of the 19th century replacement of wooden naval ships began. Semyannikov and Poletyka were among the first to receive the order from the Navy Department for construction of ships.

Large-scale restructuring began. The shops were renovated, new workshops appeared. Just one year after the foundation of the Plant, two small steamers, “Maria” and “Rabotnik” (Worker), and 8 years later, in **1865**, the first domestic battleship “Kreml” were launched from the Plant shipbuilding ways. In the years that followed, war ships such as “Minin”, “General Admiral” and others were built at the Plant.

In **1909**, specially for the polar expedition, peaceful vessels were built at Nevskiy Zavod — icebreakers “Taimyr” and “Vai-gach” - which made a voyage via the Northern Sea Route for the first time from Vladivostok to Arkhangelsk. The vessels participated repeatedly in the hydrographic research of the Arctic and Pacific Oceans during which new unknown islands (including Severnaya Zemlya) were discovered and mapped, whereby a significant contribution was made to the history of the World Ocean study and a great practical benefit was provided for seamen.



Battleship for coastal defense “Kreml”, 4323-tonner.
Manufactured at Nevskiy Zavod in 1865

Steam locomotive building

The development of the railway industry in Russia caused the necessity to rapidly increase the volume of the rolling stock. In March **1867** the Government declared a contest for the best steam locomotive manufactured at domestic plants. In **1869**, Nevskiy Zavod built the first steam locomotive which became an exhibit of the all-Russian industrial exhibition in **1870** and was recognized as the best one. The Plant was awarded a Smaller Coat of Arms of the Russian Empire. This Coat of Arms crowned later the main gate in front of the Plant main office building.



A normal-type freight locomotive with a 3-axis tender.
Manufactured at Nevskiy Zavod in 1869

Steam-locomotive building required huge investments, therefore in **1870** joint-stock company “Russian Society of Mechanical and Mining Plants” was founded. The territory of the old manufacturing plant was extended. New shops emerged, a connecting track with the Nikolayevskaya railway was built. In **1882** the 1000th locomotive was already manufactured.

In **1891**, the Plant was acquired by the engineer and industrialist Valerian Titov, joint stock company “Moscow Partnership of Nevskiy Shipbuilding and Mechanical Plant” was established. Among its founders there was such a personality in the railways construction field as Savva Mamontov, well known by industrial and cultural intellectuals. Among the many guests who visited his house there were I. Repin, F. Shalyapin, M. Vrubel, etc.

Using his extensive contacts, S. Mamontov secured new and profitable orders for the Plant for locomotives from the very first days.

In **1898**, the State Bank purchased most of the Plant shares, and since then the Plant name was changed to “Nevskiy Ship-building and Mechanical Plant”. The orders placed abroad were transferred to Nevskiy Zavod. An order was received for manufacture of two cruisers – “Izumrud” (Emerald) and “Zhemchug” (Pearls). Nicholas II with his mother Maria Fedorovna and escort were present at “Zhemchug” launching.

By 1917 the Plant manufactured

> **4000**
locomotives

174
ships for
various purposes

Electrification

In **1918**, Nevskiy Zavod was nationalized and changed its profile to power engineering.

In the **20's** the Plant was actively involved in the implementation of the State plan for electrification of the country, and in **1921** it received an order for production of caissons and shipping locks for the first HPP “Volkhovskaya”. In **1927** additional orders for iron and steel casting for DneproGES and an order for construction of tanker-type locomotives were received.

In **1922**, the Plant was named after V.I. Lenin on the initiative of the workers.

Turbine construction

In the **30's**, during the industrialization of the country, Nevskiy Zavod became the manufacturer of the first centrifugal turbo-machine in Russia for air supply to the blast furnace. New complex machines - compressors, air blowers, exhausters, turbines, steam boilers – were developed at a fast pace.

In **1934**, the first Russian turbo-exhauster was manufactured, in **1936** the first piston compressor and in **1937** – the first steam turbine rated at 6 MW were manufactured.

During the war the Plant did not stop its work: the parts for aircraft bombs were manufactured, mass production of shells was arranged, tanks were repaired and left the Plant to immediately head off to the front.

In July, **1910**, the manufacture of the 3,000th locomotive was timed to coincide with the 50th anniversary since the first large industrial orders were placed with the Plant.



Nicholas II with his mother at the ceremony of launching “Zhemchug” cruiser



“Volkhovskaya” hydroelectric power plant



Steam turbine manufacture

After the siege of Leningrad was lifted, Nevskiy Zavod received the first orders for civil products.

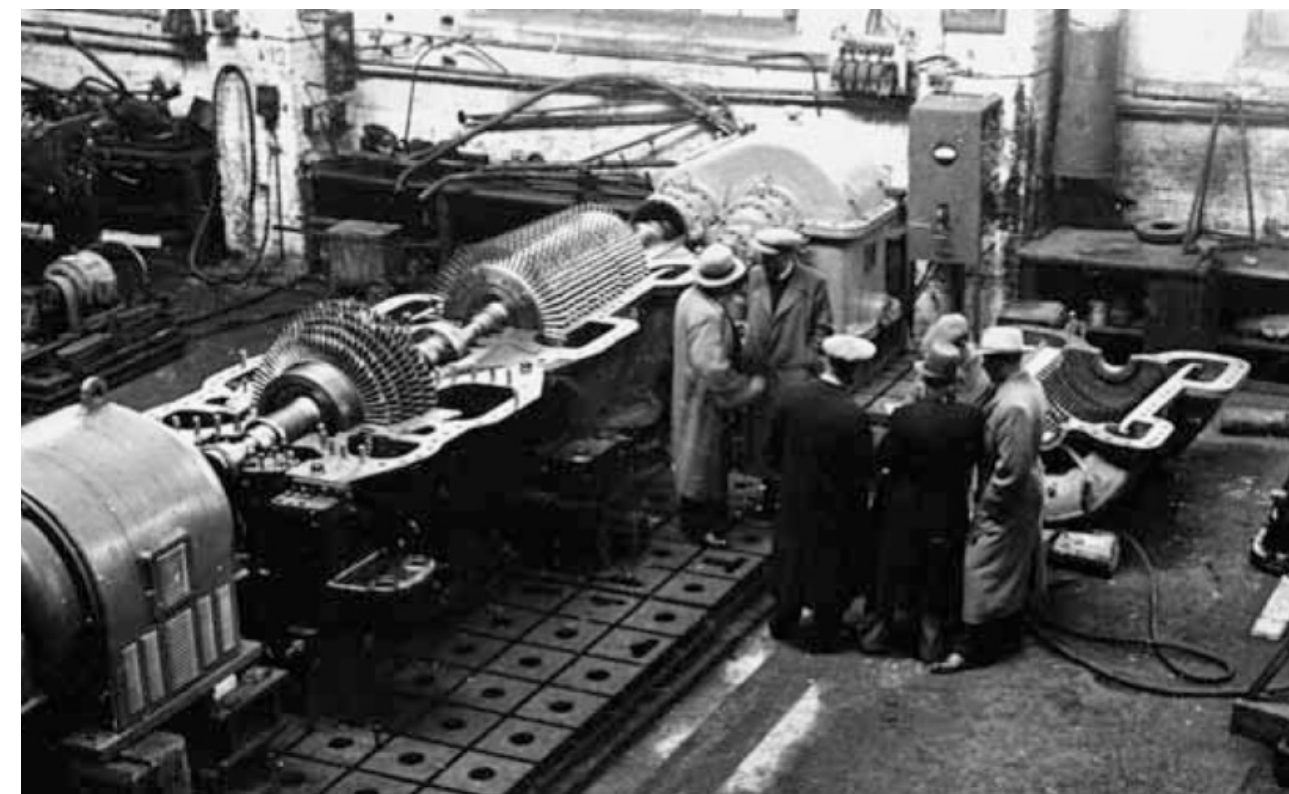
In **1945**, Nevskiy Zavod designers engaged in the primary design of a gas turbine unit which was manufactured already in **1947**.

In **1952**, the first domestic heavy-duty gas turbine GT-600 rated at 1.5 MW was created, and in 1956 as many as six industrial gas turbine units were built.

In **1958**, the first natural gas compressor H-280 was manufactured and production of gas turbines and gas-pumping units for gas-main pipelines began. This determined the key area of the Plant activity up to now.

In **1968**, serial production of the most popular in the USSR gas-pumping unit rated at 10MW - GTK10 – began.

In the **1960s**, a large range of compressor machines for chemical plants was created.



Inspection of the first gas turbine designed by chief designer S. Zherbin, 1947

In **1974**, a Research Design – and - Technological Institute of Turbo-Compressor Building was established at Nevskiy Zavod. A whole series of new machines was created: the most powerful in the USSR gas-pumping unit GTN-25 was designed and manufactured (to replace the imported one), the GTK-10 was updated, later on a new gas- pumping unit GTNR-16 rated at 16 MW was designed with efficiency of 32.5%.

In **2007**, Nevskiy Zavod became part of the power engineering company REP Holding and its key production site.

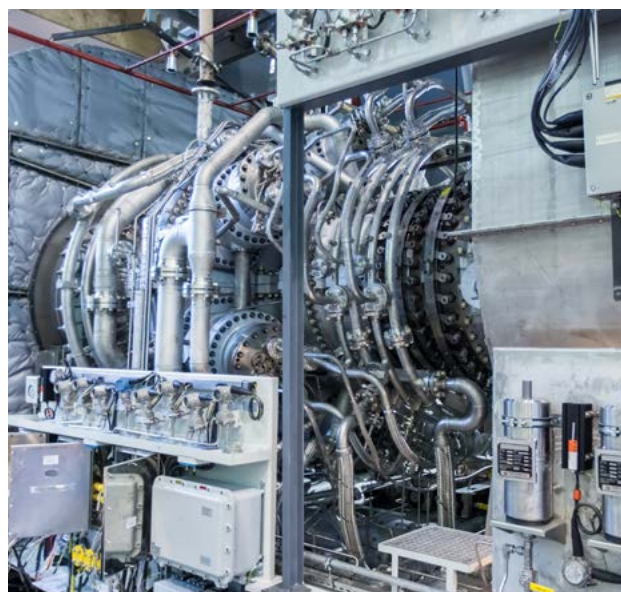
Since then a full-scale reconstruction has been carried out, with more than 100 000 sq. m of production workshops modernized and built, alongside with installation of the leading world manufacturers equipment, implementation of the integrated quality management system, issue of international certificates of conformity, construction of unique test facilities.

In **2008**, a license for manufacture of the up-to-date MS5002E (T32) turbine rated at 32 MW was obtained from GE Oil & Gas Nuovo Pignone S.p.A., and production engineering of a new generation gas-pumping unit “Ladoga-32” started. It was already two years later that the first Russian industrial turbine rated at 32 MW was put into series production.



Series production of complete electrically driven gas-pumping units with an automatic control system was launched, in-house production of electric drives and magnetic bearings was set up, manufacture of centrifugal compressors with magnetic bearings was mastered.

In 2010, series production of industrial gas turbines rated at 32 MW started



Nevskiy Zavod today

Owing to systematic retooling and successful experience in localization of world technologies, Nevskiy Zavod today is a key Russian manufacturer of turbo-compressor equipment for the largest infrastructure projects in the oil and gas industry, a leader in the segment of industrial medium power gas turbines, the only Russian manufacturer of heavy-duty gas turbines rated at 16 and 32 MW and mixed refrigerant compressors for LNG production.

As a manufacturer and package supplier of innovative equipment for power generation facilities, metallurgical and fuel and energy industries, as well as for reconstruction and new construction facilities for the gas transportation system, Nevskiy Zavod is an important production link in the strategic program of the Russian Federation fuel and energy sector modernization.



Mission

Development of a modern company as a world leader in power engineering.

Strategy

- Increasing efficiency of the main activity.
- Diversification and expansion of the activity: development of new markets, new products, including based on high-efficient science-driven projects ensuring creation of competitive products with high added value.
- Honoring the interests of the shareholders, employees, partners and customers.
- Improvement of corporate governance.
- Development of advanced manufacturing technologies.
- Manufacture of world – class power equipment.
- Partnership with the world's leaders in power engineering.
- Extensive implementation of innovative developments and international management standards.
- Implementation of advanced lean production systems.

Values

- Respect for customers' requirements, effective satisfaction of their needs, adherence to the principles of partnership and mutual trust.
- Openness towards the society and the State, willingness for open dialogue with customers and business partners.
- Adherence to the principle of fair competition.
- Effectiveness as a way to achieve steadily the maximum results.
- Responsibility for the consequences of the decisions taken.
- Taking care of employees, respect for their personal rights and interests, assistance in their professional and personal growth.
- Trust in employees — their competence and professionalism in solving production problems.



Key competencies. Competitive advantages

02

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Nevskiy Zavod is an industry expertise center of domestic technologies development for production of world-class heavy-duty gas turbines, a modern complex equipped with state-of-the-art manufacturing machinery providing a full cycle of production - from mechanical machining to assembly, integrated tests, installation and service maintenance.

It develops, manufactures and supplies in package power equipment for oil and gas, metallurgical, chemical and power industries. The equipment supplied is widely used for modernization of the gas transportation system, in the construction of modern power units and power plants, in small-scale generation, in the LNG market and some other industries.

Products

- Centrifugal and axial compressors rated up to 32 MW.
- New generation gas-pumping units rated up to 32 MW (GPU and EGPU).
- Steam turbine units rated up to 25 MW.
- Electrically-driven compressors up to 32 MW.
- Power generating units based on steam and gas turbines rated up to 32 MW.
- Integrated automation systems for industrial facilities.

Competitive advantages

- High reliability and availability of the units.
- Complete production cycle.
- Extensive production and design-and-engineering capabilities.
- Scientific and technical potential, implementing unique design and technological solutions.
- Manufacture of state-of-the-art energy conservation equipment in compliance with the requirements of API standards.
- Successful experience in localization of advanced foreign technologies.
- “Turn-key” package supply.
- Long service life of the units.
- Manufacture of the products based on its own engineering developments.
- Automated manufacturing technologies.
- High efficiency of the units, high environmental performance, compliance with the up-to-date environmental requirements.
- Reliable systems of the products control, availability of modern test beds and laboratories.
- In-house metallurgical production.

Quality

High quality of the services rendered, reliability and competitiveness of the products manufactured are assured by the existing integrated management system.

Compliance of the Integrated Management System with the requirements of the Russian and international standards, as well as PJSC “Gazprom” corporate standards in quality, environmental protection, occupational safety and health care has been confirmed by certificates issued by the largest certification bodies: Test-S.-Petersburg LLC, the International Certification Network IQNet, the Italian National Accreditation Authority ACCREDIA (member of the International Accreditation Forum IAF), the Association for Certification “Russian Register” (the accredited body of the VCS system INTERGAZSERT).

Engineering Center

The Engineering Center of Nevskiy Zavod performs research and experimental development work, implements the tasks of high-efficient turbo-compressor equipment development in compliance with the modern requirements of the relevant industries - oil and gas, chemical, metallurgical, power generation, and the innovative areas in power engineering.

The Engineering Center employs over 200 experienced specialists.

Areas of activities:

- 1 Design engineering in the field of:
 - gas and steam turbines;
 - GPU and EGPU;
 - centrifugal and axial compressors;
 - automatic control systems (ACS) and automatic regulating systems (ARS).
- 2 Modernization and technical re-equipment.
- 3 All types of tests (mechanical, thermal performance, gas-dynamic).

Production engineering

Production engineering is the whole of interrelated processes to create new or improve existing product designs in accordance with the consumer’s requirements.

Production engineering is carried out by the Engineering Center departments under supervision of chief designers who have up-to-date computer equipment, software and hardware technical equipment at their disposal. All production engineering activities are performed in accordance with the requirements of the Unified Design Documentation System.

The amount of work for production engineering depends on the type of product, its complexity, forecasted sales, lead time, product life cycle and other factors.

Technical Requirements Specification

It is prepared together with the customer’s representatives. It captures the tactical and technical requirements of the customer.

Types of work and services

- 1 Design preproduction and production support.
- 2 Research work.
- 3 Development of procedures and performance of integrated tests.
- 4 Product support for the entire life cycle.

All types of work and services have been properly licensed and certified.

Design stages for new types of equipment:

- 1 working out a Technical Requirements Specification;
- 2 technical proposal calculation;
- 3 concept design development;
- 4 basic design development;
- 5 preparation of detailed design documentation;
- 6 regulatory compliance verification, patent and metrological examination;
- 7 manufacture and test of a prototype;
- 8 detailed design adjustment and manufacture of a pilot batch;
- 9 verification, review, introduction of changes, detailed design approval;
- 10 documentation transfer to the Chief Technologist department.

Technical proposal

Contains calculations of technical parameters and economic efficiency to justify the feasibility and practicability of a new product development. The calculations are made for several options of the product manufacture, and the optimum option, with the highest expected economic effect, is analyzed and selected. Once agreed and approved, the technical proposal becomes the basis for the next stages of the design preproduction.

Concept design

It is performed not to scale, but observing the required proportions in the product dimensions.

Basic design

It is developed strictly to scale, in compliance with the standards and regulations; it contains various views, projections, sectional views with the relevant dimensions, in order to have a full picture of the design and operation of the new product.

Detailed design documentation

It is developed upon approval of the basic design and based thereon.

Based on the detailed drawings of parts, all the parts of the product are manufactured; the product is assembled and tested using the ordered components and parts.

Manufacturing preparation

- 1 Adaptation, verification, approval of the design documentation for manufacture of the product in- house.
- 2 Ordering direct and indirect materials for the product manufacture.
- 3 Writing manufacturing procedures.
- 4 Setting rates for manufacturing operations.
- 5 Development of CNC codes.
- 6 Development of machining attachments for the product manufacture.
- 7 Providing standard and specialized tools for production.
- 8 Production support at all stages of the product manufacture.

Castings manufacturing preparation at Nevskiy Zavod is based on the following strategic principles:

- 1 Using state-of-the-art high-performance manufacturing procedures, equipment and materials.
- 2 Mechanization and automation of production.
- 3 Using up-to-date development and computer simulation techniques. For castings manufacture, 3D models are used on the basis of which computer simulation of casting and solidifying processes is performed, as well as pattern equipment is developed for its further manufacture on a CNC machine. Simulation of casting processes is performed using the Computer Simulation System for Casting Processes "PolygonSoft". This software makes it possible to predict formation of defects

in castings and take measures to prevent them at the stage of pre-production engineering. Also, CAD systems such as Creo and NX are used for pattern development. Thus, a complete digital manufacturing procedure for castings is provided at the stage of preproduction, whereby high quality and geometric precision of products is achieved.

- 4 Product quality control at all stages of its manufacture.
- 5 Well-balanced production by the product range, volume and technical capabilities.
- 6 Ensuring production excellence and environmental requirements.
- 7 Complete cycle of casting manufacture.

The use of modern technologies in conjunction with the extensive experience of JSC "NZL" in the castings manufacture for power engineering industry makes it possible to achieve high results in production and recognition in the professional community. The foundry of Nevskiy Zavod was repeatedly recognized (in 2016 and 2018) as a leader in the region in culture and quality by the Foundry Workers Association of the Russian Federation, St. Petersburg and Leningrad Region.

Modern technologies are also used in blank and welding production.

The blank production is represented by modern gas-plasma cutting equipment with program control from the leading manufacturers (Czech Republic, Italy). The working surface up to 36 meters long makes it possible to machine simultaneously several sheets, charge the equipment with sheets, remove blanks. Specialized software is used for pattern cutting and best use of sheet material. Thanks to special modules of CAD systems software, developed views of sophisticated bent parts are designed for sheet bending and rolling.



CNC gas plasma cutting machine, Nevskiy Zavod assembly-welding production area

Welding production is equipped with state-of-the-art high-tech facilities. Power sources from the world's leading manufacturers - EWM, Lorch, Kemppi, Lincoln – are used with the associated advanced control modules that implement the whole range of the arc welding technology capabilities. Equipment for welding metal items by the method of extended arc is used. The facilities rotating at a preset speed and comprising welding rotators, manipulators, roller supports are used to implement heated welding. Also, integrated technological solutions are applied: an area to manufacture H-beams up to 12 meters long has been arranged, with robot welding (welding carriage with an oscillatory mechanism and welding column), shrinkage distortion straightening on a straightener.

Advanced software

The design preproduction and manufacturing preparation involves application of the “Windchill” PLM system. This system makes it possible to minimize circulation of documents on paper, while the optimized algorithms provide interaction of various company departments participating in the manufacturing process through the corporate network.

Mechanical machining on CNC machines is performed with the aid of software from the world leaders — Siemens NX, HyperMill.

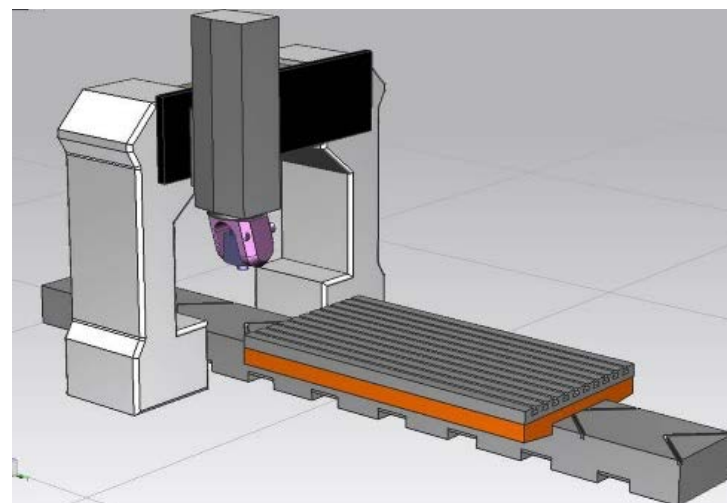
The CAD-/CAM technologies used make it possible to create 3D computer models of products and manufacture the same on CNC machines.

CAD - Computer Aided Design of products.

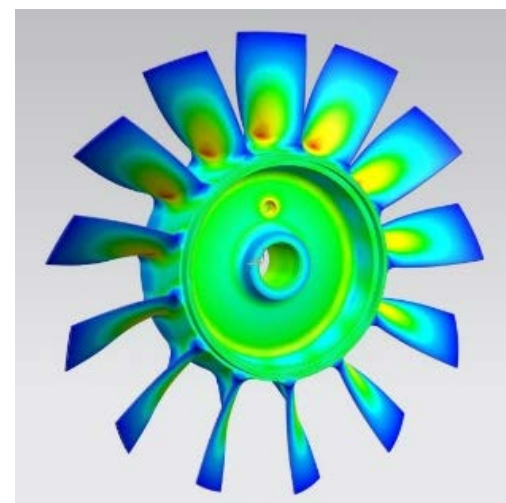
CAM - Computer-Aided Manufacturing of products on CNC machines.

The main tool is Siemens NX software - the flagship CAD-/CAM-/CAE system from Siemens PLM Software NX.

It is widely used in mechanical engineering, especially in the industries that manufacture products with high density of assembly and a large number of parts (power engineering, gas turbine engines, transport engineering, etc.) or products with irregular shapes (aircraft, automotive, etc.). NX provides a complete software solution for development of CNC codes for CNC machinery (CAM), postprocessing and machine operation simulation.



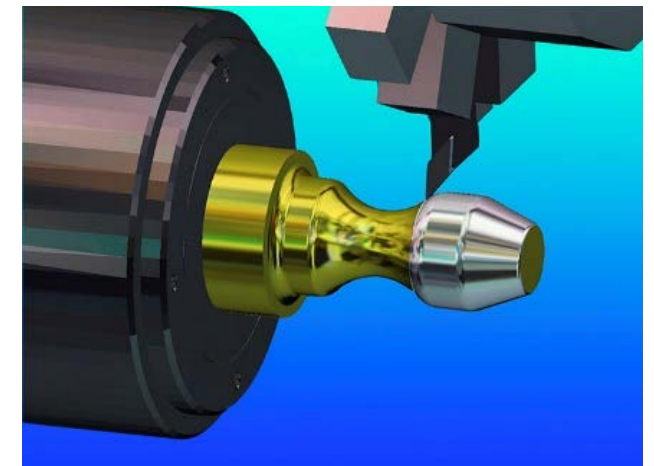
CNC portal machine



CAE-Computer Aided Engineering

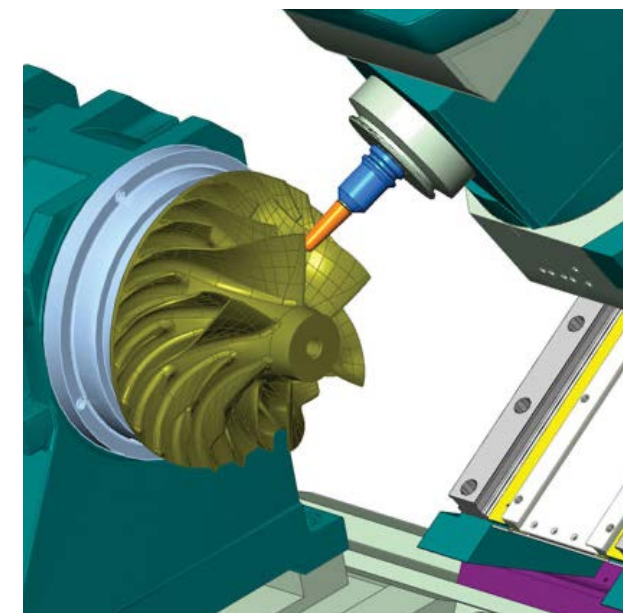
The system combines high functionality with automation of programming processes, ease of use, supports advanced types of machining: high-speed machining, submerged milling, multifunctional turning-and-milling with the capability to synchronize working elements.

In addition to classical machining, the system provides programming for industrial robots, support for various types of additive machining and much more. This ensures the associativity of machining and model, as well as its automatic update when the design changes.

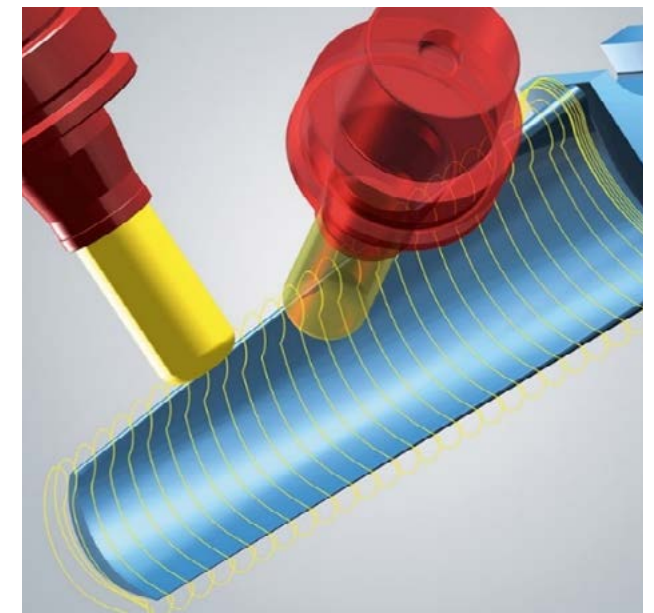


Turning simulation

HyperMILL is the tool that makes it possible to solve such difficult problems as milling turbine blades and impellers. This software offers a whole range of machining strategies: 2D and 3D strategies for high-speed cutting and high- performance milling, 5-axis machining strategies, turning by means of HyperMILL millTURN and a number of special solutions for milling shaped parts.



5-axis milling simulation for impeller



5-axis milling simulation for axial compressor guide vane

Also, HyperMILL provides a lot of other opportunities for programming automation, reducing thereby the machining time and optimizing the processes. These include features and macros technologies, automatic mirror and transformation functions, a function linking a job and manufacturing conditions, reducing thereby the time spent on auxiliary operations, as well as the functions of automatic check and prevention of collisions.

CAD-/CAM-/CAE systems cover the entire process, from concept design to manufacturing preparation and simulation. These systems help to enhance reliability of the manufactured products, improve the quality and shorten the time of manufacturing preparation.

Manufacturing capabilities

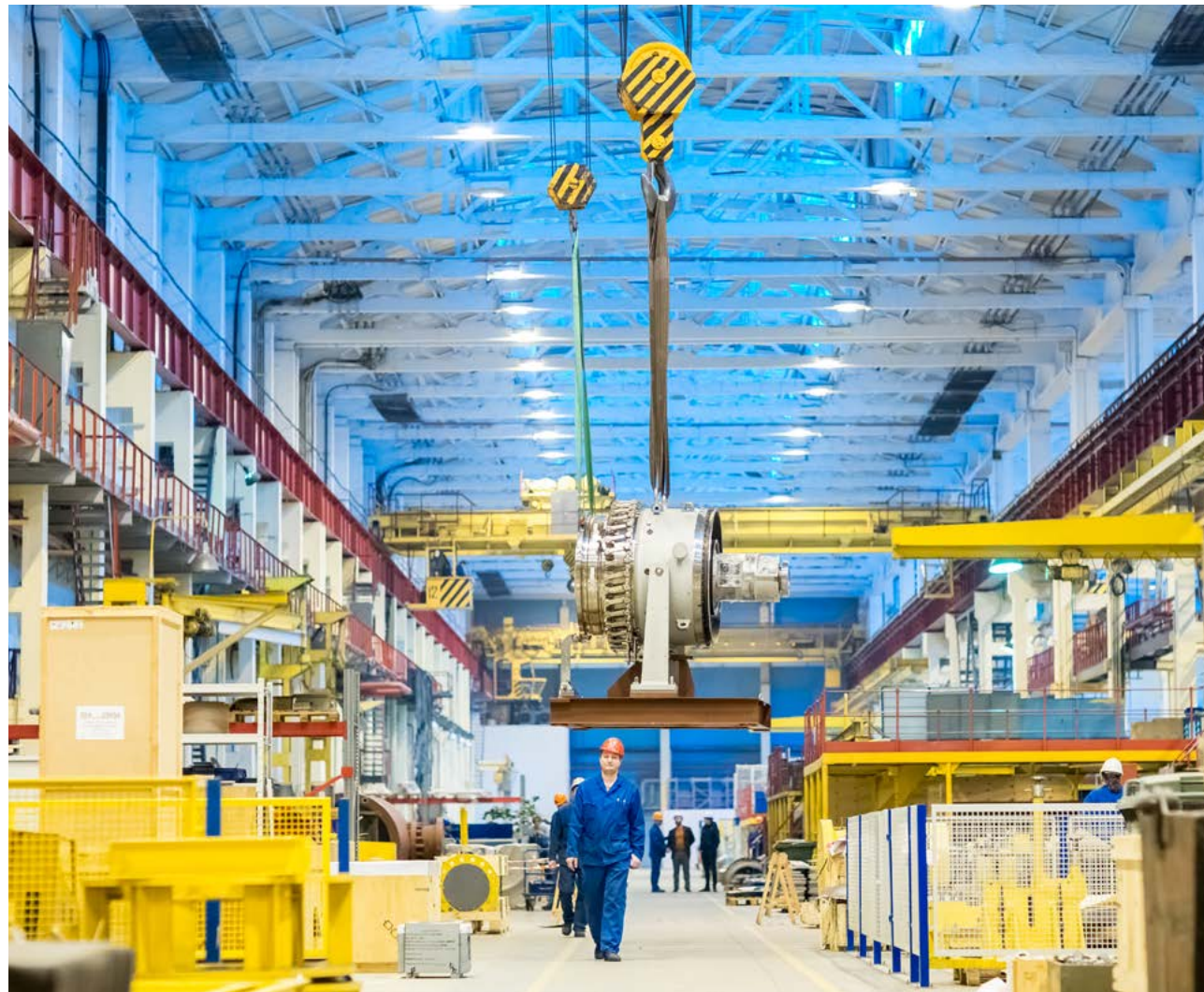
Nevskiy Zavod is a modern production complex equipped with the state-of-the-art manufacturing machinery from the world's leading manufacturers that provide a full cycle of production - from mechanical machining to assembly and integrated tests. Availability of unique test beds and laboratories is one of its competitive advantage.

The company carries out systematic analysis of the machine tools market, world trends studies and implementation of the latest technologies into in-house production, adopting the best machining practices, modernizing manufacturing facilities and retooling the plant with high-tech equipment and advanced highly efficient CNC machines.

An investment program aimed at equipment modernization and technology development in order to produce innovative and high-tech products is extensively implemented.

The production capacity of Nevskiy Zavod makes it possible to combine small batch production with production of unique non-standard products.

In addition to the introduced automatic manufacturing techniques, the process of the units design also employs most advanced 3D modeling software products and unique software making it possible to perform strength, aerodynamic, thermal analysis. The high level of design process automation makes it possible to improve the manufactured products performance on a systematic basis.



Service

Nevskiy Zavod performs a full package of service maintenance of the equipment produced in-house and by third-party manufacturers. The scope of work provides for pre-sale, warranty and post-warranty service, as well as extension of service life, factory repair and modernization.

The purpose of service maintenance for the Customer is:

- optimization of preventive maintenance;
- minimizing the time of equipment unscheduled downtime;
- improving the efficiency, reliability and safety of the equipment;
- extending the operational lifetime of the equipment.

Service maintenance is arranged in accordance with the schedule which establishes the types, list and intervals of technical maintenance and repair activities for the equipment delivered to the consumer's facilities.

Together with the developed service system, mutually beneficial formats of cooperation with custom-tailored approach are offered.

A variety of service contracts are offered to the Customer that differ in the scope of services rendered and responsibility of the company in the process of maintenance and repair.

In accordance with the Customer's expectations and requirements a work package can be offered, including:

- round-the-clock technical support;
- supply of spare parts, equipment, tooling, technical documentation;
- flexible pricing policy.



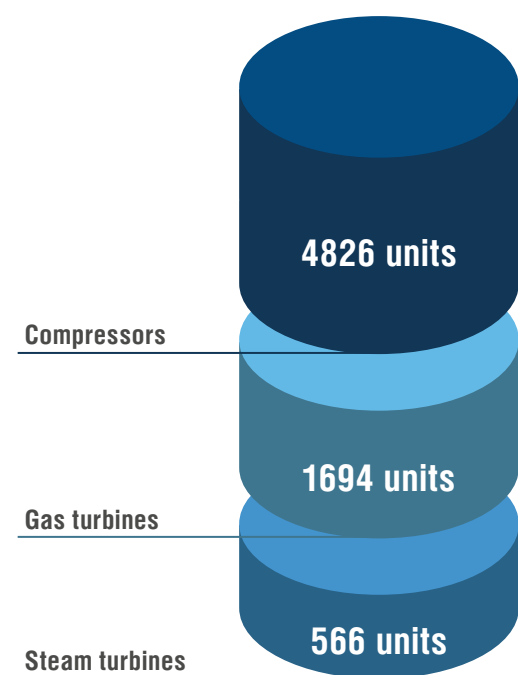
The Company by numbers

03

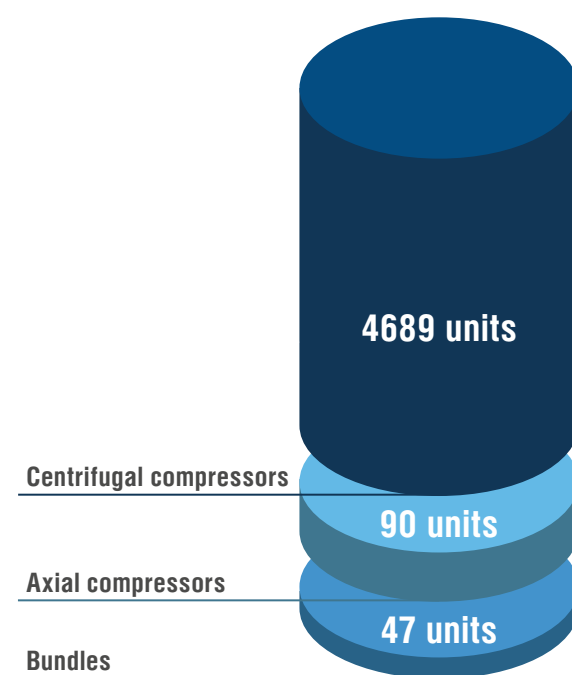
Key figures

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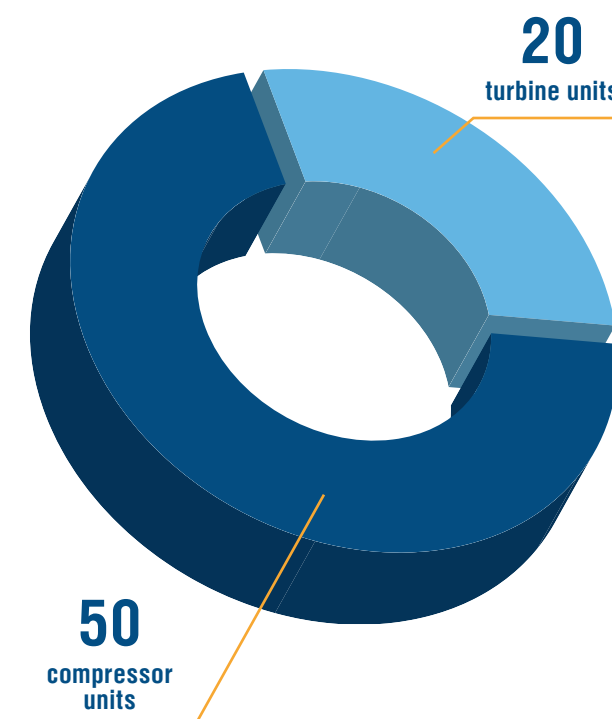
Units produced (1947-2020)



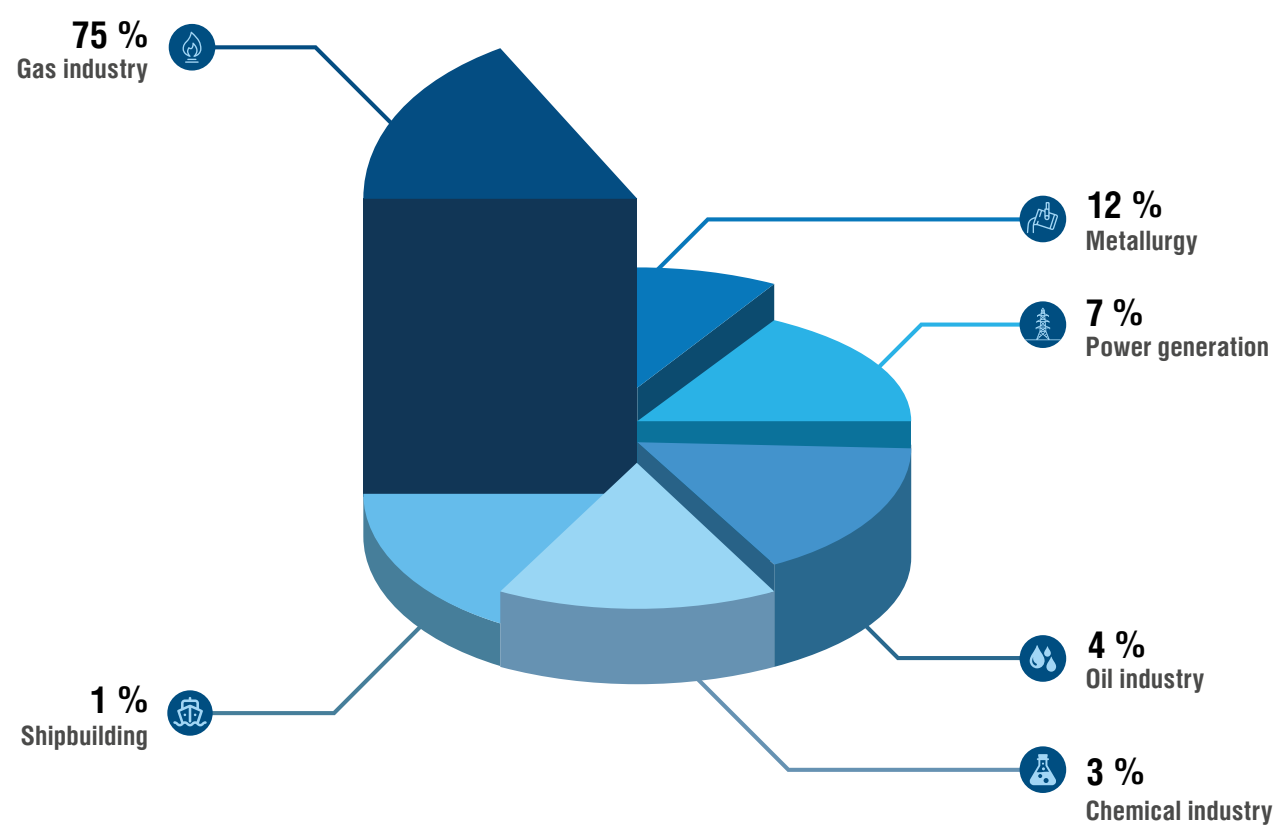
Compressor equipment



Production capabilities (annual)



Industrial distribution of Nevskiy Zavod products



70 YEARS
> 11000
 units of 400 types designed and manufactured

60 YEARS
> 80%
 of the equipment fleet operate safely at the operation facilities

> 10
 licenses from the world's manufacturers: General Electric, Solar Turbines, Siemens, S2M (SKF)

> 1000
 projects implemented

> 6500
 units in operation

> 2000
 employees



Manufacturing facilities

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Test facility	50

The success of Nevskiy Zavod is mainly based on the state-of-the-art production facilities and permanent up- grading of the technical equipment.

Due to the applied high-tech equipment, advanced procedures, and materials Nevskiy Zavod offers to the Customer competitive and high-quality Products.

Nevskiy Zavod is a modern production complex equipped with the state-of-the-art manufacturing machinery from the world's leading manufacturers that provide a full cycle of production - from mechanical machining to assembly, integrated tests, installation and service maintenance.

The main product line includes heavy-duty gas turbines rated from 16 to 32 MW, steam turbines, centrifugal and axial compressors, gas-pumping units and electrically driven gas-pumping units, in-house metallurgical products.

Thanks to systematic retooling and successful experience in localization of world technologies, Nevskiy Zavod is a key Russian manufacturer of turbo-compressor equipment for the largest infrastructure projects in the country, a leader in the segment of industrial medium power gas turbines, the only Russian manufacturer of industrial gas turbines rated at 16 and 32 MW and mixed refrigerant compressors for LNG production.

Nevskiy Zavod is equipped with modern intelligent machine tool fleet and equipment from the world's leading manufacturers (Mori Seiki, Okuma, Tos Varnsdorf, Skoda and other).

Production structure of Nevskiy Zavod

- Metallurgical production.
- Blank-and-welding production.
- Machinery production.
- Packaging.
- Test facilities.

The manufacturing process at Nevskiy Zavod is organized as a closed-circuit small-batch or single piece production due to the specifics of the products produced. In-house metallurgical production provides castings which are then transferred to the machine-assembly departments where individual parts are machined and manufactured and then assembled into assembly units and finished products. The machine-assembly departments include the test facilities where the manufactured units undergo comprehensive bed tests.

The only Russian manufacturer of industrial gas turbines rated at 16 and 32 MW



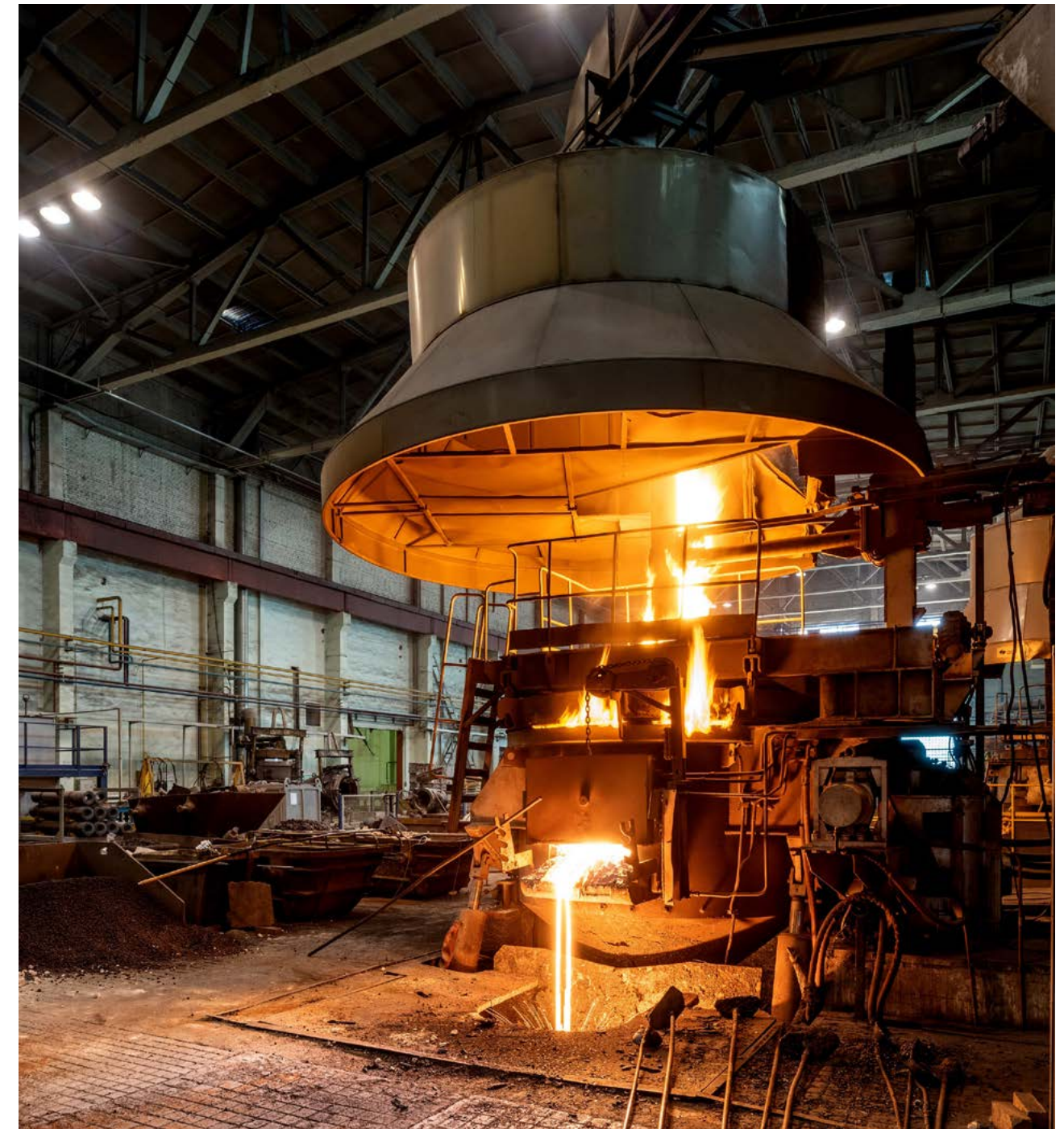
Metallurgical production

Specialization

- steel casting for mechanical parts up to 2.0 t, of carbon, alloyed (corrosion-resistant, non-magnetic) steels;
- iron casting for general purpose and power-generating parts of grey and high-strength cast iron, up to 2.5 t.
- manufacture of steel ingots from 0.5 to 3.0 t, of carbon, alloyed and high alloy steel grades.

Metallurgical production includes

- Pattern making.
- Metallurgical production.



Manufacturing facilities

The metallurgical complex is the most important link in the chain of production and packaged supply of Nevskiy Zavod equipment.

The metallurgical complex is fitted with state-of-the-art equipment that meets the highest requirements for quality, safety, environment and efficiency of production.



Molding area

Pattern making

Manufacture of wooden patterns for products of cast iron and steel, as well as expanded polystyrene patterns.

Pattern making is carried out using advanced methods on high-precision CNC machines, which makes it possible to perform work of any complexity, reduce the cost of manufacturing, increase the output rate, achieve high quality of machined surfaces.

Pattern making by advanced methods on high-precision tools



Five-axis CNC machine Dinamic FC 4000 for pattern making

Foundry production

Includes:

- molding area;
- melting – and – casting area;
- casting dressing area;
- heat – treatment area;
- machining area;
- inspection.

Molding area

Manufacture of sodium silicate and resin-coated (α -set process) molding and core sand mixtures by means of a screw mixer. Such mixtures are used to produce cores and casting moulds.

Melting-and-casting area

The area capacity is 4300 tons of molten metal/year. The modern general-purpose DC melting furnaces DPPTU -3 and DPPTU -0,5 from “Ekta” company are used for melting. Steel making and iron smelting, including high strength iron, is performed. To produce high strength iron, ladle spheroidizing modification with a cored wire (by means of a wire feeding machine) is used.

The capacity of melting furnaces (3 and 0.5 tons) makes it possible to produce castings in various steel grades up to 2 tons and cast iron, including high-strength, castings up to 2.5 tons.



Melting -and-casting area

Casting dressing area

Knockout of castings, dressing and rough machining.

Heat-treatment area

Heat treatment of castings provides for the following conditions: annealing, normalizing and tempering, stress-relief tempering, double-normalizing with tempering, and quenching.

The area is equipped with four heat-treatment furnaces and a Bosio quenching tank.



Dressing area



Heat-treatment area

Machining area

In this area pre-machining of castings and forgings is performed, as well as samples are cut out to check the metal chemical composition and mechanical properties.

The area is equipped with screw-cutting lathes, turning-and-boring lathes, horizontal boring machines, rough-grinding machines, vertical-milling and other machines for machining of castings with a mass up to 2.5 tons.



Metal casting in the melting-and-casting area of Nevskiy Zavod

Metallurgical products undergo the following types of control:

- ultrasonic testing;
- radiography;
- magnetic particles testing;
- express-testing of metal during the melting process by means of the emission vacuum spectrometer ARL3460;
- inspection of metal mechanical properties on samples.

Metallurgical complex products

Iron casting

Iron casting for parts of grey iron, up to 2.5 tons.

Product specifications

Description	Cast iron grade
Gas turbine shrouds	C425, B440
Pump housings	C425
Suction chambers of gas turbines	C425, B440
Diaphragms with steel blades of steam turbines	C415, C420, C425, C430
Covers and housings of gearboxes	C415, C420, C425
Ingot moulds for steel ingots	C415
Steam turbine bearing housings	C415, C420, C425
General-purpose plates	C415, C420, C425

*Weighing out in tons up to 2.5



LPT exhaust plenum



Compressor casing

Steel casting

Steel castings of carbon, alloyed (corrosion-resistant, non-magnetic, etc.) steel up to 2 t for mechanical products.

Product specifications

Product description	Steel grade
Steam turbine HP cylinders	20ХМЛ, 15Х1М1ФЛ, 20ХМФЛ
Feed spouts	20ГСЛ, 25Л, 35Л
Centrifugal wheels	20ГСЛ, 25Л, 30Л
Steam and nozzle boxes	15Х1М1ФЛ, 20ХМЛ, 12ХМЛ, 20ХМФЛ, 25Л
Gate valves, shutoff valves	15Х1М1ФЛ, 20ХМЛ, 12ХМЛ, 20ХМФЛ, 25Л
Nonmagnetic pressure rings	НЛ-30 (30Х3Н17Г2Л)

* Weighing out in tons up to 2.0

Delivery sites

Most of the products are manufactured as part of packaged supply of the power-generating equipment. Apart from the internal application of the metallurgical complex products, external cooperation with large metallurgical companies is implemented (PJSC "Power machines" Branch -LMZ"; JSC "KMZ "Izhora Metal"; JSC "Northern Metallurgical Company"; LLC "OMZ-Foundry"; JSC "Ural Turbine Plant", etc.)



Turbine casing elements



Compressor casing

Blank-and-welding production

Manufacture of welded metal structures for various purposes for power engineering industry.

Manufacturing equipment

- Blank production: gas plasma cutting machines 2.6 m x 36 m; 3 m x 6 m (sheet thickness: carbon steel up to 160 mm, nonstainless steel — up to 70 mm).
- Pressure shaping equipment: hydraulic press (power 1250 t), roll mills (3 and 4 roll mill - rolling thickness up to 40 mm), pipe bending equipment (pipes up to Ø 108x6), guillotine-shears (sheets up to 14 mm thick).
- Welding: welding machines from leading manufacturers and associated welding equipment: semiautomatic welding (MIG/MAG) EWM, Lorch, Lincoln.
- Argonarc (TIG) and manual welding units (MMA) kempfi, EWM, Lorch.
- H-beam welding area: welding tractor with a power source, welding column with a power source and a straightener for H-beams.
- Mechanical: turning (of DIP-300 type), turning-and-boring (upto Ø2250 mm), planing (up to 4 m), rolling, milling, drilling and boring machines without CNC, not high accuracy, for weld preparation.
- Other: shot-blasting chamber (ВШД 4970 x 5850 x 11100, cart 25 t); painting-and-drying chamber Savim s.r.l; gas furnace (height 1600, bottom 2450 x 3980).

Blank-and-welding

- Blank-and-mechanical production: gas cutting and hot forging area; mechanical area.
- Assembly-and-welding production: baseplate area; pipe area; assembly area for compressor wheels and cylinders; assembly-and-welding area.

Main products

- Metal structures of baseplates for compressors, turbines, auxiliary equipment.
- Vessel and heat-exchanging equipment — condensers, air coolers, oil tanks and associated piping.
- Welded casings of air compressors (K-3000, K-5500 etc.).
- Air ducts, rectangular and round in section, air filters, exhaust systems for turbines.
- Turbine inlet, exhaust plenums.
- Maintenance platforms (platforms, ladders, fencing).
- All blanking operations of NZL with the use of gas, plasma cutting, metal cutting, forging, shaped bending.

Limitation: crane of 80 t.



Assembly-and-welding production



Auxiliary baseplate manufacture

Machinery production

Machinery production structure

- Blades production.
- Rotor production.
- Casing production.
- Tools production.
- Magnetic bearings production area.
- Assembly production.
- Test bed department.



Blades production

Mechanical machining specializaton

Combined mechanical machining of products of rotor blade/guide vane type for gas/steam turbines, tooling for manufacture of turbines, compressors, magnetic bearings.

Manufacturing facilities

High-accuracy machine tools fleet, including milling and EDM machines, 5-axis machining centers from the world manufacturers (Okuma, Sodick and other).

These machines are equipped with CNC systems that make it possible to perform high-quality combined mechanical machining according to the product parameters. There is also general-purpose equipment of various modifications to solve a wide range of tasks (horizontal-milling, vertical-drilling, longitudinal-milling, copy-milling, polishing machines, etc.).

Manufacturing capabilities parameters

Combined machining up to	Ø 350 mm, L 1400 mm
Milling up to	width 1050 mm, length 560 mm, height 460 mm
Erosion machining up to	width 570 mm, length 400 mm, height 350 mm





Wire EDM



5-axis machining center Okuma MakTurn 250

EDM machines



Sodick AQ 537L

Equipment specifications

Max machining diameter	Ø 350 mm
Center-to-center distance	1400 mm
Axis movement*	X = 475 mm, Y = 80 mm, Z = 1170 mm, C = 360°
Main spindle speed	38–5000 rpm
Tool spindle speed	50–6000 rpm

* X – length, Y – width, Z – height

Equipment specifications

Work piece dimensions	570 X 370 X 350 mm
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Станок Sodick AQ 55L

Equipment specifications

Work piece dimensions	550 X 400 X 350 mm
-----------------------	--------------------

Automated mechanical machining center for compressor blades



UNIKA 1100 machine for 5-axis milling of blades

Parameter	Unika 1100
Operating area	
X-axis motion, mm	1100
Y-axis motion ; mm	600
Z-axis motion; mm	600
Max. length of the blade; mm*	470
Max.diameterof the blade; mm	350
Max. mass of the blade; kg	20
Milling head	
Spindle taper	HSK-63 A
Speed, rpm	20 000

* Depending on the clamping fixtures used

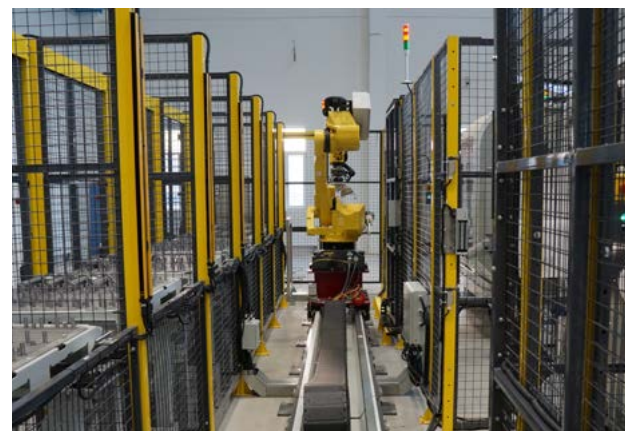
UNIKA 1700 turning machine for 5-axis milling of blades with a turning function

Parameter	Unika 1700 turning
Operating area	
X-axis motion; mm	1700
Y-axis motion; mm	600
Z-axis motion; mm	600
Max length of the blade; mm*	1066
Max diameter of the blade; mm	400
Max mass of the blade; kg	50
Milling head	
Spindle taper	HSK-63 A
Speed, rpm	20 000
Rotary tables	
Angular accuracy; c	+/-5
Max speed; rpm	1000
Max speed of spindle when turning	1000

* Depending on the clamping fixtures used

M710iC/70 Robot machine with 6 controlled axes

Parameter	m710ic/70
Main characteristics	
Rated robot capacity, kg	70
Max radius of the robot operation, mm	2050
Positional repeatability of the robot tool, mm	+/-0,04
Number of the robot axes, pcs	6
Travel speed on the track with a load, m/min	60
Positional repeatability of the linear axis, mm	+/-0,1



Robot-operated machine Fanuc M-710 ic 70



Robot-operated machine for shot peening Roesler ALS 2800 RP



External view of the robot-operated shot - peening machine Roesler ALS 2800 RP



Blasting chamber ALS 2800

Equipment description

- Blasting chamber ALS 2800 with a L-shaped door.
- Rotary table (dia 1500 mm).
- 6 satellites on the rotary table.
- Robot ABB 4600 for external and internal machining.
- Filtering module ATEX.
- Pneumatic system for shot recovery with a cyclone and a switch.
- Recirculation system with one magnetic separator.
- 2 sieve systems SWECO.
- 2 double spiral separators.
- 2 doublehead tanks, each with 2 Magna-valves/2 metering systems.
- 2 double head tanks, each with 3 Magna-valves/3 metering systems.
- 2 x 3 blasting lines + 2 x 2 blasting lines.
- One calibrating weight measuring system.
- 4 systems for shot metering.
- Electrical cabinet with PLC Siemens S7.
- PC with a supervisory control system SUPERVISOR MASTER.

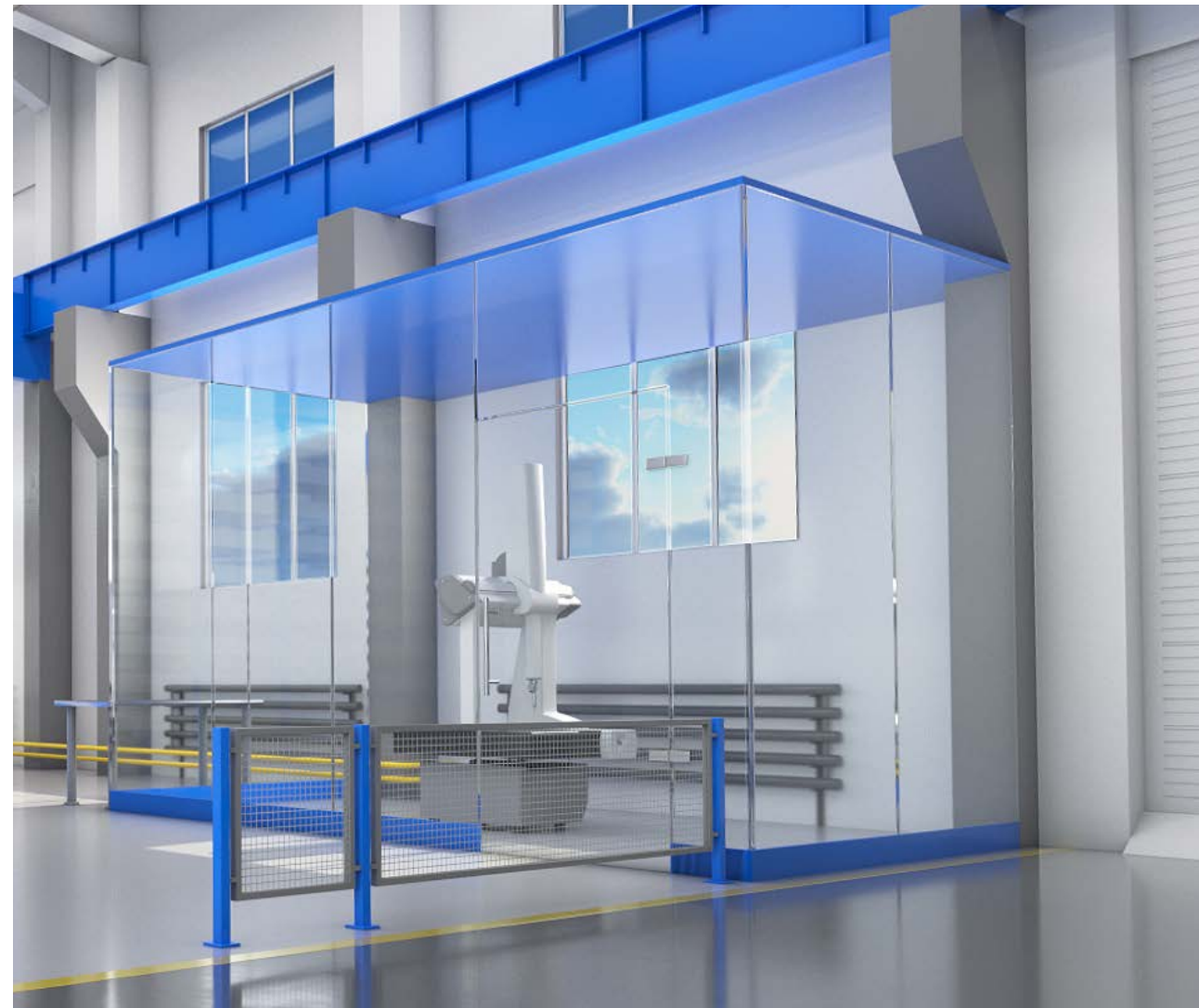
Shot peening is the process of “bombing” the surface of the product with microbeads (steel, ceramic or glass), the purpose of which is to form a plastically deformed surface layer (with a depth approximately equal to the diameter of the microbeads used); thereby high-intensity residual compressive stress is induced (up to half the yield limit of the material hardened).

Introducing surface residual stresses is useful for the following reasons:

- enhanced microhardness of the product surface means increased wear resistance;
- tensile stresses that develop in the material as a result of external loads application (centrifugal force, thermal loads) are added to the acting residual compressive stresses – hence, the level of the resulting stresses is reduced compared with the product not hardened;
- a growing surface crack requires much more energy to overcome the local area of compressive stresses than in case without hardening.

As a result, hardened parts are characterized by a higher endurance limit - with a cyclic load of more than 105 cycles — up to 20%.

Coordinate measuring machine COORD3 Universal 10-7-7



Measurement range on axes x, y, z: X-Y — not less than 1000 mm; Z — height from the table to quill — not less than 700 mm

Rotor production

Mechanical machining specialization

Combined mechanical machining of such product types as wheel, disk, balance piston, shaft, rotor and parts for manufacture of gas and steam turbines, compressors, magnetic bearings.

Manufacturing facilities

The production department is equipped with high-accuracy machine tool fleet consisting of turning lathes, 5-axis turning and milling machining centers from the world manufacturers (WFL, HOESCH, HEIDE, MAX MUELLER and other).

These machine tools are equipped with CNC systems that make it possible to perform high quality combined machining according to the product parameters. There is also general-purpose equipment of various model types to solve a wide range of tasks (turning, horizontal-milling, horizontal-boring, vertical-milling, grinding turning-and-boring, radial-drilling, surface-grinding, cylindrical-grinding, centerless-grinding machines, etc.).

Equipment specifications

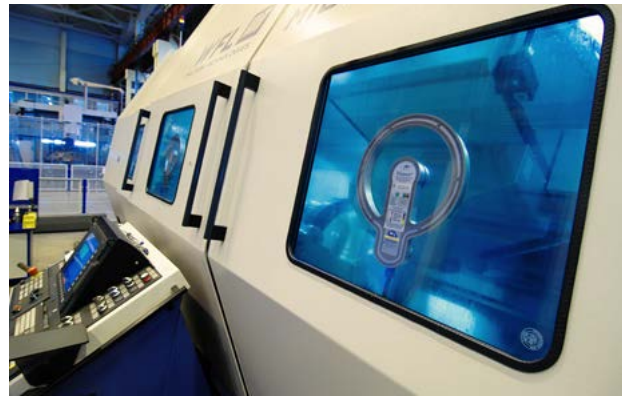
Max machining diameter	Ø 1500 mm
Center-to-center distance	5000 mm
Axis travel	X = 1120 mm, Y = 800 mm, B = -110°/+90°
Main spindle speed	1600 rpm
Tool spindle speed	3200 rpm

Manufacturing capabilities parameters

Rough machining up to	Ø 2600 mm, L 8000 mm
Tool spindle speed	Ø 1300–1500 mm, L 5000–6000 mm



Nevskiy Zavod rotor production



5-axis machining center WFL 150



5-axis machining center WFL 150



Nevskiy Zavod rotor production



5-axis machining center WFL 150

Equipment specifications

Max machining diameter	Ø 1500 mm
Center-to-center distance	6000 mm
Axis travel	X = 1500 mm, Z = 6000 mm
Main spindle speed	500 rpm
Max mass of work piece	30 000 kg

Casing production

Mechanical machining specialization

Combined mechanical machining of such product types as disk with blades, diaphragm, wheel, casing, frame, package stator, compressor unit and parts for manufacture of gas and steam turbines, compressors, magnetic bearings.

Manufacturing facilities

The production department is equipped with high-accuracy machine tool fleet consisting of turning-and-boring lathe, horizontal boring, milling, drilling machines, 5-axis machining centers from the world manufacturers (Skoda, Tos Varnsdorf, Toshulin, Waldrich Coburg, Okuma, etc.).

These machine tools are equipped with CNC systems that make it possible to perform high quality combined machining according to the product parameters. There is also general-purpose equipment of various model types to solve different tasks (turning-and-boring lathes, horizontal boring, radial drilling machines, etc.).

Manufacturing capabilities parameters

Turning-and-boring machining up to	Ø 6300 mm, L 5000 mm
Horizontal boring up to	width 3500 mm, length 3500 mm, height 3750 mm
Portal milling up to	width 3500 mm, length 12 000 mm, height 3500 mm



5-axis machining center OKUMA VTM 2000 YB



5-axis machining center OKUMA VTM 2000 YB



5-axis machining center OKUMA VTM 2000 YB

Equipment specifications

Max machining diameter	Ø 2000 mm
Max dia of work piece	Ø 2400 mm, L 1400 mm
Axis travel	X = 1600 mm, Y = ±800 mm, Z = 1400 mm, C = 360° B = -30/120
Tool spindle speed	40–10 000 rpm
Faceplate	Ø 2000 mm
Faceplate speed	4–200 rpm
Max mass of work piece	10 000 kg

Portal type vertical milling centers

Equipment specifications

Max work piece	h = 3500 mm
Column spacing	4400 mm
Table	12 000 x 3600 mm
Axis travel	X = 13 500 mm, Y = 5400 mm, Z = 1000 mm, W = 2400 mm
Spindle speed	1000 rpm
Max mass of work piece	m = 1500 kg/m ²



Portal milling machine W. Coburg 20-10GM360NC

Equipment specifications

Maximum work piece	h = 2000 2500 x 6500 mm
Column spacing	2800 mm
Table	2500 x 6500 mm
Axis travel	X = 6500 mm, Y = 2500 mm, Z = 1000 mm W = 2500 mm
Spindle speed	1000 rpm
Max mass of work piece	25 000 kg



Portal milling machine W. Coburg 17-10FP250NC

Tools production

Mechanical machining specialization

Combined mechanical machining of such product types as disk with blades, flanged sleeve, wheel, casing, shoe, valve, bolt, nipple, stud, tooling for manufacture of gas and steam turbines, compressors, magnetic bearings.

Manufacturing facilities

The production department is equipped with high-accuracy machine tool fleet consisting of horizontal boring, milling, drilling machines, 5-axis machining centers from the world manufacturers (Tos Varnsdorf, Okuma, Mori Seiki, etc.).

These machine tools are equipped with CNC systems that make it possible to perform high quality combined machining according to the product parameters. There is also general-purpose equipment of various model types to solve a wide range of tasks (turning, turning-and-boring, vertical-milling, radial-drilling, coordinate-boring, surface-grinding, bench-drilling, universal shapening, internal-grinding, cylindrical-grinding, centerless-grinding machines, etc.).



5-axis machining center Mori Seiki NT4200DCG/1500S



Equipment specifications

Combined machining up to	Ø 660 mm, L 1576 mm
Turning up to	Ø 710/420, L 2000 mm
Turning-and-boring up to	Ø 1250 mm, L 800 mm
Horizontal boring up to	width 1250 mm, length 1400 mm, height 1400 mm

Magnetic bearings production area

Magnetic bearings are produced under the SKF (S2M) licensed technology.

Mechanical machining specialization

Complete cycle of the magnetic bearing subassemblies assembly, from iron rough pieces arriving from the mechanical machining production departments to finished product release.

Manufacturing facilities

The production department is fitted out with up-to-date equipment for all stages of assembly of magnetic bearing subassemblies: axial bearing, radial bearing module and radial - axial bearing module.

The production area includes

- Machine tools for high-accuracy and high-speed winding of inductance coils required for various subassemblies of magnetic bearings.
- Autoclave for impregnation of individual parts of the magnetic bearing in the electric varnish at a certain pressure and temperature, which provides varnish penetration into all components, closing all air pockets and ensuring high quality impregnation.
- Drying ovens for varnish drying and crystallization.
- Special facility for electrical testing at all stages of assembly, including a waterproof testing machine.

Equipment specifications

Max machining diameter	Ø 660 mm
Center-to-center distance	1576 mm
Axis travel	X = 750 mm, Y = ±210 mm, Z = 1550+100 mm, B = ±120°
Main spindle speed	5000 rpm
Tool spindle	12 000 rpm



Magnetic bearing production area



Assembly production

Main activities

- Assembly of axial and centrifugal compressors, gas and steam turbines.
- Hydraulic tests of centrifugal compressor covers and casings.
- Hydraulic tests of K-5500, K-6600 compressor type casings.
- Hydraulic tests of confusers and process pipeline connections.
- Pneumatic tests of centrifugal compressor diaphragms.
- Mechanical tests of assembly fixtures by load lifting.
- Tests of bearing, gas turbine and axial compressor casings with kerosene.

Manufacturing equipment

- Assembly stand for gas turbines.
- Assembly stands for vapor compressors.
- Assembly stands for axial compressors.
- Assembly stand for centrifugal compressors.
- Subassembly area for turbine parts.
- Steam turbine assembly area.
- Centrifugal compressor assembly area.
- Hydraulic test area.
- Washing, drying and painting chambers.
- Shot-blasting and sand-blasting chambers.





Packaging

Manufacturing equipment

- Blank production (pipeline manufacture):
band saws;
pipe cutter;
manual plasma and gas cutting;
pipe benders.
- Welding:
welding machines;
semiautomatic machines (MMA, TIG, MIG/MAG);
plates;
driving roller devices;
manipulators (up to 12 tons);
calibrators.

Limitation

- Welding area – 80 ton crane;
- Packaging area – 200 ton crane.

Main activities

- Welding of centrifugal and axial compressor elements: compressor casings, nozzles and confusers (for connection to main pipelines), rotor impellers, diaphragms and stator blades, suction covers, discharge covers.
- Welding, brazing of gas and steam turbine elements: casing parts, diffusers, ducts, diaphragms, shrouds, steam turbine wheels.
- Welding of air, fuel pipelines, headers; piping bending, fitting.
- Welding of air compressor and blower impellers (K-3000, K- 5500, K-6600, H-9000).
- Welding of parts made of high-strength steels with preliminary and concurrent heating. Welding of parts made of heat-resistant nickel-cobalt alloys.
- Packaging, piping, electric harness, connection of turbines and compressors.
- Assembly, connection of instrumentation, regulators block- cabinets
- Assembly of SKF (S2M) magnetic bearing parts, gluing of electric steel lamination and vacuum impregnation of electromagnetic coils.



Test facility

The production site of Nevskiy Zavod is equipped with unique high-tech test beds.

Mechanical, performance and investigation integrated tests of the manufactured turbocompressor equipment are carried out on these test beds.

Test beds

- Gas turbine test bed.
- Steam turbine test bed.
- Centrifugal compressor test beds.
- Axial compressor test beds.
- Vibration test bed.
- High-voltage tests.
- High-speed and low-speed balancing machines.



T16 gas turbine test bed



32 MW gas turbine test bed



Centrifugal compressor test bed



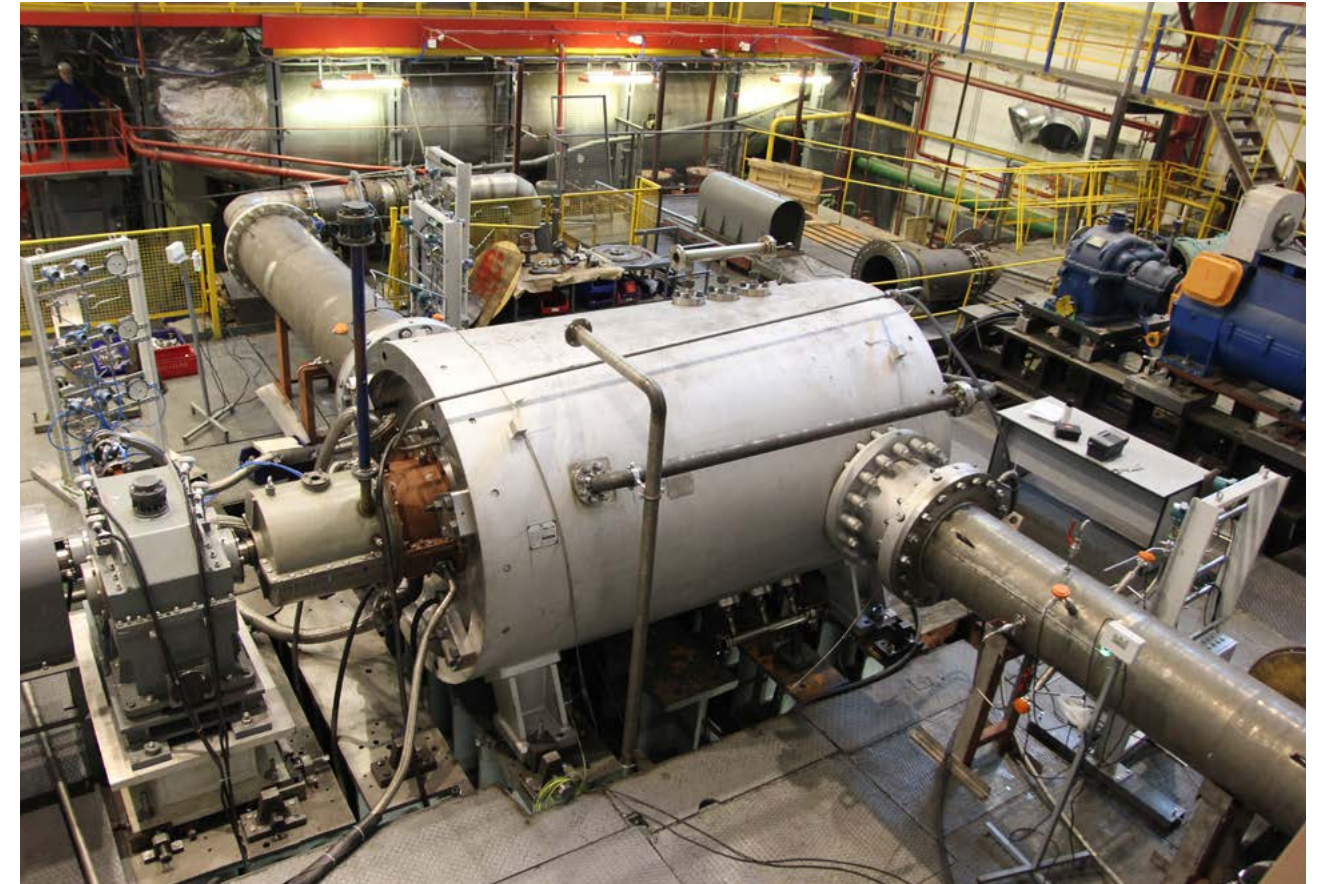
Axial compressor test bed



Schenck high-speed balancing machine



Steam turbine test bed



Centrifugal compressor test bed on model gas in a closed circuit



Equipment for gas industry

05

Gas-pumping units with a gas turbine drive	54
Gas-pumping unit GPA-32 “Ladoga”	54
T32 GTU rated at 32 MW	57
Centrifugal compressors for GPU rated at 32 MW	59
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Electrically driven gas-pumping units (EGPU)	72
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Changeable flow channels (bundles) for modernization of natural gas compressors	84

Gas-pumping units with a gas-turbine drive

Design and manufacture of the equipment for gas industry is one of the top priority lines of Nevskiy Zavod activities.

A new line of gas-turbine units (GTU) in the power range from 16 to 32 MW has been developed. Nevskiy Zavod offers manufacture and supply of gas-pumping units rated at 16, 25 and 32 MW produced and assembled in-house.

Manufacture and supply of gas-pumping units rated at

16
MW

25
MW

32
MW

Gas-pumping unit GPU-32 “Ladoga”

Nevskiy Zavod produces a high-technology gas-pumping unit “Ladoga-32” operable in any challenging environmental conditions, remarkable in its high efficiency (36 %), low emissions and prolonged service life.

GPA-32 “Ladoga” is a key link in the strategic program for reconstruction of the Russian gas transmission system. This is a new high-efficient unit designed for the Russian market which has been successfully operating at many compressor stations in Russia.



GPU-32 “Ladoga” equipment in the packaging area of Nevskiy Zavod

GPU layout options at compressor stations

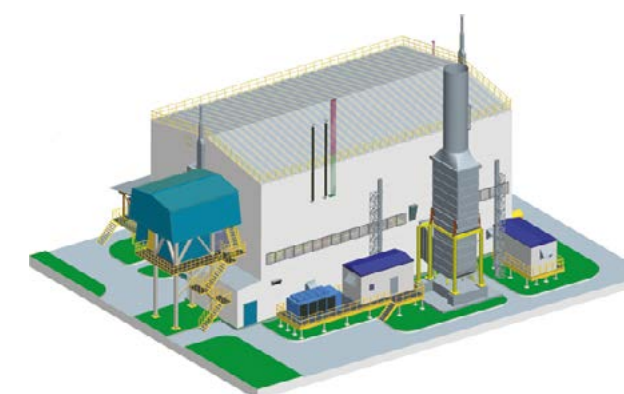


Advantages

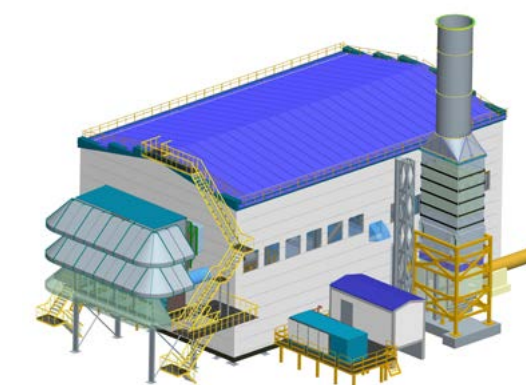
- Technologically perfect product for transmission of natural gas at a pressure up to 220 atmospheres.
- High efficiency.
- Low level of harmful emissions in compliance with the up-to-date environmental standards.
- High reliability and operational availability.

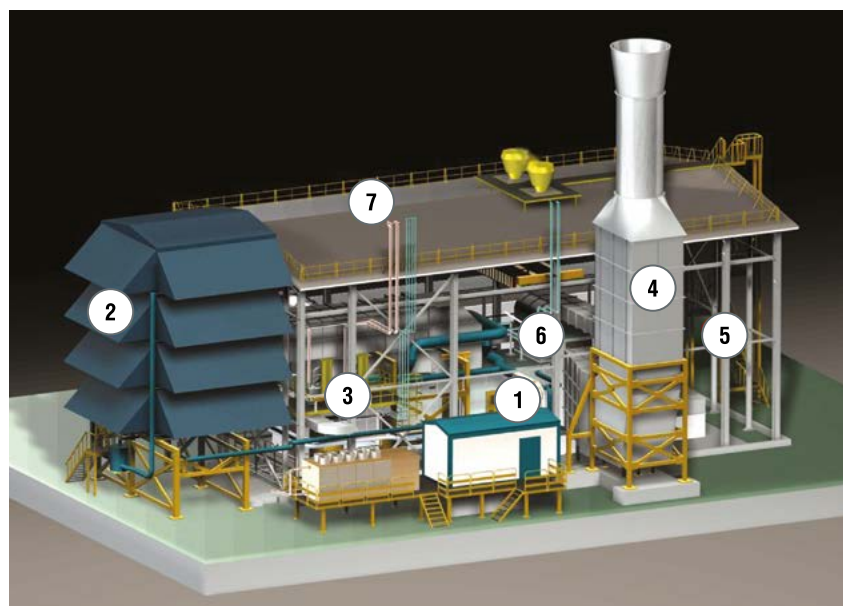
Unit configuration

- T32 gas turbine unit rated at 32 MW.
- Centrifugal compressor.
- Control and power supply system.
- Hangar building with lifting equipment and the following systems:
 - air filtering;
 - exhaust gas recovery;
 - GTU module ventilation, cooling;
 - hangar building ventilation;
 - buffer gas supply;
 - barrier and instrument gas (air/nitrogen supply);
 - fuel gas supply;
 - oil supply system;
 - washing of the GTU axial compressor flow channel;
 - fire-fighting;
 - lighting;
 - CCTV.



GPA-32 “Ladoga”
The total operating time throughout the world to this date is more than **16 million hours**





GPU-32 "Ladoga" configuration

- 1 T32 gas turbine unit
- 2 Filter house
- 3 GTU cooling and ventilation syhstem
- 4 Exhaust system
- 5 Natural gas compressor
- 6 Integrated automatic control system (KSAU) consisting of two units — ACS and electric ones
- 7 Individual hangar-type building

GPU-32 "Ladoga" main technical characteristics

Parameter	Type		
	GPU-32	GPU- 32-02	GPU- 32-03
Drive coupling rated power, on site conditions; MW, no less than	31,2	31,2	31,2
Volume capacity referred to the normal conditions (0.1013 MPa, 20 °C); mil m ³ /day	78,9	62	66
Polytropic efficiency of the centrifugal compressor; %, no less than	85	80	80
GTU effective efficiency when operating at rated power, on site conditions; %, no less than	36	36	36
Rated gas operating pressure, abs., at the centrifugal compressor outlet; MPa	11,86	7,45	7,45
Pressure ratio	1,4	1,44	1,38
Rated speed of the GTU power turbine rotor	5714	5714	5714
Temperature downstream of the turbine; °C (rated /max)	510/600	510/600	510/600
Fuel gas flow; kg/s	1,74	1,74	1,74

T32 gas turbine unit rated at 32 MW

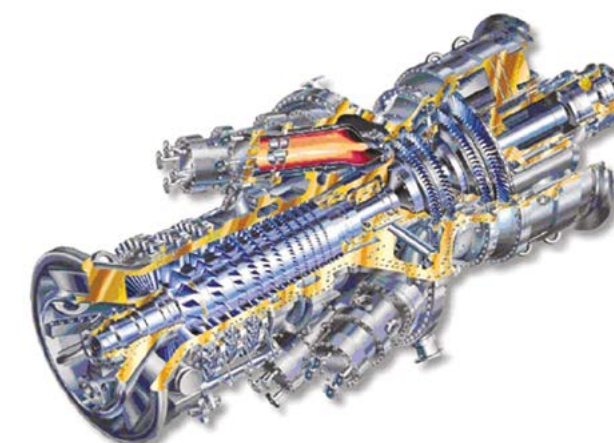
- T32 is a high-technology turbine rated at 32 MW produced by Nevskiy Zavod under the license of GE Oil & Gas (Nuovo Pignone S.p.A.);
- A new generation machine for any challenging environmental conditions.

Advantages

- Rated power — 32 MW.
- High efficiency — 36 %.
- Improved enviornmental performance, low level of emissions (NOx = 18 ppm).
- Long service life, high level of repairability.
- T32 is a multipurpose turbine.



32 MW GTU on the Nevskiy Zavod production site



Longitudinal section of 32MW GTU

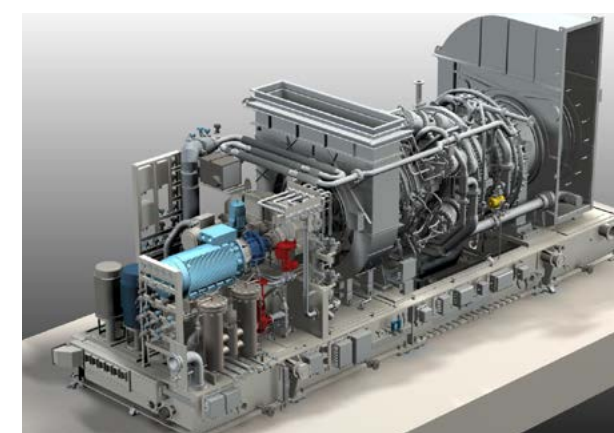
The GTU is produced in two design versions — two-frame (T32) and single-frame (T32-1)

Application

- As part of gas-pumping units at compressor stations of gas-main pipelines.
- As part of combined-cycle plants at Combined Heat and Power Plants and Central Heating and Power Plants.
- In ship-building as the main propulsion plant for ships and vessels.



Single-frame design of T32-1 with enclosure

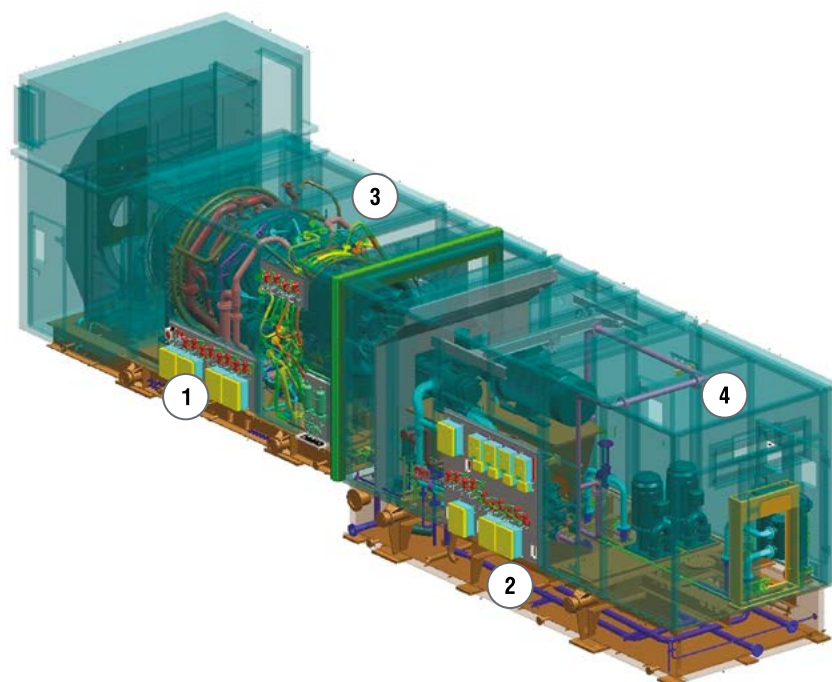


Single-frame design of T32-1

The main systems of the gas turbine unit

Two-frame design of T32 GTU

- 1 Turbounit T32 on its own baseplate
- 2 Auxiliary baseplate with all systems providing the GTU operability: starting system, oil supply and fuel system
- 3 Heat-and-noise insulating enclosure of the GTU
- 4 Heat-and-noise insulating enclosure of the auxiliary baseplate



The main parameters of T32

Parameter	Value
Rated drive coupling power corrected according to GOST R 52200–2004; MW, no less than	32
GTU effective efficiency corrected acc. to GOST R 52200–2004 when operating at rated power; %, no less than	36
Rated speed of the LPT rotor; rpm	5 714
Variation range of the LPT rotor speed; % of the rated value	70 to 105
Sense of LPT rotor rotation, if viewed from the side of the loading device; CW	GOST 22378-77
Time of startup and acceleration to the minimum operating mode (from the hot standby condition); min	25
Rated fuel gas flow; kg/s	1,74
Fuel gas pressure; g, MPa	от 3,1 до 3,5
Irrecoverable oil losses; kg/h, no more than	0,25
Rated/max temperature of combustion products downstream of the turbine (across the turbine exhaust duct section); °C	510/600
Combustion air flow in the nominal operating mode; kg/s	100
Combustion products flow (across the turbine exhaust duct section); kg/s	101,7
Air pressure ratio in the axial compressor	17
Harmful substance content of exhaust gas (measured in the dry sample at 0°C, 0.1013 MPa and standard oxygen concentration of 15%):	
NO _x , mg/m ³ , no more than	34,7
CO, mg/m ³ , no more than	
Rate of harmful substance emission with combustion products at the rated power conditions:	
NO _x , g/s, no more than	3,7
CO, g/s, no more than	2,6

Centrifugal compressor for GPU rated at 32 MW

Natural gas compressor of H-400 type

Brief description

The machine is designed for gas transmission via gas-main pipelines as part of the gas-pumping unit rated at 32 MW, operates as part of gas pipeline systems with a working pressure of 11.86 MPa (basic version 400-21-1C) and 7.45 MPa (versions 400CПЧ1, 44/76-32C and 400CПЧ1, 38/ 76-32C)

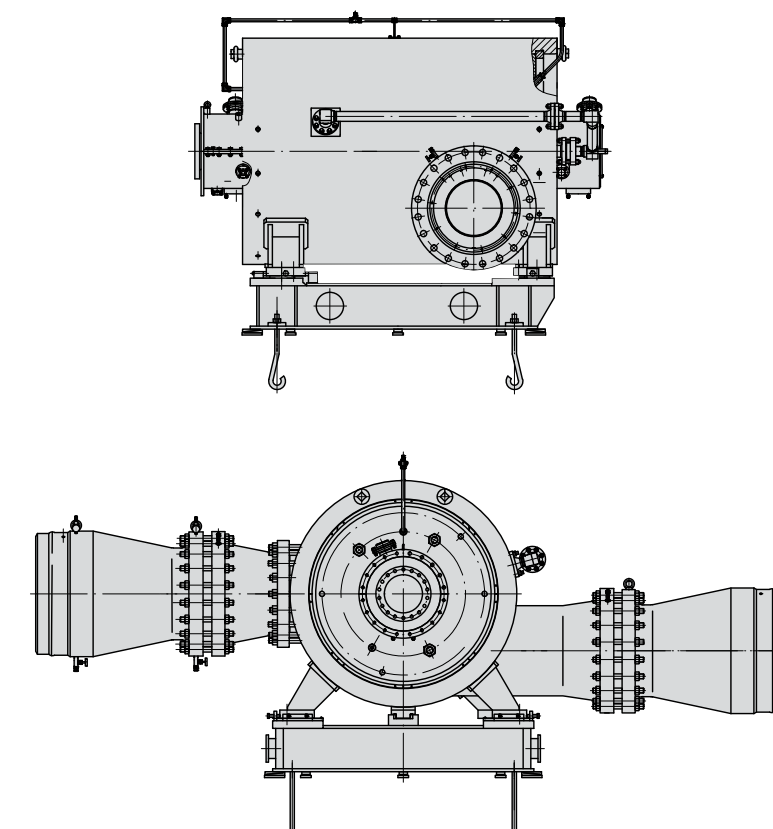
Advantages

- Efficiency no less than 0.85.
- Pressure ratio 1.44.
- Capacity referred to initial conditions 505 m³ rpm.
- Design speed of the compressor rotor 5550 rpm.
- Application of flow channels with varying geometry.

Configuration

Centrifugal two-stage compressors 400-21-1C, 400CПЧ1, 44/76-32C and 400CПЧ1, 38/76-32C are completely unified in their casing, running gear and drive coupling. The base compressor 400-21-1C has a flow channel with vaned diffusers, compressors 400CПЧ1,44/76-32C and 400CПЧ1, 38/76-32C have flow channels with vaneless diffusers.

All compressors are equipped with dry gas seals made by “John Crane Iskra”. The compressor consists of a casing in assy, a package (flow channel), pipelines, journal and journal -thrust bearing housings.



Technical characteristics

Parameter	Type		
	400-21-1C	400СПЧ 1,44/76-32С	400СПЧ 1,38/76-32С
Capacity referred to the normal conditions (0.1013 MPa and 20 °C); million m ³ /day	78,9	62	66
Volume capacity at the initial conditions; mil m ³ /day	505	748	780
Power consumed; MW	30,4	29,5	28,3
Polytropic efficiency; %, no less than	85	85	84
Pressure ratio	1,4	1,44	1,38
Final gas pressure (abs.); MPa	11,86	7,45	7,45
Compressor inlet temperature; °C	5	15	20
Compressor rotor speed; rpm	5550	5550	5550

Note

The compressor parameter values can be changed for specific operating conditions required. The design speed of the compressor rotor is 97–98 % of the turbine rated speed according to cl. 5.23 “Standard technical requirements for GPU with a gas turbine drive and its systems” Gazprom Standard 2.3.5-138-2007.

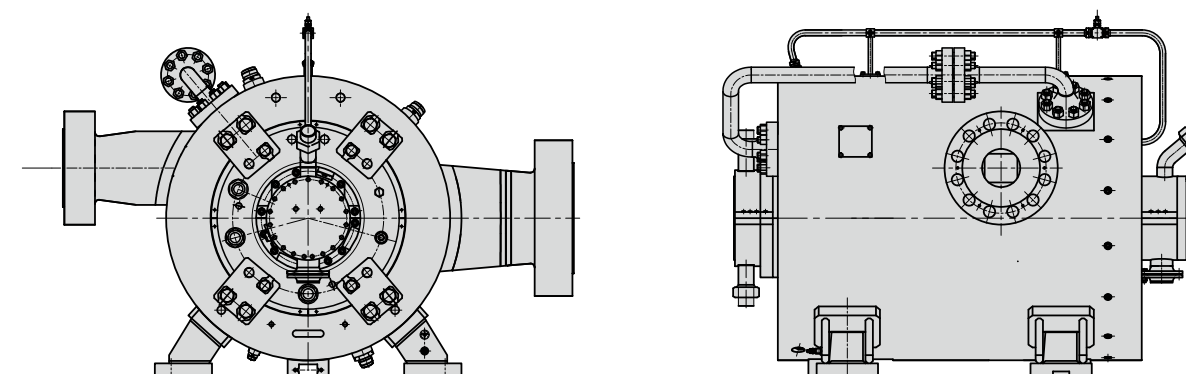
Natural gas compressor 150-2,6/226-5714/32C for GPU-32

The natural gas centrifugal compressor of ЦБК150-2,6/226-5714/32C type with a pressure ratio of 2.6, supplied as part of the GPU rated at 32 MW, is designed to compress gas at CS “Slavyanskaya” for the project “Development of gas transportation capacity for the unified gas supply system of the North-West Region, route section “Gryazovets — CS “Slavyanskaya””.

Compressor ЦБК150-2,6/226-5714/32C is a centrifugal machine with a vertical split of the casing, equipped with a system of gas dynamic seals, oil sliding bearings and a system of dry gas seals (hereinafter DGS) made by “John Crane Iskra”.

Advantages

- Efficiency not lower than 0.85.
- Pressure ratio 1.44.
- Capacity referred to initial conditions 505 m³ rpm.
- Design speed of the compressor rotor 5550 rpm.
- Application of flow channels with varying geometry.



Technical characteristics of Centrifugal Compressor 150-2,6/226-5714/32C

Parameter	Value
Capacity referred to the normal conditions (0.1013 MPa and 20 °C); million m ³ /day	19,74
Volume capacity at the initial conditions; m ³ /min	143
Power consumed; MW	28,5
Polytropic efficiency; %, no less than	85
Pressure ratio	2,603
Final gas pressure (abs.); MPa	22,15
Compressor inlet temperature; °C	23,5
Compressor rotor speed; rpm	9615

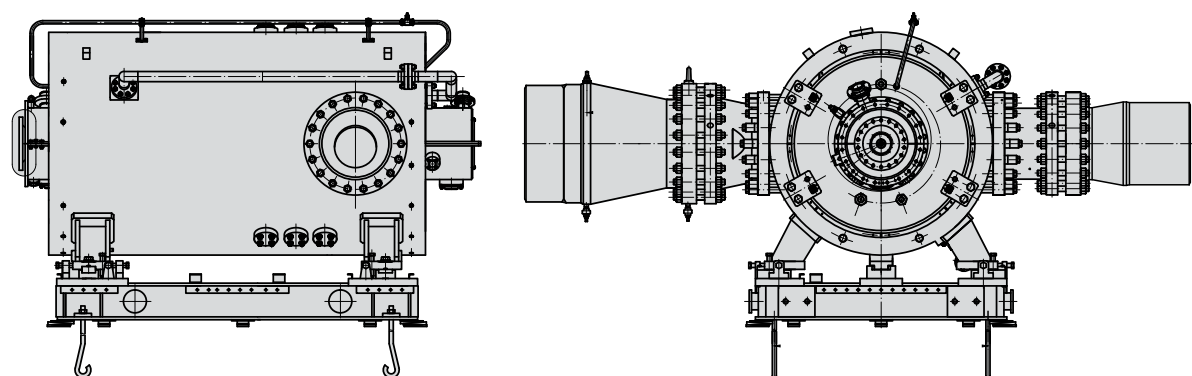
The main parameters of Centrifugal Compressor 150-2,6/226-5714/32C correspond to the specified data at the following initial design conditions

Parameter	Value
Gas pressure, abs., at the inlet of the compressor suction branch pipe; MPa	8,51
Gas temperature at the inlet of the compressor suction branch pipe; °C	23,5
Gas density referred to 20 °C and 0.1013MPa; kg/m ³	0,687
Design speed of the compressor rotor; rpm	9615

Natural gas compressor 425-3,6/69-32C for GPU

Compressor 425-3,6/69-32C is designed for completion of the GPU rated at 32 MW “Ladoga” at the Amur Gas Processing Plant BCS.

The centrifugal compressor is seven-stage, with one-section flow channel, vertical split of the barrel-type casing. The compressor is equipped with a system of dry gas dynamic seals (hereinafter DGS) made by “John Crane Iskra”.



Advantages

- Pressure ratio 3.6.
- Capacity referred to initial conditions 446 m³ rpm.
- Design speed of the compressor rotor 5500 rpm.

Technical characteristics of CC 425-3,6/69-32C

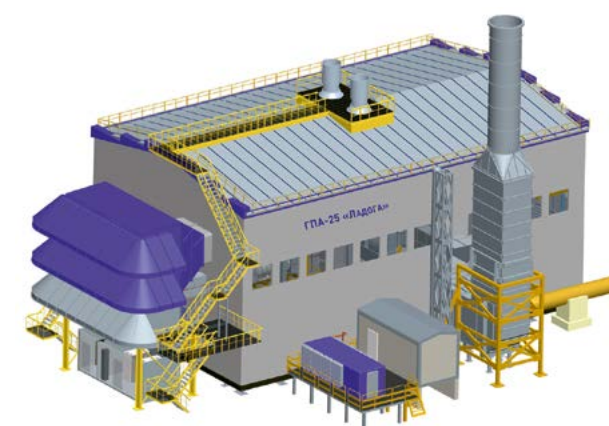
Parameter	Value
Capacity referred to the normal conditions (0.1013 MPa and 20 °C); million m ³ /day	12
Volume capacity at the initial conditions; m ³ /min	425,7
Final gas pressure (abs.), at the outlet of the compressor discharge branch pipe; MPa	6,75
Pressure ratio	3,6
Polytropic efficiency; %, no less than	0,864
Power consumed; MW	21,5
Initial gas pressure (abs.), at the inlet of the compressor suction branch pipe; MPa	1,85
Gas temperature at the inlet of the suction branch pipe; °C	10,1
Compressor rotor speed (rated); rpm	5500
Power turbine rotor speed (rated); rpm	5714

Gas-pumping unit GPU-25 “Ladoga”

Nevskiy Zavod offers manufacture of GPU-25 “Ladoga” for installation at compressor stations of the gas-main pipelines with operating pressure from 5.5 to 12.0 MPa.

GPU-25 “Ladoga” is designed for natural gas transmission and can be used both for reconstruction of existing gas compressor stations, and for construction of new ones for gas-main pipelines. It is supplied in the individual hangar-type building, in complete ready-to-use modules.

The unit design ensures operation in any climatic zones and provides for maximum reparability on site.



Configuration

- Gas turbine unit rated at 22.4 MW.
- Natural gas centrifugal compressor.
- Integrated automatic control system (KSAU).
- Filter house.
- Exhaust system.
- GTU cooling system.
- Axial compressor washing system.
- Control systems for dry gas dynamic seals.
- Separation and buffer gas treatment units.
- Oil supply system of the turbine and compressor.
- Fuel gas treatment and supply system.
- Individual easy-to-assemble hangar-type building with the systems of forced draft, exhaust, emergency ventilation and heating, lighting, gas detection, fire-fighting and alarm.

The unit design ensures operation in any climatic zones

T25 gas turbine engine configuration

- Inlet section.
- Axial compressor.
- Annular combustion chamber.
- High pressure turbine (gas generator turbine).
- Power turbine.

T25 GTU advantages

- High reliability.
- Best-in-its class electric efficiency.
- High efficiency in various operating modes.
- Lateral rollout of the turbounit for technical maintenance.

Design features

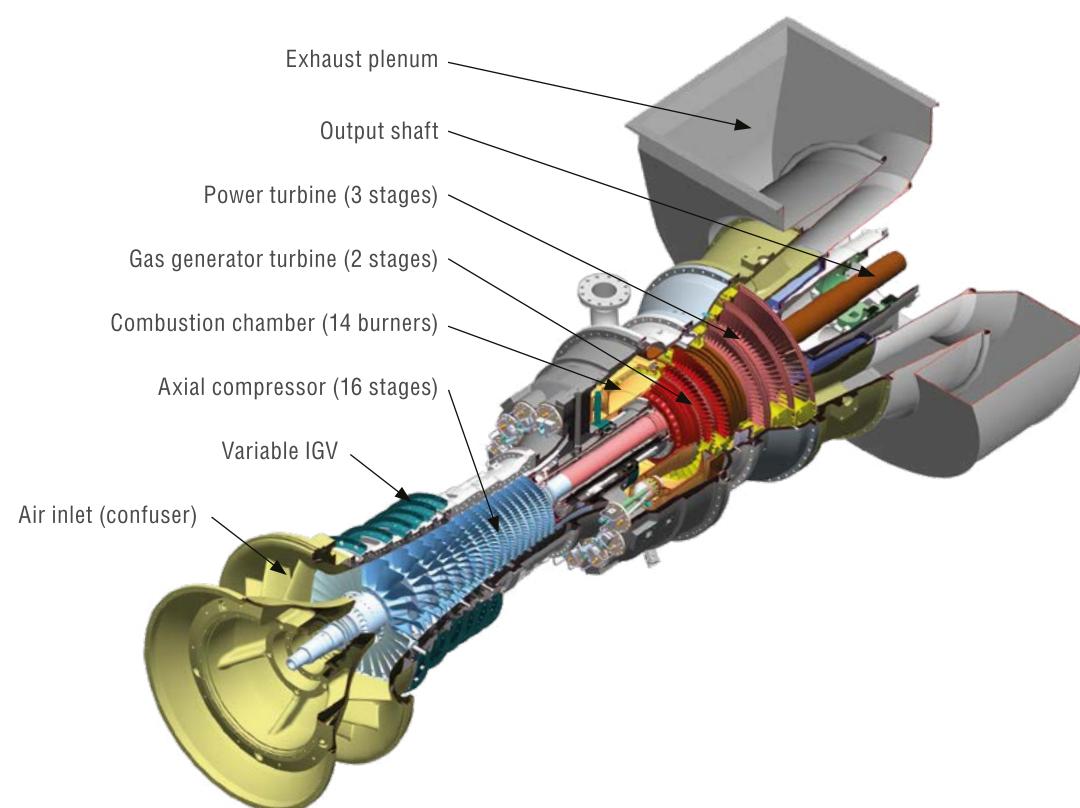
The T-25 two-shaft gas turbine is a fully integrated and independent drive. Combines high-performance operation with reliable industrial design, which ensures high efficiency, low operating expenses and long service life.

Power turbine (PT) — low pressure turbine

- Three uncooled stages.
- The 1st and 2nd st. rotor blades are equipped with interrelated peripheral damping platforms.
- The PT module is supplied completely assembled and is attached to the aft end of the gas generator turbine casing by means of a gas-tight flanged connection.

High pressure turbine

- Two-stage, with cooled nozzles and rotor blades.



Axial compressor

Axial compressor

- 16-stage, with 6 rows of variable guide vanes, high pressure ratio (24:1) and extractions: for anti-surge valve downstream of the 9th stage; to cool the power turbine downstream of the 11th stage.
- Rated mass flow of cycle air — 67.3 kg/s.
- The IGV and guide vanes of the first five stages are variable, controlled by a dedicated actuator.

Combustion chamber

- Annular
- Type: SoLoNOx (dry low emission) or common (conventional).
- Fuel: gas, liquid fuel, associated gas.
- Expanded operating range load range: 40–100 %.
- LPT outlet temperature: 465 °C.
- Fuel burners: can be maintained on site.

T25 GTU rated at 25 MW

High-tech gas turbine T25, simple cycle. Production and assembly are carried out in Russia on the Nevskiy Zavod production site under the license and in cooperation with Solar Turbines. Features high (40%) economical efficiency for this power class and low emissions.

Key figures

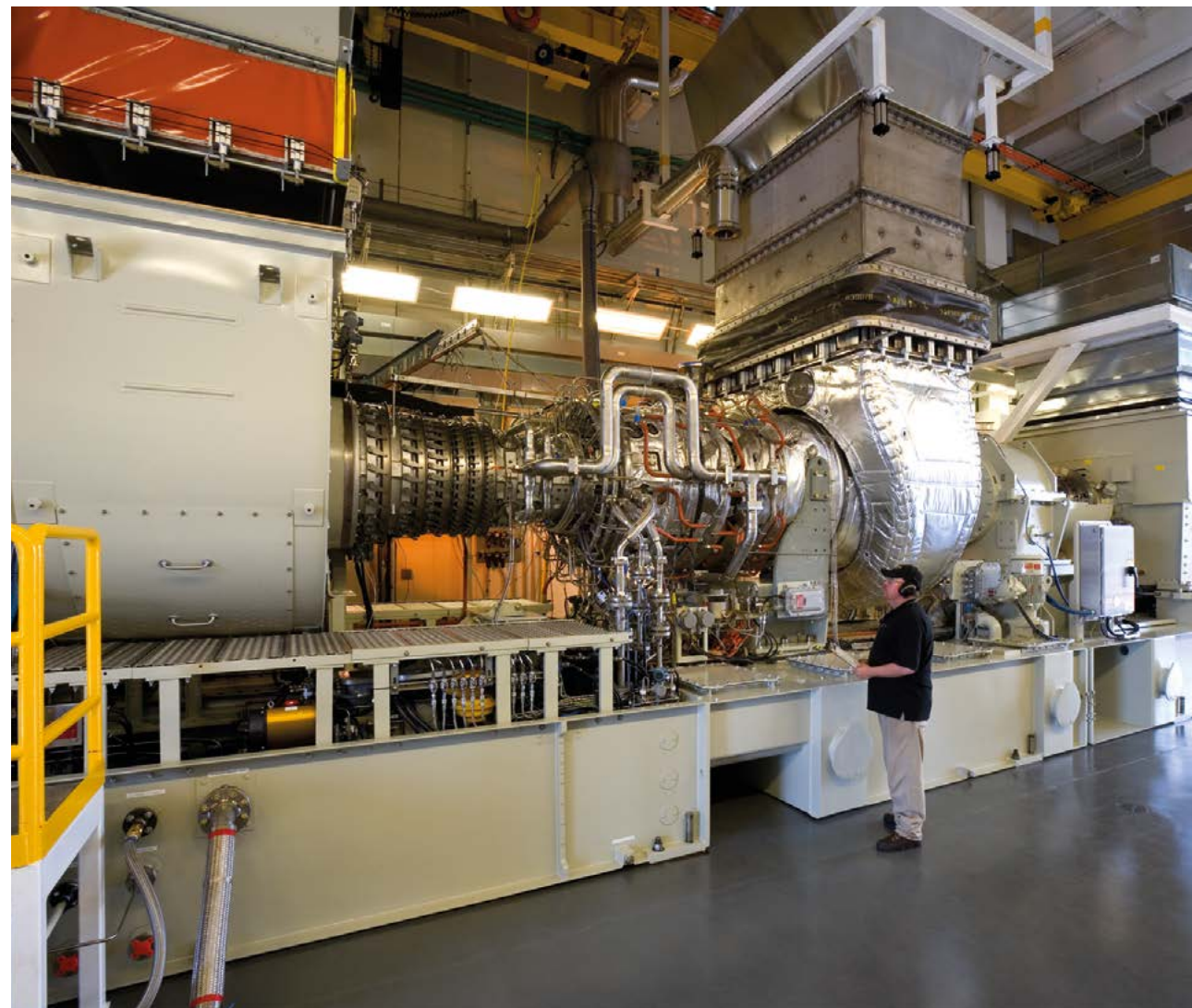
- 22.37 MW — shaft power;
- 40 % — efficiency, mechanical drive;
- 38.9 % — efficiency, electrical (simple cycle);
- 200 ths. hours — total service life;
- NOx emission — no more than 25 ppm.

T25 configuration

- Gas turbine.
- Starting system.
- Fuel system.
- Oil lubrication system.
- Turbotronic 4 control system.
- Oil tank frame.
- Electric wiring on skid.
- Pipelines and manifolds.
- Inlet plenum of the turbine air-intake system.
- Turbine exhaust plenum.
- Noise-and-heat insulating enclosure.
- Ventilation system.
- Fire detection and fire-fighting system.
- Gas detection system.

T25 main parameters

Parameter	Value
Shaft power; MW	22,4
Efficiency; %	40
Exhaust gas flow; kg/s	68,24
Exhaust gas temperature; °C	465
Pressure ratio	24
Fuel gas flow (Q _{PH} = 50 000 kJ/kg); kg/s	1,12
Rated output shaft speed; rpm	6300
Rated speed of the LPT rotor (maximum); rpm	6300 (7000)
Emission (at 15% O ₂ in dry combustion products):	
nitric oxide; mg/m ³	≤ 50
carbon oxide; mg/m ³	≤ 50



T25 GTU on the test bed

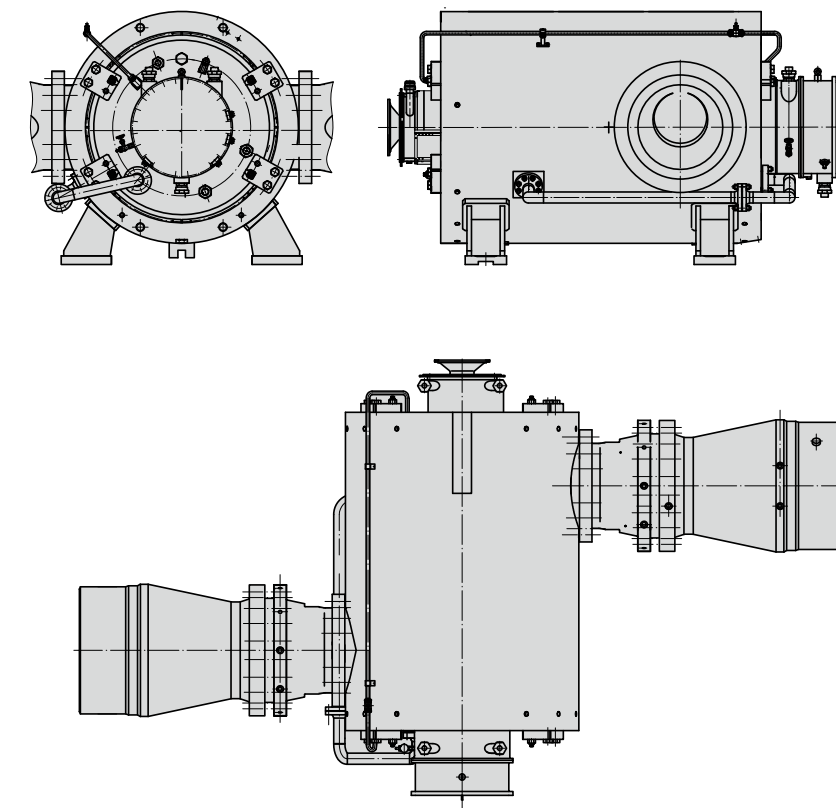
Centrifugal compressor for GPU rated at 25 MW

Parameter	Value
Capacity referred to initial conditions; m ³ /min	340
Gas pressure at the inlet of the compressor suction branch pipe; MPa	8,24
Gas pressure, final, abs., at the outlet of discharge branch pipe; MPa	11,86
Pressure ratio	1,44
Polytropic efficiency; no less than	0,88
Power consumed; MW	21,5
Compressor rotor speed; rpm	6300



High efficiency, low operating expenses and long service life

Unified casing of centrifugal compressor for T25



Gas-pumping unit GPU-16 “Ladoga”

Nevskiy Zavod offers manufacture of GPA-16 of “Ladoga” series to be installed on compressor stations of the gas-main pipelines with the operating pressure from 5.5 to 12.0 MPa.

GPU-16 “Ladoga” is designed to transport natural gas, and can be used both for reconstruction of existing gas compressor stations, and for construction of new ones on the gas-main pipelines. The unit is supplied in an individual hangar-type building delivered as a turnkey package.

The 16 MW gas-pumping unit is manufactured and assembled at the production facilities of Nevskiy Zavod.

Configuration

The modular design of T16 and easy access to the auxiliary systems facilitate significantly the gas turbine maintenance.

The T16 arrangement on the baseplate provides lateral rollout of the high and low pressure parts, as well as the entire turbounit, which makes it possible to perform promptly comprehensive technical maintenance.

- 16 MW gas turbine unit.
- Natural gas centrifugal compressor.
- Integrated automatic control system.
- Filter house, including anti-icing system.
- Control system for dry gas dynamic seals.
- Separation and buffer gas treatment and supply systems.
- Instrument air treatment and supply system.
- Fuel gas treatment and supply system.
- Exhaust system.
- Fire-fighting system of the gas-pumping unit.
- Turbo-unit cooling system.
- Axial compressor washing system.
- Hangar-type building with the systems of emergency, exhaust, plenum ventilation, lighting, heating etc.
- Cargo lifting equipment inside the building.
- Air heating unit for the building.
- Auxiliary equipment meeting individual Customer’s requirements and construction climatology specifics.



Power turbine rollout from under the enclosure



Lateral rollout of the entire gas turbine engine from under the enclosure



Lateral rollout of the gas generator from under the enclosure



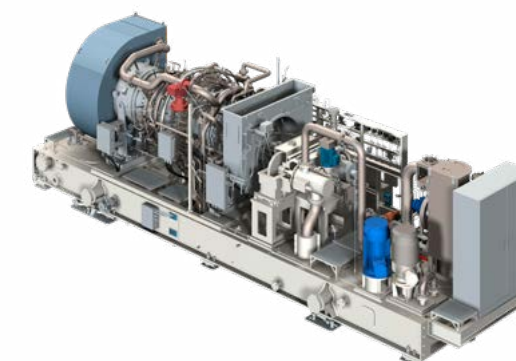
T16 gas turbine unit

T16 gas turbine unit rated at 16 MW

T16 is a new standard for industrial gas turbines of 16 MW class, fully complying with modern market requirements as to increased efficiency, reduced harmful emissions and improved reliability. T16 was designed by engineers of Nevskiy Zavod in partnership with GE Oil & Gas for application at the facilities of the Unified Gas Supply System and in the energy sector. The turbine belongs to the class of industrial GTU with a long service life and wide opportunities for service maintenance on site, which is achieved by the implemented concept of modular maintenance.

Configuration

- Turbo-unit on the baseplate.
- Auxiliary equipment on the baseplate.
- Automatic control system.
- Noise-and-heat insulating enclosure of the GTU.



T16 turbounit with the auxiliary systems on the baseplate with the enclosure removed



T16 turbounit with the auxiliary systems on the baseplate under the enclosure

Key figures

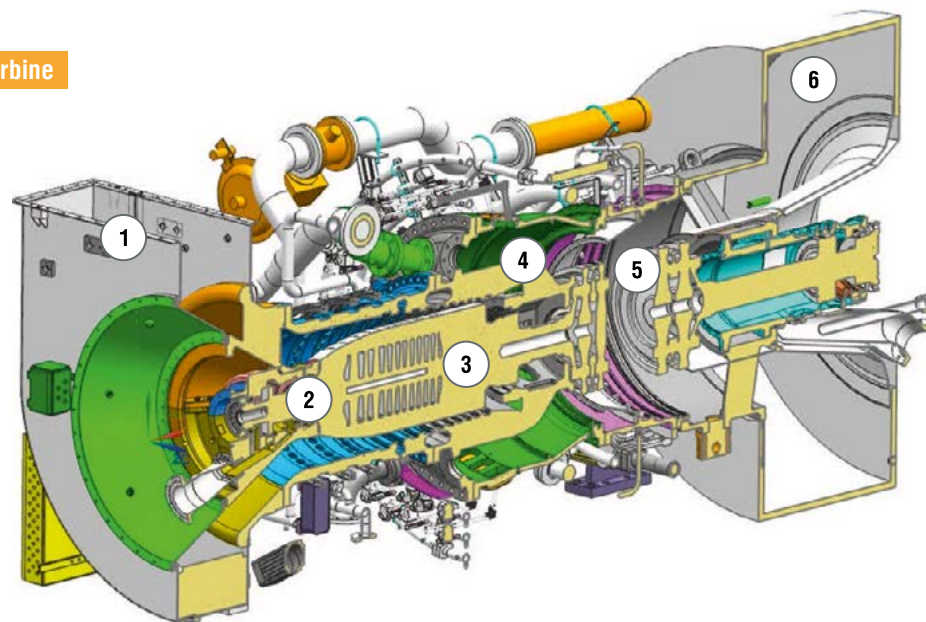
- 16.5 MW — shaft power.
- 37 % — efficiency, mechanical drive.
- 80 % — efficiency, combined electric power and heat production.
- 200 000 hours — total life cycle.
- NOx emission — no more than 25 ppm.

Design features

- GTU type — stationary, two-shaft.
- Two-stage HPT and two-stage LPT.
- 12-stage axial compressor, pressure ratio — 19.
- Low-emission combustion chamber.

Longitudinal section of T16 turbine

- 1 Inlet plenum
- 2 Axial compressor
- 3 High pressure turbine
- 4 Annular combustion chamber
- 5 Power turbine
- 6 Exhaust plenum



- Two-stage high pressure turbine with cooled blades.
- The two-stage low pressure turbine with the 1st stage variable guide vanes, maintains high efficiency over a wide working range.
- The combustion chamber ensures NOx emission no more than 25 ppm.
- Three stages of the axial compressor with variable guide vanes.

T16 GTU advantages

- High performance.
- Exemplary Environmental Performance.
- Long service life.
- Easy maintenance.
- Repairability on site.
- High level of operational readiness.
- Lateral rollout of both turbounit and LPT and gas generator.
- Transportation in turnkey condition due to modular and compact design of the GTU.



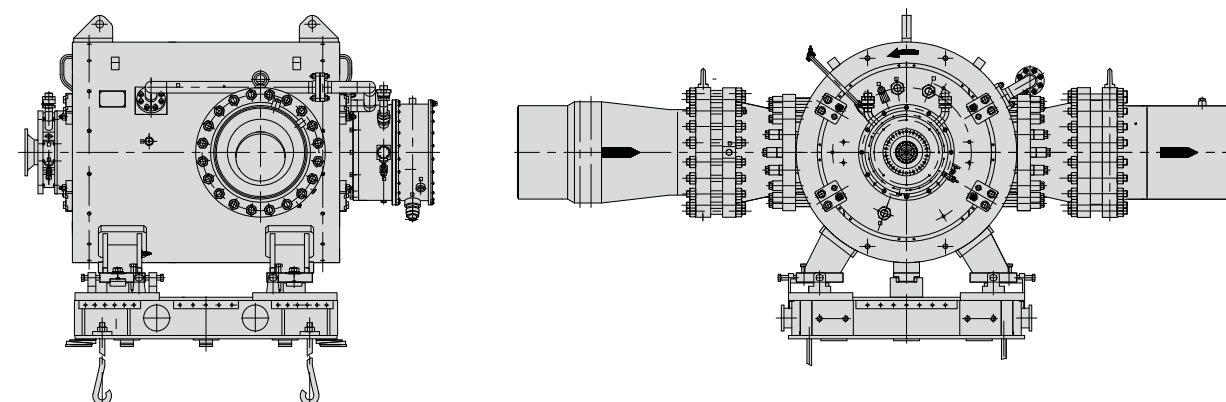
Transportation of the T16 GTU in turnkey condition

T16 GTU main parameters

Parameter	Value
Power turbine shaft power rating as per ISO, MW, no less than	16,5
Efficiency calculated from the power turbine coupling power as per it. 1, ISO; %, no less than	37
Power turbine coupling power at station conditions; MW, no less than	16
Efficiency calculated from the power turbine coupling power as per it. 3; %, no less than	36,5
Maximum drive coupling power at station conditions, at negative ambient temperature; MW, no more than	19,2
Temperature of combustion products downstream of the power turbine, rated /maximum; °C	492/600
Rated speed of the HPT rotor; rpm	10 204
Rated speed of the LPT rotor; rpm	7800
Sense of the HPT rotor rotation: clockwise if viewed from the compressor side	GOST 22378
Range of the LPT speed variation; % of the nominal value	70÷105
Starting time and time required to reach the minimum operating conditions (from the "hot standby" condition); min.	25
Rated fuel gas flow in the station conditions (at a fuel calorific value of 50 MJ/kg); kg/s	0,88
Fuel gas pressure upstream of the stop valve (gage); MPa	3,4 to 3,7
Cycle air flow (reference value); kg/s	53,7
Pressure ratio in the axial compressor	19

Centrifugal compressors for 16 MW gas-pumping units

The centrifugal compressors are designed for installation in the shop buildings as part of the gas-pumping units rated at 16 MW.



Configuration

- Compressor drive: gas turbine.
- Compressor: compressor unit in assy, confuser, transition duct.

The main technical characteristics of Centrifugal Compressor 650-11-1C, 525-11- 1C, 385-22-1C, 315-12-1C, 375-1,3/101- 7800/16CMΠ

Parameter	Type				
	650-11-1C	525-11-1C	385-22-1C	315-12-1C	375-1,3/101-7800/16CMΠ
Capacity referred to 20 °C and 0.1013 MPa; million Nm ³ /day	62,3	45,6	32,7	21,4	50,76
Volume capacity referred to the initial conditions; m ³ /min	658	522	385	315	373
Final gas pressure (abs.), at the outlet of the discharge branch pipe; MPa	7,45	7,45	7,45	7,45	9,91
Initial gas pressure (abs.), at the inlet of the compressor suction branch pipe; MPa	5,96	5,52	5,17	4,38	7,62
Initial gas temperature at the inlet of the suction branch pipe, °C	15	15	15	15	15
Pressure ratio	1,25	1,35	1,44	1,7	1,3
Polytropic efficiency	0,89	0,89	0,88	0,87	0,86
Power consumed; MW	15,2	15,1	15,1	15,4	15,1
Rated speed of the rotor; rpm	7800	7800	7800	7800	7800
Operating speed range; % of the rated value	70÷105	70÷105	70÷105	70÷105	70÷105

Electrically driven gas-pumping units (EGPU)

Nevskiy Zavod produces in series EGPU rated at 4, 6.3, 10.5 and 12.5 MW. These units are designed for compression of natural gas at compressor stations and its transmission via gas-main pipelines. The company produces direct-drive oil-free units on an active magnetic bearing, with dry gas dynamic seals and variable-frequency electric drive, with the own control system.

Serial production of EGPU rated at

4 MW **6,3** MW **10,5** MW **12,5** MW

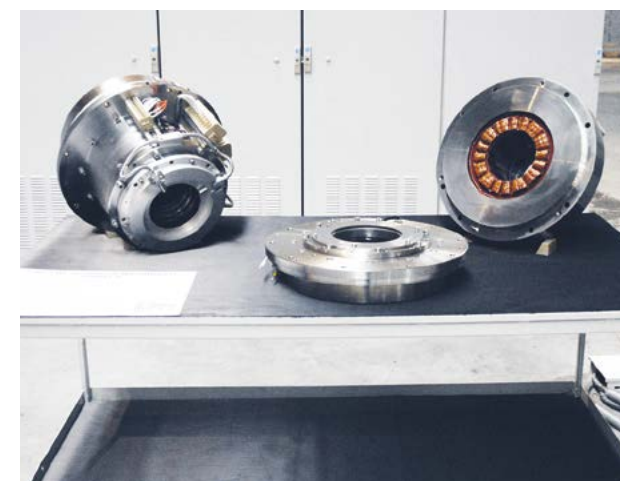
The unit design and the automatic control system allow for remote control of the compressor station equipment.

The new generation EGPUs are designed to replace the out-of-date electrically driven units during the reconstruction of the compressor stations. A total of 40 units have been delivered.

Configuration

- Natural gas centrifugal compressor.
- Asynchronous high speed electric motor.
- Semiconductor frequency converter.
- Automatic control and governing system of the unit.
- Active magnetic bearing system.
- Electric power supply system.

The EGPU scope also includes packaged modular buildings for the frequency converter and power supply control. The packaged modular buildings for EGPU are self-contained constructs with heating, air conditioning, main, outside and emergency lighting systems that are delivered to the operating sites in turnkey condition. Owing to the building design a minimum amount of construction, installation and commissioning works are required on site.



Technical characteristics of the EGPU

Parameter	Type			
	EGPA-- 4,0/8200- 56/1,26-P	EGPA-- 6,3/8200- 56/1,44-P	EGPA-- 10,5/6500- 2,1/2,2-Y	EGPA-- 12,5/5600- 56/1,5-P
Nominal input voltage; V	6000 / 10 000	6000 / 10 000	6000 / 10 000	6000 / 10 000
Volume capacity referred to 20 °C and 0.1013 MPa; mil m ³ /day	12,5	12,0	8	22,137
Pressure ratio; p.u.	1,26	1,44	2,2	1,5
El. drive efficiency; p.u.	0,93	0,93	0,96	0,96
Rated power of the drive; kW	4000	6300	10 500	12 500
Rated speed; rpm	8200	8200	6500	6500
Accuracy of speed maintenance without transducer; %	< 1	< 1	< 1	< 1
Operating speed range; %	70 to 105	70 to 105	70 to 105	70 to 105
Time for acceleration to the rated speed, no more than; min.	< 2	< 2	< 2	< 2
Initial gas pressure, abs., at the compressor inlet; MPa	3,5	3,81	0,936	4,966

Delivery references

Projects for reconstruction of PJSC “Gazprom” compressor stations with electric drives (“Gazprom transgaz Tomsk”, “Volodino”, “Proskokovo”, “Chazhemto”, “Parabel”, “Vertikos”, “Alexandrovskaya”, “Gazprom Transgaz St. Petersburg” facilities, Yety-Purovskoye GKM BCS, etc.).

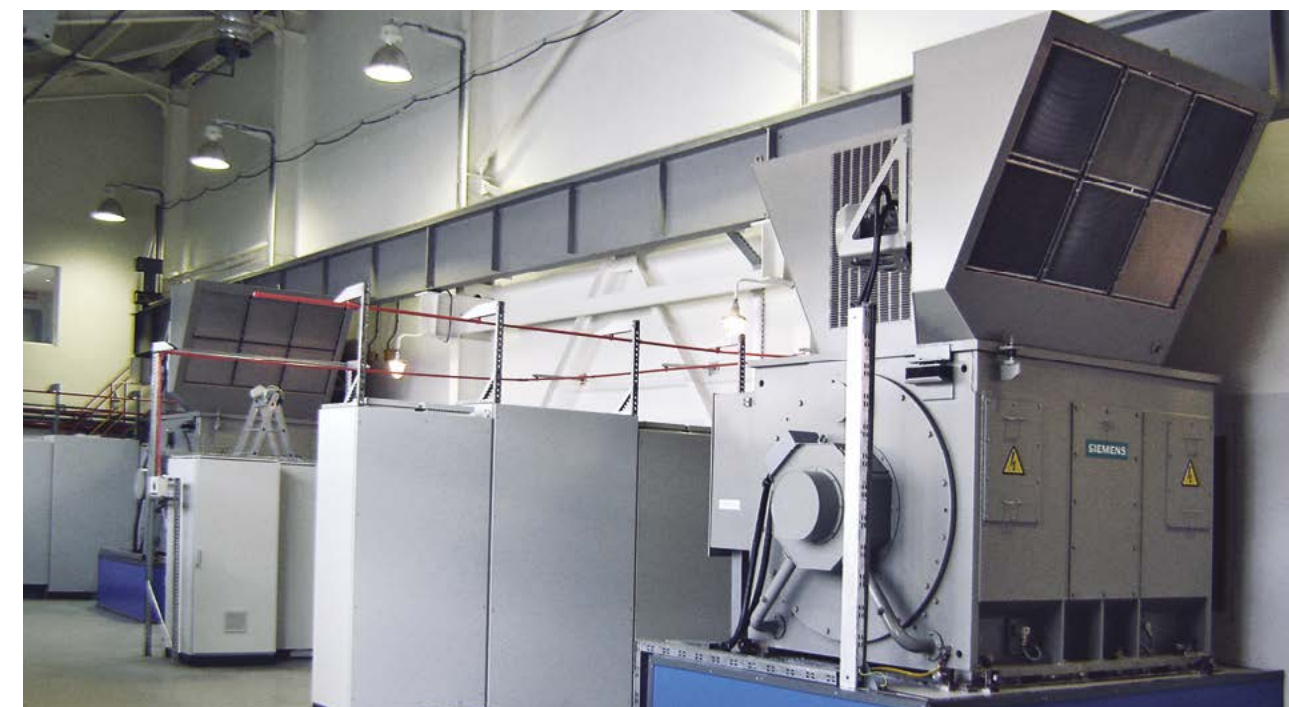
Electric motors for EGPU

El. motors power rating — 4, 6,3 and 12.5 MW.

Produced on the site of Siemens-Electroprivod LLC, designed to drive a centrifugal compressor with a quadratic dependence of the shaft torque on speed. The electric motor torque is transmitted directly to the compressor shaft by means of an intermediate flexible shaft.

The electric motor operates as part of the variable-frequency electric drive with power supply from the frequency converter.

The 4 and 6 MW el. motors are cooled by air. The 4.0 MW el. motor is equipped with a built-in fan; the 6.3 MW el. motor is provided with an external ventilation unit. The 12.5 MW el. motor has a combined air - liquid cooling with an internal heat - exchanger.



A high-speed el. motor at CS “Alexandrovskaya”

Semiconductor frequency converters

The semiconductor frequency converters are equipped with an input matching transformer (transformers), a cooling system and provide the output parameters of the electric drive to the preset accuracy in case of supply voltage changes, acceleration and deceleration of the electric motor at a preset rate within the allowable limits of the semiconductor frequency converter output current.

The control system of the semiconductor frequency converter is microprocessor - based and provides control of the el. motor, monitoring, diagnostics and protection of the semiconductor frequency converter.

The operating area of the semiconductor frequency converter relay protection covers both the electrical circuits of the semiconductor frequency converter of its own, and the el. motor stator coils.

The cooling system of the semiconductor frequency converter allows for any number of EGPU starts without limiting the interval between starts.

Converter protection

Type of protection	Protection implementation
Current protection against external multi-phase short circuit	Current cutoff without time delay
Current protection against single - phase ground short circuit	Current protection without time delay, initiating trip
Protection against overload	Initiates reduction of the motor rotor speed
Current protection against phase failure	Initiates tripping without time delay
Protection against the internal cooling system failures	Its operation is determined by the algorithms specified in the operational documentation
Protection against voltage rise	Initiates trip
Protection against voltage drop	Initiating trip with a delay and possible use of kinetic energy store of the motor rotor to maintain voltage

Automatic control and governing system of the EGPU (EGPU ACS)

The ACS is similar to that of the ELESKU (electronic means of monitoring and control) type and is designed to provide the preset operating conditions and to control the main parameters of the gas – pumping unit, its continuous and trouble-free operation.

The ACS provides the EGPU operation both completely independent, and as part of the compressor station under control of the dispatcher level systems.

The EGPU ACS is made as an integrated complete control and information system for the EGPU and its auxiliary equipment based on the industrial and proven hardware, information and software facilities, using the rational number of the information representation formats

Advantages of Nevskiy Zavod EGPU

- Application of variable-frequency el. drive.
- Application of magnetic bearings and dry gas dynamic seals.
- Reduction of operating expenses due to direct drive and oil-free system .
- Complete automation, minimally manned operation.
- Electric power saving up to 30 %.
- Possibility of remote control of the compressor station equipment.
- Compliance with the up-to-date environmental requirements.
- Packaged turnkey supply.

ACS components

- Control cabinet - one per compressor.
- Monitoring and control panel consisting of:
- Back-up control panel - one per compressor;
- Operator’s workstation - two compl. sets (the main one for a group of compressors and a standby one).



Automatic control and governing system

Centrifugal compressors 220-11-1CMΠ, 200-21-1CMΠ, 300- 21-1CMΠ, 320-31-1CMΠ, 250-21-1CMΠ for EGPU

Configuration

The centrifugal compressors are designed for installation on the gas-pumping units equipped with asynchronous el. motors as a drive.

The compressor rotor is equipped with two radial magnetic bearings and a double-sided axial magnetic bearing, the electric motor rotor — with two radial magnetic bearings. The rotor position is stabilized by the magnetic attraction forces acting on the rotor from the side of electromagnets.

- Gas dynamic seals system (GDS).
- Active magnetic bearing (AMB) system of the rotor (a set of magnetic bearings) produced under the license of SKF(S2M).
- Confuser, complete set of transducers to measure gas flow for operation of the anti-surge protection and in-process measurement of the centrifugal compressor capacity with an error no more than 4%.
- Compl set of tools for compressor assembly and disassembly.

Auxiliary bearings (included in the AMB) provide the unit rotor rundown in case of emergency cutoff of the magnetic bearing system power. Also, uninterrupted power supply for the magnetic bearing system by accumulators is provided for in case of the main power supply failure.

The active magnetic bearing of the centrifugal compressor is controlled and monitored from the centrifugal compressor control cabinet. Explosion protection of the magnetic bearing is provided by the compressor design.

The main technical characteristics of the centrifugal compressor

Parameter	Type				
	220-11-1* EGPA 4,0	200-21-1* EGPA 6,3	300-21-1* EGPA 12,5	320-31-1* EGPA 12,5	250-21-2,2 EGPA 10,5
Volume capacity referred to 20 °C and 0.1013 MPa; million Nm ³ /day	12,5	12	22,137	15,85	8
Volume capacity referred to initial conditions; m ³ /min	220	202	280	320	590
Final gas pressure at the compressor outlet; MPa abs.	4,41	5,49	7,45	5,59	2,06
Pressure ratio	1,26	1,44	1,5	1,747	2,2
Polytropic efficiency; no less than	0,85	0,85	0,85	0,84	0,825
Power consumed; MW	3,8	6	12	12,1	9,98
Initial conditions					
Initial gas pressure at the compressor inlet; MPa, abs.	3,5	,381	4,966	3,2	0,9364
Gas temperature at the compressor inlet; °C	15	15	15	15	15
Gas density referred to 20 °C, 0.1013 MPa; kg/m ³	0,682	0,682	0,682	0,7071	0,69
Rated speed of the rotor; rpm	8200	8200	6500	6500	6500

* CMΠ (SMP)— with dry seals and magnetic bearings

The compressor design employs dry gas dynamic seals and a magnetic bearing system. Oil is not needed for the compressor operation, which reduces considerably operating expenses.

Active magnetic bearing system

The motor and compressor design employs an active magnetic bearing providing contactless support of the compressor and motor rotors in the controlled magnetic field before startup, during operation and shutdown of the unit .

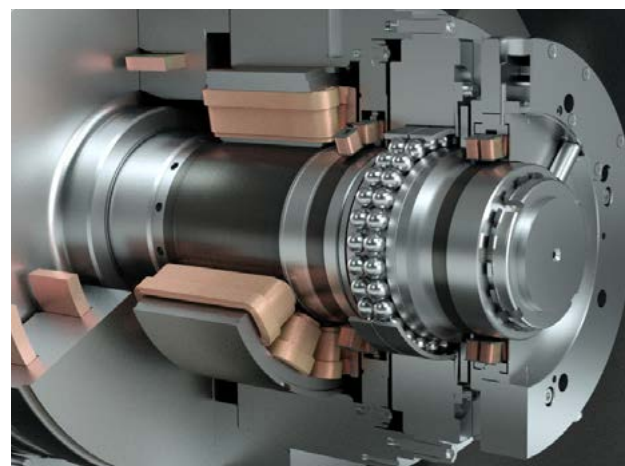
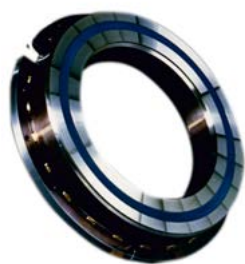
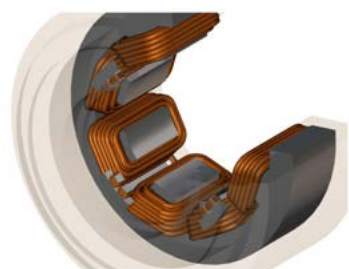
The active magnetic bearing system is produced on Nevskiy Zavod site according to the licensed technology of SKF (S2M).

Advantages

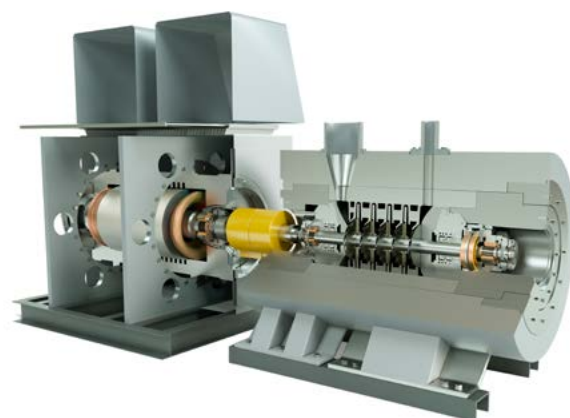
- Lower operating expenses.
- Longer service life of the bearing parts.
- Higher efficiency due to no mechanical losses.
- Fewer additional equipment.
- Higher reliability.
- Better environmental performances.

Bearings are completed with:

- Auxiliary bearings providing up to 20 emergency “falls” of the rotor from the nominal speed;
- Temperature sensors;
- Inductive transducers of radial and axial movement;
- Rotor speed transducers.



Active magnetic bearing system



Unified gas-pumping units

GTU for unified gas-pumping units

Nevskiy Zavod develops and manufactures unified gas-pumping units based on gas-turbine engines of various power rating.

The design features of the auxiliary systems and hangar-type buildings make it possible to use all engines, currently available at Nevskiy Zavod, as well as gas-turbine units with similar dimensions and technical parameters as part of the unified gas- pumping unit.

The main objective of the GPU unification is to avoid unnecessary diversity of the GPU elements with the same intended purpose and the type variety of its component parts, to make uniform, as far as possible, the methods of their manufacture, assembly, testing and servicing.

Unification of the unit systems makes it possible to

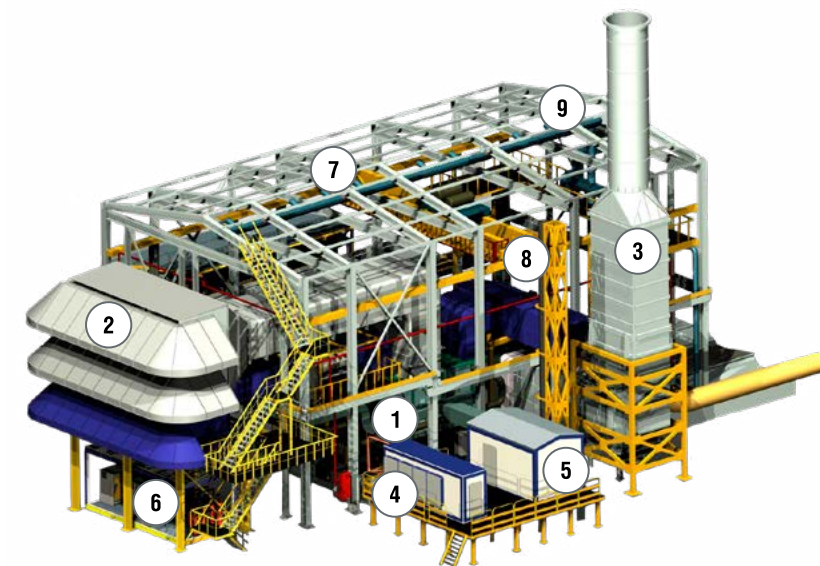
- Significantly reduce the volume of design work and the time for design;
- Reduce the time of the new equipment development;
- Reduce the cost of new products mastering;
- Increase the level of mechanization and automation of the production processes by increasing the seriation level and reducing labor input;
- Reduce the nomenclature of spare parts and the cost of GPU repair.

Unification contributes to higher quality of the GPU elements, their reliability and durability. Unification improves the basic technical and economic indicators both of the manufacturers and operating companies.

Using unified GPU during construction of new pipelines makes it possible to significantly reduce the time of development and the cost of the design documentation, as well as to reduce the metal consumption. In addition, this offers an additional opportunity to manage delivery of the equipment to meet the GPU installation schedule.

Configuration of the unified gas-pumping unit

- 1 GTU
- 2 Filter house
- 3 Exhaust system
- 4 Oil air-cooler
- 5 Hangar heating unit
- 6 Instrument air treatment
- 7 Metal framework of the hangar-type building
- 8 Lifting equipment
- 9 Hangar ventilation system



Unification level of auxiliary systems

GPU auxiliary equipment	Level of system unification (%)
GPU exhaust system	100
Oil supply system	90 (depending on oil volume)
Oil vapor separation system	100
GTU cooling and ventilation system	97 (depending on air flow)
Washing system for the engine gas-air duct	100
Draining system	100
DGS and buffer gas system	100
Separation gas system	100
Fuel gas treatment and supply system	90–100 (depending on gas composition)
Air-intake system	100
Electric equipment	100
Hangar building lighting	100
Earthing	100
Instrumentation	90
Instrument air system	100
Hangar type building	100
Maintenance platforms, ladders and supports	100
Hangar building ventilation and heating systems	100
Integrated ACS (KSAU) of the GPU	100 (container unit)
CCTV system	100
Fire-fighting system	90 (not unified within the enclosure)
Fire alarm and gas detection system	100

Unified centrifugal compressors

Nevskiy Zavod develops and manufactures new generation centrifugal compressors with a high-performance flow channel for electrically-driven and gas turbine gas-pumping units over the power range from 4.0 to 32.0 MW.

Based on the accumulated design experience Nevskiy Zavod develops high-performance flow channels for centrifugal compressors over a wide operation range. The new models have advantages over the previous generation centrifugal compressors, especially as regards the polytropic efficiency and unification and standardization of the compressor flow channel components and assemblies.

The model stages with 3D impellers blades increase essentially efficiency of the centrifugal compressor flow channel. The use of domestic advanced engineering technologies in the design of centrifugal compressors has allowed Nevskiy Zavod to provide high efficiency of flow channels due to increased polytropic efficiency.

Advantages of Nevskiy Zavod compressors

Nevskiy Zavod has its own production of magnetic bearings (under the license of SKF). The active magnetic bearing system is successfully applied not only in electrically-driven gas-pumping units, but also on centrifugal compressors as part of gas-pumping units on gas-main pipelines facilities and booster compressor stations.

- Operating expenses reduction.
- Twofold increase of the bearings service life compared with the oil ones.
- Efficiency increase due to no mechanical losses.
- Reduction in the quantity of additional equipment.
- Higher reliability.
- Improved environmental performance.



Within the framework of the program of GPU unification (PJSC "Gazprom") Nevskiy Zavod has developed and then manufactured a unified centrifugal compressor rated at 16 MW with polytropic efficiency no lower than 87- 88%. Unification of centrifugal compressors consists in the development of universal elements of the flow channel, bearing and seal parts. The advantage of unified centrifugal compressors is reduction of the production time and costs.

The 405-21-1C centrifugal compressor is designed to transmit gas via gas-main pipelines. Its casing is vertically split, it is equipped with dry gas seals and oil slide bearings. The compressor casing provides application of changeable flow channels with pressure ratio of 1.35, 1.44(1.5) and 1.7 for final absolute pressure up to 9.91MPa (101 kgf/cm²).



Unified centrifugal compressor 405-21-1C



Machining of the main disc with blades of the CC impeller

The main advantages of 405-21-1C compressor

- Unification of the flow channel parts and elements.
- High efficiency — 87.2 %.
- Compatibility with GTU of different types.

Nevskiy Zavod has developed a product range of unified compressors for various power ratings

The main technical characteristics of the compressors

Parameter	Type			
	405-21-1C	400-21-1C	220-11-1*	200-21-1*
Power; MW	16	25 to 32	4 to 6,3	4 to 6,3
Volume capacity referred to 20 °C and 0.1013 MPa; million Nm ³ /day	33	78,6	12,5	12
Volume capacity referred to initial conditions; m ³ /min	400	505	220	202
Final gas pressure at the compressor outlet; MPa abs.	7,45	11,86	4,41	5,49
Pressure ratio	1,44	1,4	1,26	1,44
Polytropic efficiency; no less than	0,875	0,85	0,85	0,85
Power consumed by the compressor; MW	15,5	30,4	3,8	6
Initial conditions				
Initial gas pressure at the compressor inlet; MPa, abs.	5,17	8,45	3,5	3,8
Gas temperature at the compressor inlet; °C	15	5	15	15
Gas density referred to 20 °C, 0.1013 MPa; kg/m ³	0,676	0,689	0,682	0,682
Rated speed of the rotor; rpm	5200	5550	8200	8200

* СМП (SMP)— with dry seals and magnetic bearings

Centrifugal compressors for underground gas storage

The 47-71-1C compressor for compressor stations of underground gas storage

The 47-71-1C (47-71-1) compressor is part of the unit GPA-4RM-02 and is designed for gas injection into the underground storage facility.

The compressor is driven directly from the turbine, without a gearbox.

The compressor flow channel is designed with vaneless diffusers to provide a wide range of steady operation. The branch pipes (nozzles) are arranged on one side. Inside the casing boring there is a package inserted that consists of two covers, suction chamber and diaphragms connected with each other by elastic ties. The package is fixed by means of a split thrust ring.

Configuration

- Compressor casing.
- Compressor package.
- Journal and thrust bearings.
- ACS.
- Lubrication system.
- Dry seals system.
- Compressor rotor.

The main technical characteristics of the compressors

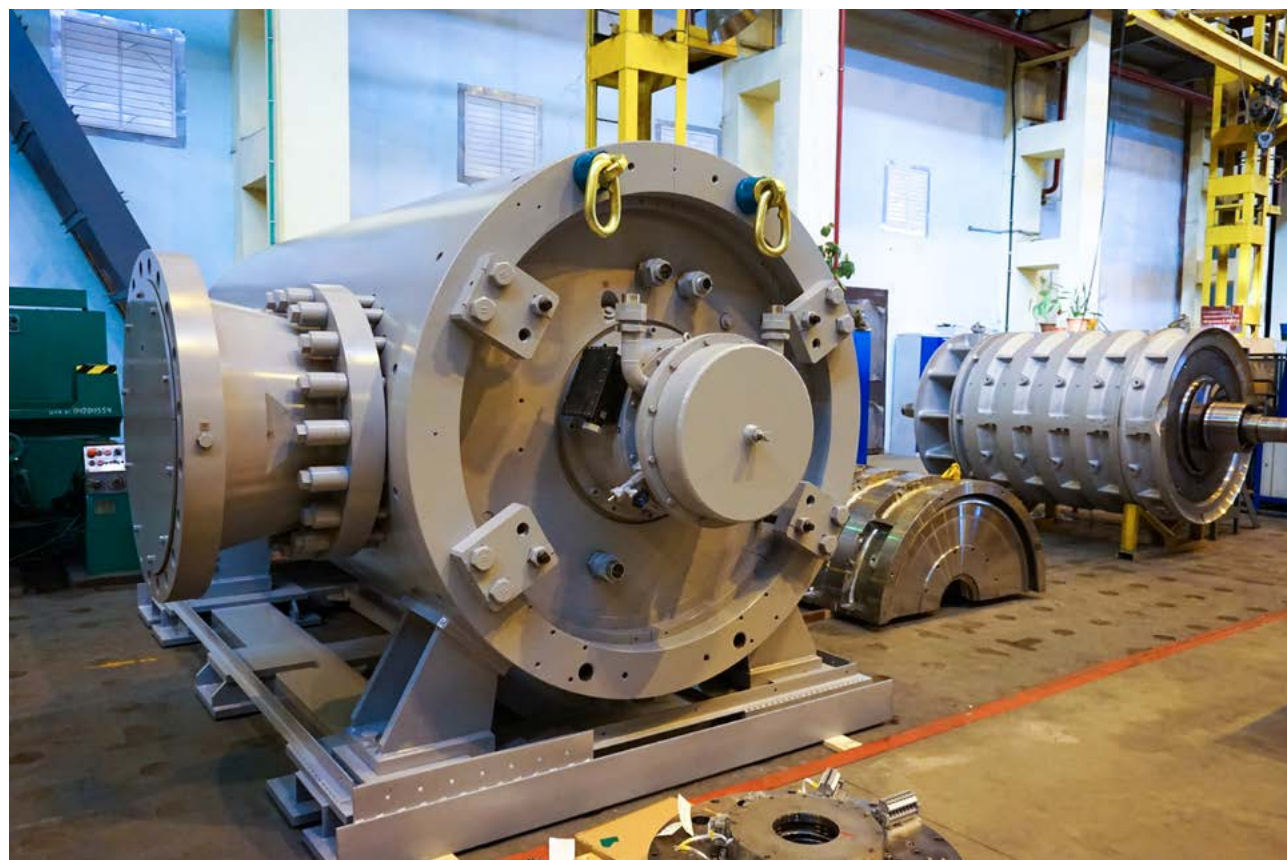
Parameter	Type	
	47-71-1C	47С СПЧ 2,5/116
Volume capacity referred to 20 °C and 0.1013 MPa; million Nm ³ /day	3,44	2,51
Volume capacity referred to initial conditions; m ³ /min	45	44
Final gas pressure at the compressor outlet; MPa abs.	9,5	8,25
Pressure ratio	1,98	2,34
Polytropic efficiency; no less than	0,8	0,805
Power consumed by the compressor; MW	3650	3300
Initial gas pressure at the compressor inlet; MPa, abs.	4,8	3,53
Gas temperature at the compressor inlet; °C	15	6
Gas density referred to 20 °C, 0.1013 MPa; kg/m ³	0,682	0,682
Rated speed of the rotor; rpm	10 290	10 350

Changeable flow channels for modernization of natural gas compressors

The changeable flow channels (CFC, “СПЧ” in Rus.) are designed for modernization of compressors for gas-pumping units that have reached the end of their useful life or become obsolete, as well as in case of changes in the compressor station operating conditions.

The package includes the rotor, stator elements and seals of the flow channel, bearings and high pressure end face seals, the joint with the drive and overhead main oil pump that supplies oil both to the high pressure system and to the lubrication system of the modernized compressor. During operation the compressor becomes completely independent of the external power supply. The stator elements of the flow channel are made without a horizontal split. The rotors of all CFCs are made two-point.

The CFC design can employ a magnetic bearing system. The magnetic bearing system is manufactured at Nevskiy Zavod under the licensed technology of S2M (SKF).



CFC with the active magnetic bearing system at Zapadno-Tarkosalinskoye gas field BCS

The main parameters of changeable flow channels for modernization of serial natural gas compressors

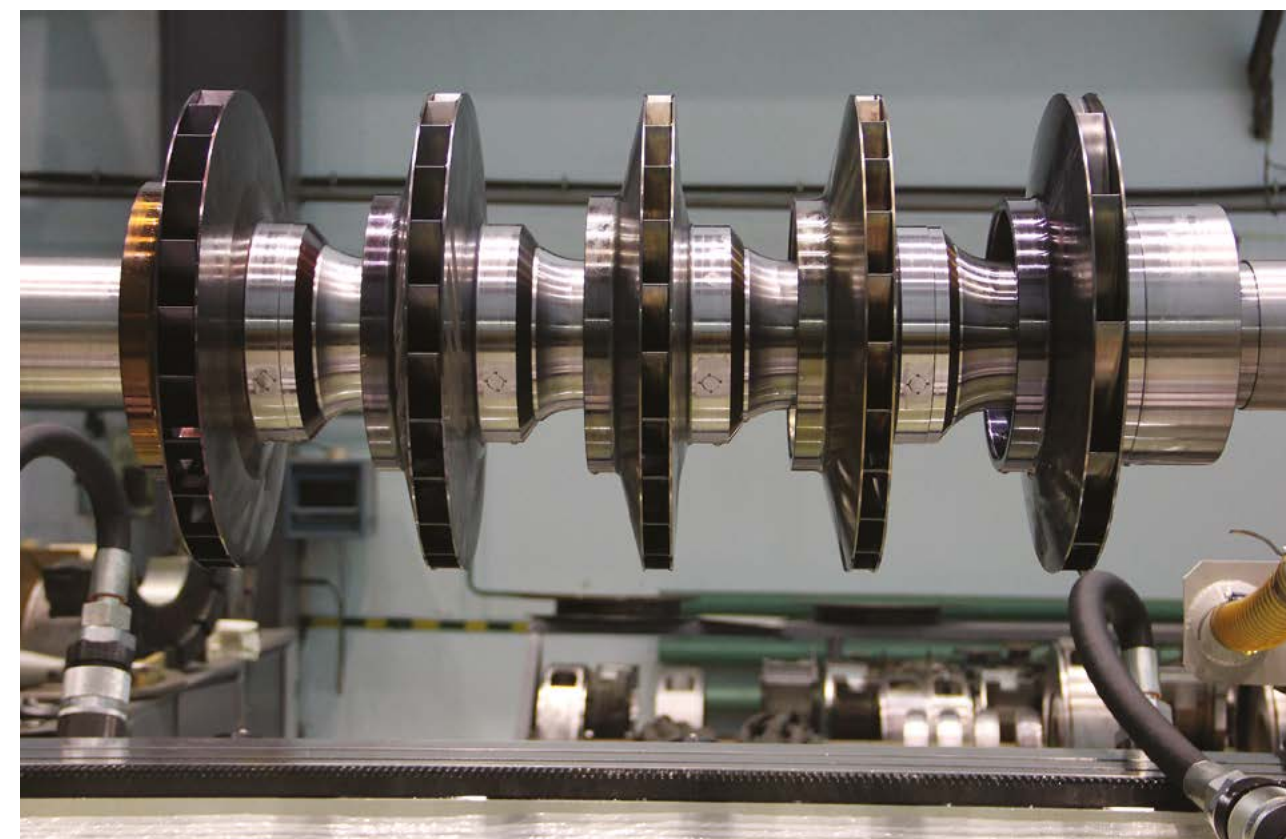
Parameter	Type									
	235-26-1	235 СПЧ 1,32/76 -5000 ЗГПА	235-28-1	295ГЦ2-500/26-45М	235 СПЧ 1,4/76-5300-АЛ-31СТ	370 СПЧ 1,4/7,45-9000	370 СПЧ 1,4/76-6500-ПС90	СПЧ-295-16/30-3.0 СМ	155 СПЧ 10/76-2.2С	СМЧ 16/76
Capacity referred to 20 °C and 0.1013 MPa; million Nm ³ /day	28	30,4	35	11,4	39	18,16	23,45	8,58	7,67	38
Mass capacity; m ³ /min	221	240	276,2	90,5	224,3	143,3	185	-	-	-
Volume capacity referred to initial conditions; m ³ /min	312	332,8	408	441,4	377	212	248	485	156	460
Final gas pressure at the compressor outlet; MPa	7,45	7,45	7,45	4,02	7,45	7,45	7,45	3,5	7,45	7,083
Pressure ratio	1,35	1,32	1,4	2,2	1,45	1,4	1,45	3	2,2	1,37
Polytropic efficiency; no less than	0,83	0,83	0,82	0,8	0,81	0,81	0,83	0,81	0,82	0,835
Power consumed by the compressor; MW	11,5	11,5	15,95	15,2	16	8,5	13,2	15	9,5	15,8
Initial conditions: gas pressure at the compressor inlet; MPa, abs.	5,52	5,64	5,32	1,83	5,14	5,32	5,14	1,167	3,39	5,17
Gas temperature at the compressor inlet; °C	15	15	15	30	15	15	15	8	35	15
Gas density referred to 20 °C, 0.1013 MPa; kg/m ³	0,682	0,682	0,682	0,686	0,682	0,682	0,682	0,686	0,766	0,682
Rated speed of the rotor; rpm	5000	5000	5200	5300	5300	4800	6500	5150	8800	5150
Compressor drive	СТД-12500	СТД-12500	ДЖ-59 or ДГ-90	ПС-90	АЛ-31 СТ	ГТК-10-4	ПС-90	295ГЦ2-500/26-45М	НЦ10 ДКС-01	НЦ-16/76-1.44

Changeable flow channels for modernization of serial natural gas compressors

Parameter	Type					
	370-21-2	370 СПЧ 1,23-6500 ПС	370 СПЧ 1,5/76- ЭГПА-Р	520-21-1	650-23-1	650 СПЧ 1,37/76- 5000- НК36СТ
Capacity referred to 20 °C and 0.1013 MPa, million Nm ³ /day	25,4	32,6	20,75	32	36,9	54
Mass capacity, m ³ /min	200,5	251,5	162,8	252,6	291,5	426,2
Volume capacity referred to initial conditions, m ³ /min	300	430	260,6	528	420	610
Final gas pressure at the compressor outlet, MPa	7,45	7,11 (at the 2nd compressor)	7,45	5,49	7,45	7,45
Pressure ratio	1,42	1,54	1,5	1,42	1,37	1,37
Polytropic efficiency, no less than	0,81	0,83	0,84	0,81	0,83	0,835
Power consumed by the compressor, MW	12,4	10,5 (on the 2nd compressor)	11,4	15,9	15,85	23,2
Initial conditions: gas pressure at the compressor inlet; MPa, abs.	5,546	4,61 (1st compressor)	4,97	3,866	5,44	5,44
Gas temperature at the compressor inlet; °C	15	10 (at the 1st compressor inlet)	15	15	15	15
Gas density referred to 20 °C, 0.1013 MPa; kg/m ³	0,682	0,682	0,6783	0,682	0,682	0,682
Rated speed of the rotor; rpm	4800	6500	4800	5200	5200	5000
Compressor drive	СДГ-12,5-2	ПС-90	СДГ-12,5-2	ГТНР-16	ДЖ 59 ЛГ ор ДГ-90	НК-36 СТ

Delivery sites

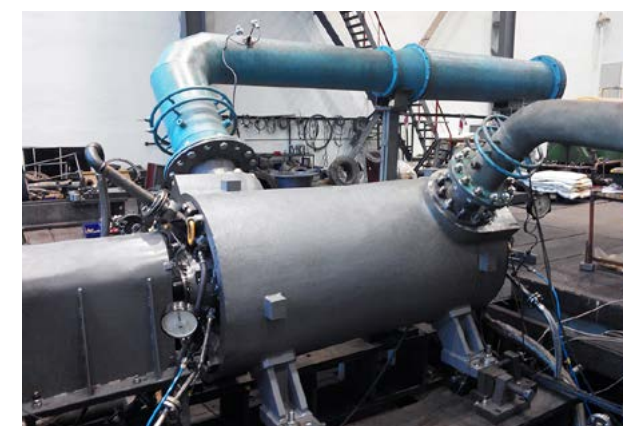
Nevskiy Zavod performs packaged supply of up-to-date gas-pumping units to the compressor stations of the gas- main pipelines and for PJSC "Gazprom" reconstruction and new construction projects.



Rotor 155 СПЧ on the Schenk high-speed balancing machine



295 СПЧ at Zapadno-Tarkosalinskoye gas field BCS, OOO "Gazprom Dobycha Noyabrsk"



СПЧ 155-1076-2.2С for BCS of OOO "Gazprom Dobycha Urengoy"



295 СПЧ 3 on the test bed of Nevskiy Zavod



CFC on the test bed of Nevskiy Zavod



Equipment for LNG plants

06

Compressor units	90
Equipment for auxiliary power generation	93

Nevskiy Zavod possesses the necessary techniques and tools, scientific and technical potential and experience to perform independently thermal, gas-dynamic, strength and vibration tasks of engineering analysis, as well as is ready to develop design, design-and-engineering and operational documentation for a wide range of the main and auxiliary equipment for natural gas liquefaction facilities.

In 2017, for the Vysotsk LNG project, the company designed and manufactured the first Russian centrifugal compressor K-905-71-1C for the refrigeration cycle, thereby bringing a competitive Russian product to the market and opening up great prospects for creation of Russian natural gas liquefaction technology.

Compressor units

Nevskiy Zavod possesses broad competences in the development and manufacture of liquefaction trains, ranging from warm to cold refrigerant.

The company designs and manufactures units of various configuration, power and design for any process cycle of natural gas liquefaction:

- feed gas compressor;
- refrigerant compressor (mixed, methane, ethylene, propane, nitrogen);
- boil-off gas compressor;
- fuel gas compressor.

Mixed refrigerant centrifugal compressor K905-71-1C

The compressor is used in the process cycle of natural gas liquefaction as part of the mixed refrigerant compressor unit.

The first Russian refrigeration cycle compressor was developed and manufactured in 2017 by Nevskiy Zavod specially for the Vysotsk LNG project.

In 2019, the compressor was put into operation at the Cryogaz-Vysotsk LNG plant as part of a mixed refrigerant compressor unit. Under this project, Nevskiy Zavod supplied two mixed refrigerant compressor units (MRC). The equipment is an important link in the technological chain for LNG production in the port of Vysotsk. In addition to the main process equipment, the scope of supply includes a package of auxiliary systems that ensure the functioning of the units, their operation and ease of maintenance. The mixed refrigerant compressor units will work for two independent process trains of natural gas liquefaction in a refrigerant closed cycle of equal capacity - 330 ths. tons of LNG per year. The terminal will be commissioned as a single production facility with a capacity of 660 thousand tons of LNG per year. Liquefied gas will be supplied to consumers in the North-West region of Russia.

The MRCs produced by Nevskiy Zavod are used in the natural gas liquefaction process. Each unit is a gas turbine driven centrifugal compressor which is equipped with all the necessary auxiliary systems located in an individual hangar-type building with adjoining container units.

The design features of the compressor are: two sections in one barrel-type housing, 7 compression stages, as well as dry gas- dynamic seals and high-tech elements of the flow channel - integrally-machined impellers with 3D blades. Nevskiy Zavod is the only Russian company that has mastered the manufacture of these elements and uses them extensively in its new projects.

Nevskiy Zavod has become the first in Russia and the third in the world to manufacture compressor equipment of this type. The production of mixed refrigerant compressors mastered by Nevskiy Zavod will allow in the future to create Russian LNG technology, increase the share of domestic high-tech compressor equipment in the construction of medium- and large-capacity plants, as well as reduce dependence on foreign manufacturers service programs.

Technical characteristics of the K905-71-1C compressor



Mixed refrigerant centrifugal compressor K905-71-1C

K905-71-1C configuration

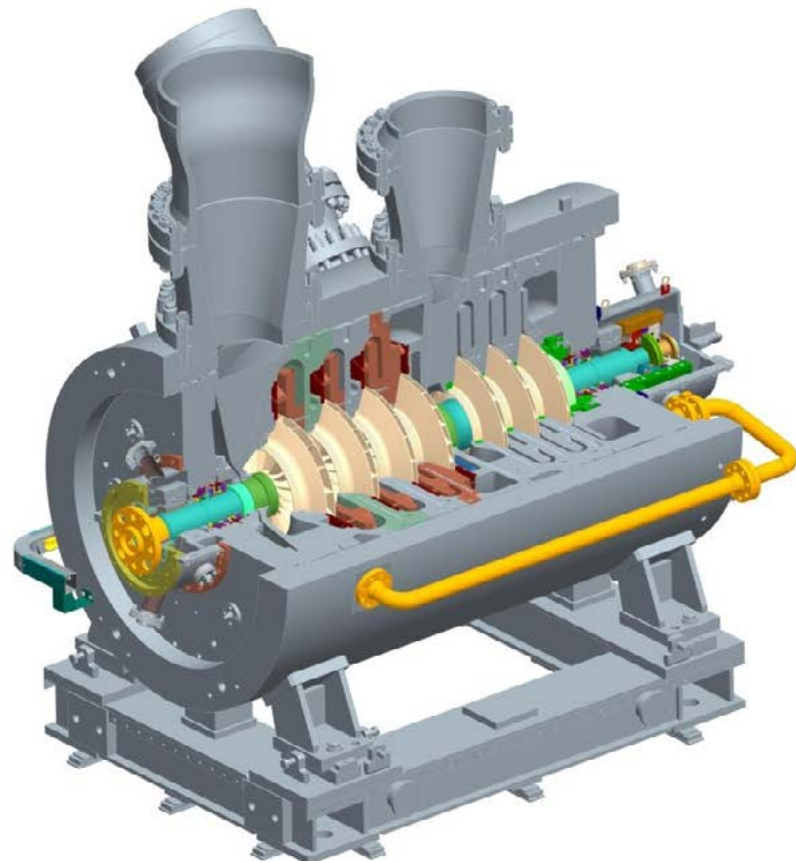
- Two-section compressor with a barrel-type casing
- 7 compression stages: 4 — in the first section, 3 — in the second section
- Dry gas-dynamic seals (DGS)
- A rollout device, special tool kits



Mixed refrigerant centrifugal compressor K 905-71-1C at Cryogaz Vysotsk LNG PLant

The main advantages of the K905-71-1C compressor

- Reduced operating expenses and reduced amount of auxiliary equipment.
- Increased operational life and reliability of the unit due to using parts made from a solid forging (without welding and rivetting).
- Efficiency increased by 2–4% due to 3D profiling of the flow channel.
- Application of unified parts and components.
- Expanded range of capacity and head loads.
- Reduced mass and dimensions parameters.



3D-model of K905-71-1C compressor

The main technical characteristics of K905-71-1C

Parameter	1st section	2nd section
Capacity referred to 20 °C and 0.1013 MPa, ths.; Nm ³ /h	134,492	147
Volume capacity referred to initial conditions; m ³ /h	54 146	8077
Initial gas pressure (abs.) at the compressor inlet; bar	3	17,7
Final gas pressure (abs.) at the compressor outlet; bar	18,2	51
Pressure ratio	6,067	2,881
Gas temperature at the compressor inlet; °C	33	35
Polytropic efficiency; no less than	0,825	0,805
Power consumed; MW	17,230	–
Rated speed of the rotor; rpm	6200	–

Equipment for auxiliary power generation of LNG plants

Nevskiy Zavod develops and manufactures the main and auxiliary equipment for gas turbine and steam turbine units which can be used as part of power units operating at power plants in gas turbine, steam power and combined cycles.

More details are in Chapter 10, p.128



An element of K905-71-1C compressor mock-up model



Equipment for oil industry

07

Compressors for oil-associated gas	96
Two-cylinder Centrifugal Compressor for oil production facilities	99
Units based on a high-speed two-cylinder compressor	101
Units with a high-speed variable el. drive	103

Nevskiy Zavod performs packaged supply of equipment for the oil industry. These units are made as stationary, various sizes, featuring long service life and good repairability.

Oil-associated gas compressors

Purpose and application

The centrifugal compressor machines of this group are designed to compress raw oil-associated gas and to supply it to the place of its utilization. These units are used at electric and thermal power stations, gas-processing plants, underground storage facilities and other sites.

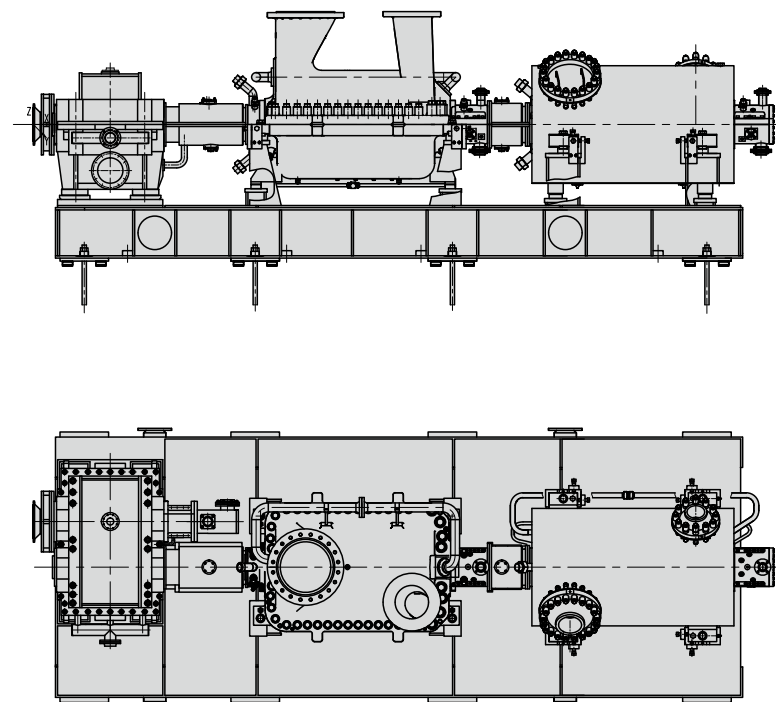
The machines are made in one- and two-cylinder explosion-proof versions. The units feature high mounting availability and are supplied fully completed, in preassembled modules, equipped with modern hardware making it possible to fully automate the unit control process.

Configuration

The unit includes a drive el. motor and the compressor unit with the ASKU automatic control system developed by JSC "NZL".

Standard scope of supply

The scope of supply includes a compressor, an electric motor, instrumentation and ASKU ACS. The compressors consist of cylinders with rotors, foundation plates and frames, anchor bolts, intermediate air cooler with supports and connecting air ducts, couplings, step-up gears, lubrication system (including the oil tank, filter unit and pumping unit), anti-surge control and protection system. Also, the following is supplied together with the compressor: a complete set of tools to lift the upper part of the compressor cylinders and rotors, for alignment of the compressor and drive rotors; wrenches and tools for technical maintenance; replacement spare parts and operational documentation.



Design features

K890-122-1 compressor

The K890-122-1 compressor is designed to compress raw oil gas at gas-processing plants and field compressor stations and to supply it to the common collector.

It is a two-cylinder twelve-stage machine. Each cylinder includes six stages. The rotor of each cylinder has its own optimum speed. The tightness of the compressor cylinders is provided by end face seals. The step-up gears are installed between the L.P. cylinder and el. motor drive, as well as between the cylinders.

Gas and oil are cooled in the air coolers.

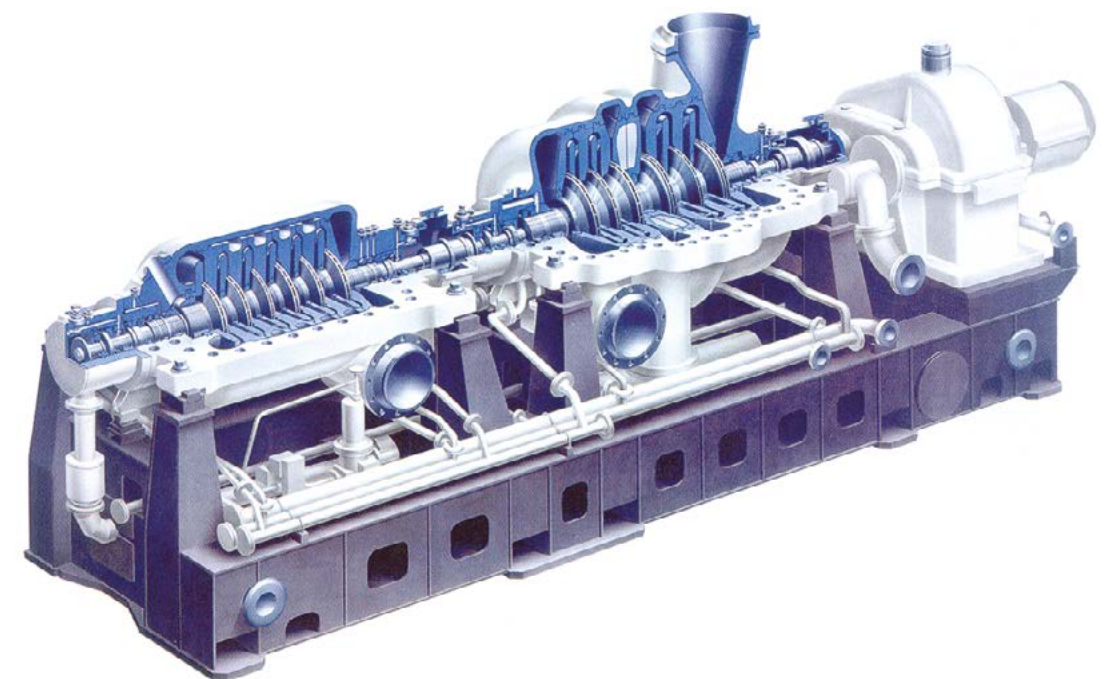
Design features

K411-122-1 compressor

The K411-122-1 compressor is designed to compress raw oil gas with a density of 0.824 to 1.12 kg/m³ at gas-processing plants and field compressor stations and to supply it to the common collector.

It is a two-cylinder three-section twelve-stage machine with vaneless diffusers. The L.P. cylinder sections feature an opposite direction of the compressed air flow, which reduces leakages through the balance piston. The cylinder casings are horizontally split. The compressor is equipped with anti-surge protection and a bleed-off valve allowing for continuous operation in the partial load conditions.

The tightness of the compressor cylinders is provided by the end face seals.



K411-122-1 compressor

The main technical characteristics

Parameter	Type								
	K890-122-1	K411-122-1	K410-121-1	K410-121-2	415-61-1	K354-101-1	K380-103-1	K320-131-1	340-81-5
Mass capacity; kg/s	19,4 (18,25)	8,93	8,93	10,1	11,72	9,53 (9,73)	9,73	10,086	13,5
Volume capacity at suction conditions; m ³ /min	760 (820)	372	372	395	372	355 (345)	345	320	300
Final gas pressure; MPa, abs.**	3,63	3,53	3,7	3,7	1,57	3,82	3,82	3,1	1,3
Gas density; kg/m ³ , at normal conditions (20 °C and 760 mmHg)	0,98 (0,957)	0,91*	0,91*	1,12**	0,91*	0,83 (0,913)	0,98	0,75	1,42
Initial gas parameters									
Temperature; °C	15	15	15	30	15	15	15	15	35
Pressure; MPa, abs.	0,157	0,157	0,157	0,147	0,206	0,186	0,186	0,25	0,1275
Rated rotor speed (LPC/HPC); min ⁻¹	5240 LPC 9270 HPC	11 129	10 345	9677	10 345	8559 LPC 18 419 HPC	8100/ 17 445	10 800	4800/ 9370
Power consumed by the rotor; MW	10 (11,2)	4,95	5,17	4,95	4,243	5,2 (5,3)	5,3	5,3	3
Overall dimensions; m									
Foundation length	16,3	11	11	11	8,2	12,2	12,2	12,2	7
Foundation width	4,5	2,9	2,9	2,9	2,9	4	4	4	2,8
Height	2,6	2	2	2	4	4,8	4,8	4,8	2
Hook lifting height from the floor level of the machine room	5	4,9	4,9	4,9	4,2	3,5	3,5	3,5	4,2
Design mass; t									
Compressor in the scope of supply (without an el. motor drive)	77,3	38,89	37,65	37,65	26,23	34,8	35	35	29
Mass of the heaviest part for									
Installation	36 (LPC unit)	24 (com-pressor unit)	22,4 (com-pressor unit)	22,4 (com-pressor unit)	14,5 (com-pressor unit)	10,2 (el. motor stator)	10,2 (el. motor stator)	25 (com-pressor unit)	7,15 (the main el. motor)
Operation	10 (upper part of the LPC casing)	4,3 (el. motor rotor)	4,3 (el. motor rotor)	4,3 (el. motor rotor)	3,17 (el. motor rotor)	3,5 (upper part of the LPC in assy)	3,5 (upper part of the LPC in assy)	5,2 (HPC package)	2,5 (upper part of the LPC in assy)

* Operation on gas with density of 0.824; 1.02; 1.12 kg/m³ is also possible alongside with the above-mentioned values

** Operation on gas with density of 1.22; 1.35 kg/m³ is also possible alongside with the above-mentioned values

Two-cylinder centrifugal compressor for oil-associated gas

Purpose

These centrifugal compressors are designed to provide the required parameters for compression of a mixture of natural gas and oil-associated gas as part of the gas-pumping unit (GPU).

Configuration

- Two-cylinder centrifugal compressor.
- Gas dynamic seals system.
- Oil supply system.
- Transition ducts with confusers, a set of transducers to measure gas flow for operation of the anti-surge protection system and in-process metering of the centrifugal compressor capacity with an error no more than 4 %.
- A set of tools for assembly and disassembly of the compressor.

All pipelines have passed hydraulic tests, have been air-purged and passivated

Brief description of the unit

The centrifugal compressor consists of a step-up gear with parallel shafts made by Voith Turbo BHS Getriebe GmbH, high pressure cylinder (hereinafter HPC), low pressure cylinder (hereinafter CPC), foundation frame and oil and drainage system piping.

The step-up gear is four-shaft. It has one low-speed shaft driven by a gas turbine engine. The sense of the low-speed shaft rotation is clockwise, when looking at the compressor from the drive side. The step-up gear has two high-speed shafts to transmit torque to the compressor LPC and HPC rotors and the shaft whereon the main oil pump is installed. Between the HPC, LPC and step-up gear there are membrane couplings installed - MKB300, Voith Turbo BHS Getriebe GmbH (2 pcs.). The membrane coupling is covered with a guard. The step-up gear and both cylinders are installed on a common foundation frame.

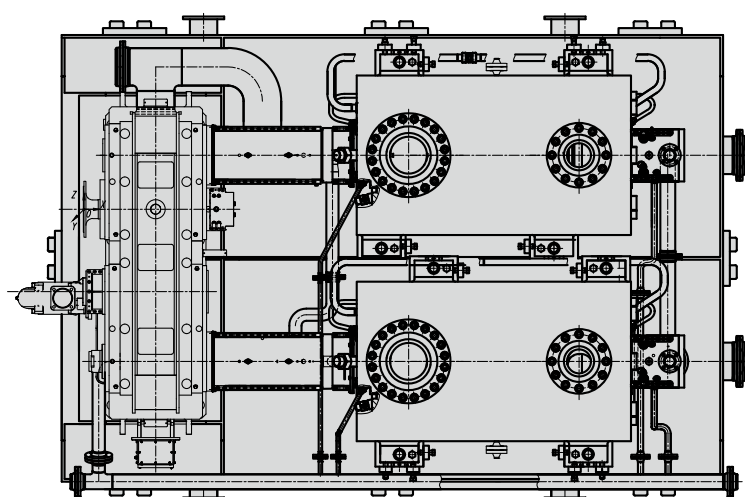
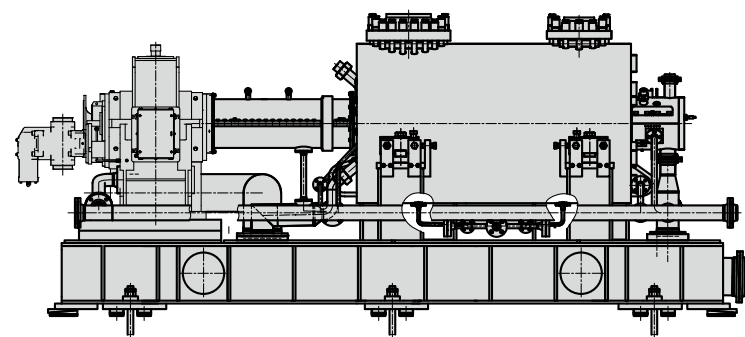
The oil and drainage system piping is part of the centrifugal compressor. One part of the piping is designed to supply and drain oil for lubrication of the step-up gear and compressor bearings (for both cylinders). The other part of the piping is designed to provide drainage of the compressor (from both cylinders). All pipelines have passed hydraulic tests, have been air-purged and passivated. Oil flushing of the piping is performed on site, using the tools from the scope of centrifugal compressor supply. On the HPC and LPC there are a suction and delivery pipelines installed. The pipelines are attached to the casing by means of studs.

Brief description of the unit

The compressor is connected with process pipelines by flanges. A parallel connection circuit is applied for compressors in the compressor yard. The process pipelines between the compressor LPC and HPC are connected according to the sequential compression scheme.

The compressor unit consists of a casing in assy, a package, discharge cover with a branch connection and a seal cage, a journal bearing assembly, a disc with a seal cage installed thereon, a journal-thrust bearing unit, two cages upstream of the DGS, DGS assemblies, two two-piece rings, a balance line pipe, pipeline behind the balance piston. Seal rings are used for sealing the flow channel in the casing. The package and discharge cover with a branch connection fixed by rings are installed in the casing. The compressor rotor rests on the journal bearings taking up radial load. The thrust shell takes up axial load. The LPC package is a separate assembly unit. It consists of a suction cover, suction chamber, package stator, spacer, rotor and seal cages. Seals prevent gas leakage inside the flow channel. The centrifugal compressor is equipped with a dry gas seal system made by LLC "TREM-Kazan". The centrifugal compressor design makes it possible to disassemble dry seals without disassembly of the compressor flow channel.

Both HPC and LPC cylinders are multistage turbomachines of centrifugal type. Gas flow and pressure rise in the flow channel are generated by the centrifugal force field in the impellers that causes gas movement from the center of the impellers to their periphery and by conversion of the kinetic energy of gas into the potential pressure energy.



The main technical characteristics and parameters

Parameter	ЦБК165-8,6/ 120-9000/16С		ЦБК165-3,4/ 110-9000/18С		ЦБК165-4,2/ 106-7100/6,0С		СПЧ165-10,4/ 106-7100/6,0С	
	LPC	HPC	LPC	HPC	LPC	HPC	LPC	HPC
Volume capacity referred to 20 °C and 0.1013 MPa, abs., MMSCMD	3,45		8		1,61		1,13	
Volume capacity referred to suction conditions; m ³ /min	178	86 (69*)	163	82,5	43,3	25	80	21
Final gas pressure, abs., at the outlet of the compressor discharge branch pipe; MPa	3,75	11,7	6,7	10,95	4,5	10,43	3,83	10,43
Power consumed by the compressor; MW, no more than*	14,5		15,3		3,8		4,55	
Initial gas pressure, abs., at the inlet of the compressor suction branch pipe; MPa	1,35	3,6	3,35	6,44	2,5	4,35	1	3,68
Gas density, kg/m ³ , at 20 °C and 0.1013 MPa, abs.; kg/m ³ **	0,7982		0,8228		0,943		0,943	
Polytropic efficiency; %	83	82	0,83	0,815	81	80	82	80
Initial gas temperature at the inlet of the compressor suction branch pipe; °C	26	45	35	45	30	45	30	45
Compressor rotor speed; rpm	8870	8870	8450	8450	9295	15 750	9400	15 927

* Taking into account mechanical losses in LPC 100 kW and HPC 100 kW and without taking into account mechanical losses in the step-up gear 500 kW
 ** Gas density referred to 20 °C and 0.1013 MPa is assumed for design gas composition (see cl.4.4.1)

The units based on a high-speed two- cylinder compressor

415-61-1 compressor

The 415-61-1 compressor is designed to compress raw oil gas with a density of 0.824 to 1.12 kg/m³ at field compressor stations and to supply it to the common collector.

This is one-cylinder six-stage centrifugal machine equipped with tight end face seals. The compressor is equipped with two gear pairs of the step-up gear designed for operation on gas with the following density values, kg/m³: 0.824; 0.91; 1.02; 1.12. Operation on gas with the other density values is provided by installation of replacement gear pairs. The compressor casing is horizontally split.

K354-101-1 compressor

The compressor is designed to compress oil-associated gas at gas processing plants.

The compressor and all completing equipment are explosionproof and can be operated in the explosive category room of B-1A class with 2T-2 explosive mixture category and group.

The compressor is two-cylinder, two-section, ten-stage. The compressor cylinder tightness is provided by oil end seals.



Compressor K354-101-1

The el. motor and the exciter are explosion-proof, purged under gage pressure in the closed ventilation cycle.

The compressor unit is equipped with the systems of control, protection, monitoring and signalling, protection against backflow of gas from the network to the compressor, against surge, axial displacement of rotors of all the cylinders, against temperature rise of the unit bearing shells, as well as against oil pressure reduction in the lubrication system.

Modernized unit based on compressor K320

The K320-131-1 centrifugal compressor is designed to compress oil-associated gas at gas-processing plants.

The compressor and all the completing equipment are explosion-proof and can be operated in the explosive room of B-1A class, with 2T-2 explosive mixture category and group.



Centrifugal compressor K320-131-1 at CS of Severo-Danilovskoye Field TPE

The compressor is two-cylinder, two-section, thirteen-stage. The tightness of the compressor cylinders is provided by means of oil end seals. The LP cylinder has a cast steel casing horizontally split. The HP cylinder has a forged barrel type casing with an end cover.

The el. motor and the exciter are explosion-proof, purged under gage pressure in the closed ventilation cycle.

The K320-131-1 compressor is designed for the foundation dimensions of the K380-103-1 and K354-101-1 units, which makes it possible to replace the outdated equipment at minimum expense.

The units driven by a high-speed variable el. motor

The K230 is part of the electrically-driven gas-pumping unit EGPA- 4,0/14000 and is designed for compression and transmission of oil-associated gas

Configuration

- Compressor K230-81-1 CMП.
- High-speed el. motor.
- Semiconductor frequency converter.
- Automatic control and governing system of the unit.

Scope of supply

- Compressor unit.
- Dry gas seals system (DGS).
- Magnetic bearing system of the rotor, including the control cabinet with the UPS batteries (energy consumption of the magnetic bearing system \approx 5 kW) and cables.
- Complete set of restrictive flow orifice device for the anti-surge protection system.
- Complete set of transition discharge branch pipe.
- Foundation frame with fasteners.
- Intermediate shaft guard up to the fire-proof partition.
- Counter-flanges of the magnetic bearing, dry gas seals with sealing and fastening elements on the side of the compressor.
- Complete set of plugs for pressure test of the gas loop.
- Intermediate gas cooler.
- Complete set of special tools.
- Tools for assembly and disassembly of the compressor and its component parts.
- Complete set of replacement parts.
- Complete set of replacement parts for installation, pre-commissioning and acceptance tests.
- Complete set of transport boxes.
- Piping to supply and remove gas and air flows from the dry gas seals system instrumentation to the seal.

Description of the K230-81-1 CMП compressor

The compressor is made one-cylinder, two-section, eight-stage. The compressor casing is forged, with a welded discharge branch pipe and a bolted suction branch pipe.

The compressor is equipped with a magnetic bearing of the rotor, the digital control system of which is connected with the unit control and governing system "ELESKU 4000/14 000". The rated speed of the compressor shaft is 14 000 rpm, the drive power — 4.0 MW.

The tightness of the compressor is provided by dry gas dynamic seals. To prevent damage to the surfaces of stator and rotor parts of the magnetic bearing in case of power failure and in emergency conditions, auxiliary bearings are installed to provide emergency rundown of the rotor. The confuser and a set of transducers to measure gas parameters provide operation of the compressor anti-surge protection system.

Technical characteristics of the compressor

Parameter	Value
Rated mechanical power consumed by the compressor on the el. motor intermediate shaft; kW	3800
Volume capacity referred to 20 °C and 0.1013 MPa; ths. m ³ /day	855
Volume capacity referred to initial conditions; m ³ /min	235
Final gas pressure, abs., at the compressor outlet; MPa	3,5
Initial gas pressure, abs., at the compressor inlet; MPa	0,25
Gas temperature at the compressor inlet; °C	15
Rated speed; rpm	14 000
Sense of rotor rotation (clockwise, when looking at the compressor from the drive side)	right-hand

High-speed electric motor

The high speed el. motor is designed to drive the K230-81-1 ЦМП centrifugal compressor with quadratic dependence of the torque on the shaft on speed. The torque of the electric motor is transmitted directly to the compressor shaft by means of an intermediate shaft. The electric motor operates as part of the variable frequency electric drive with power supply from the frequency converter and with the variation of the current frequency from 0 to 250 Hz and that of voltage from 0 to 3300 V. The el. motor is equipped with the rotor magnetic bearing system manufactured by Nevskiy Zavod under the license of S2M (SKF).

Magnetic bearing complete set:

- magnetic bearing control cabinet for magnetic bearing digital control;
- two radial magnetic bearings including radial electro-magnetic supports with two units of radial-axial position transducers each;
- auxiliary bearings providing emergency rundown of the rotor to prevent damage to the surfaces of the magnetic bearing stator and rotor parts in case of power failure and in emergency conditions.



High-speed el. motor

El. motor protection

Type of protection	Protection implementation	Location
Current protection of the el. motor against multi-phase short circuits	Current cutoff without time delay	Frequency converter
Current protection against single - phase ground short circuit	Current protection without time delay, initiating trip	Frequency converter
Protection against overload	Current overload 123% - warning is generated, current overload 126% - emergency trip	Frequency converter
Current protection against phase failure	Initiates tripping without time delay	Frequency converter
Protection against excessive rotor vibration	Two – level protection: – warning; –initiates tripping without time delay.	Magnetic bearing CS
Protection against magnetic bearings overheating		Magnetic bearing CS
Protection against excessive temperature or cooling system failure		ACS

Technical characteristics of the el. motor

Parameter	Value
Supply voltage at all operating conditions; V	3300
El. motor power rating; kW	4000
Maximum continuous power; kW	4200
Rated efficiency; p.u.	0,958
Rated torque; Nm	4658
Rated current; A	970
Maximum continuous current; A	1020
Rotor moment of inertia; kg*m ²	48
Mass; kg	15 500
Protection degree as per GOST 14254	IP22
Cooling system	air
Maximum allowable axial displacement of the rotor; mm	±2,5
El. motor mounting version	IM1001

Semiconductor frequency converter

Technical characteristics

Parameter	Value
Total output power; kVA, no less than	5200
Rated output current; A	910
Efficiency in the rated conditions (without transformer); p.u.	0,985
Rated power factor; p.u.	0,96
Rated output voltage; Ur, V	3300
Output voltage range; V	0...Ur
Rated frequency of output voltage; fr, Hz	223
Soft start by underfrequency relay from 0 to the preset operating frequency	0...1,05xf _n
Cooling system	air
Protection degree as per GOST 14254	IP22

Delivery sites

The equipment is supplied to the facilities of PJSC “Gazprom Neft”, PJSC “LUKOIL”, PJSC “NK “Rosneft”, PJSC “NK” Russ-Neft”, PJSC “SIBUR Holding”, PJSC “Surgutneftegaz”, PJSC “TATNEFT”, JSC “TNK-BP Holding”, PJSC “AK “Transneft”, JSC “KazMunayGaz” and other.



Equipment for chemical industry

08

Steam turbines for chemical industry units	108
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Equipment for chemical industry ranks a notable position in the product line of Nevskiy Zavod.

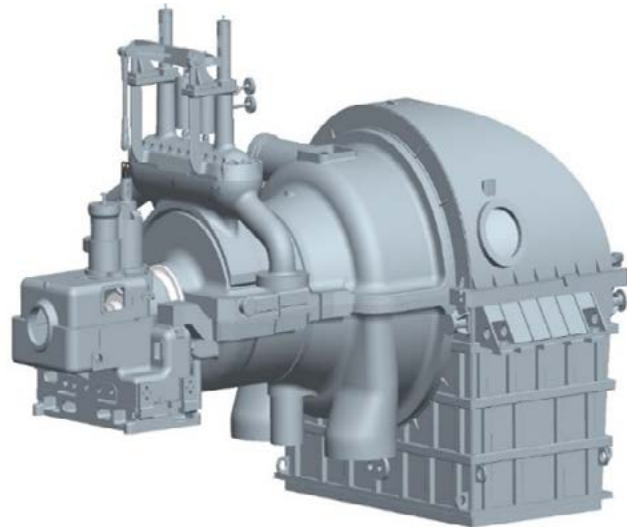
The units are designed to compress various gases in the production of nitrogen fertilizers, ethylene, propylene, as part of the facilities for isothermal storage of ethylene and propylene, to supply natural gas to the combustion chambers of gas turbine units, for the production of sulfuric and nitric acids and in other industries.

Steam turbine drives for chemical industry units

Place of installation

Foreign countries

- Bulgaria
- Ukraine
- Lithuania
- Georgia
- Uzbekistan

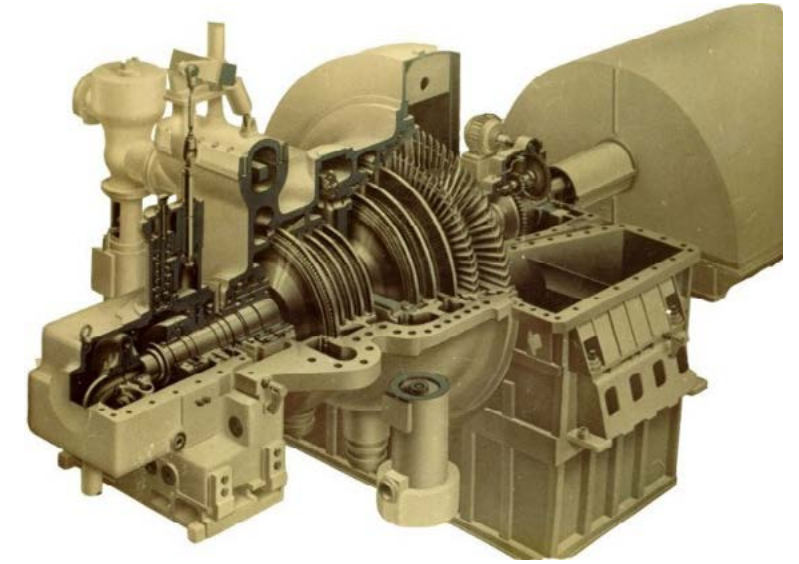


Types	Power, MW
K15-4,0-1	15
K-11-3,4	11
K-10-3,6	10
P-3,5-4,0/1,5	3,5
P-2,3-3,5/1,7	2,3
П30-10, 0/4, 0-1	29,4
П28-10/1, 2-1	26,5

Place of installation

Russia

- Kemerovo
- Berezniki
- Kirovo-Chepetsk
- Togliatti
- Cherepovets
- Nizhnekamsk
- Kstovo (Nizhniy Novgorod)
- Rossosh



K-10-3,5

K-10-3,5 steam turbine is designed to drive OK2100-A axial compressor intended for compression of atmospheric air and its delivery to FCC unit at petroleum processing plants and petrochemical plants.

The turbine is of active type, single-cylinder, condensing. Sense of the rotor rotation is counterclockwise when looking at the turbine along the steam flow.

P-3,5-4,0/1,5

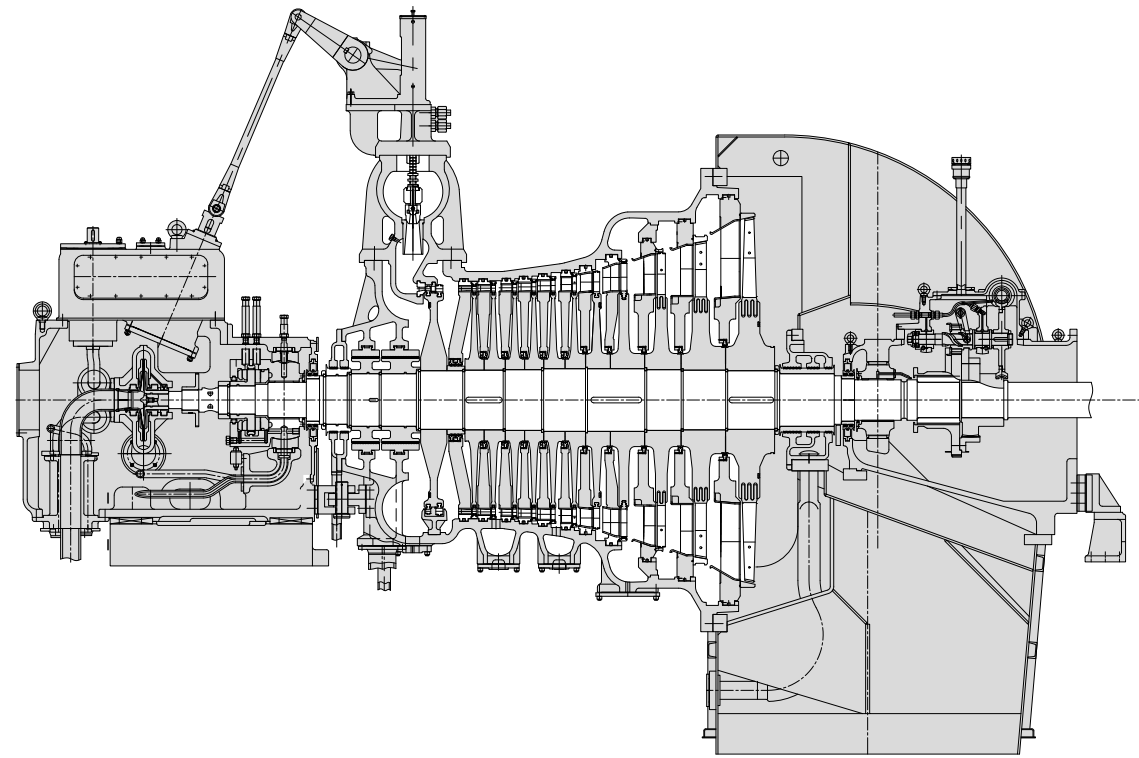
P-3,5-4,0/1,5 back pressure steam turbine is part of ГТТ-12М unit, operating in the cycle of weak nitric acid production and it is designed for the unit startup, regulation of the operating conditions and for compensation of deficient power on the unit shafts in operating modes during operation.

P-2,3-3,5/1,7

P-2,3-3,5/1,7 back pressure steam turbine is part of KMA-2 unit operating in the cycle of weak nitric acid production and it is designed for the unit startup, regulation of the operating conditions and for compensation of deficient power on the unit shafts in operating modes during operation.

K-15-41-1 steam turbine

K-15-41-1 steam turbine serves to drive a centrifugal air compressor designed to compress atmospheric air as part of the process line for ammonia production with a capacity of 1500 t/h.

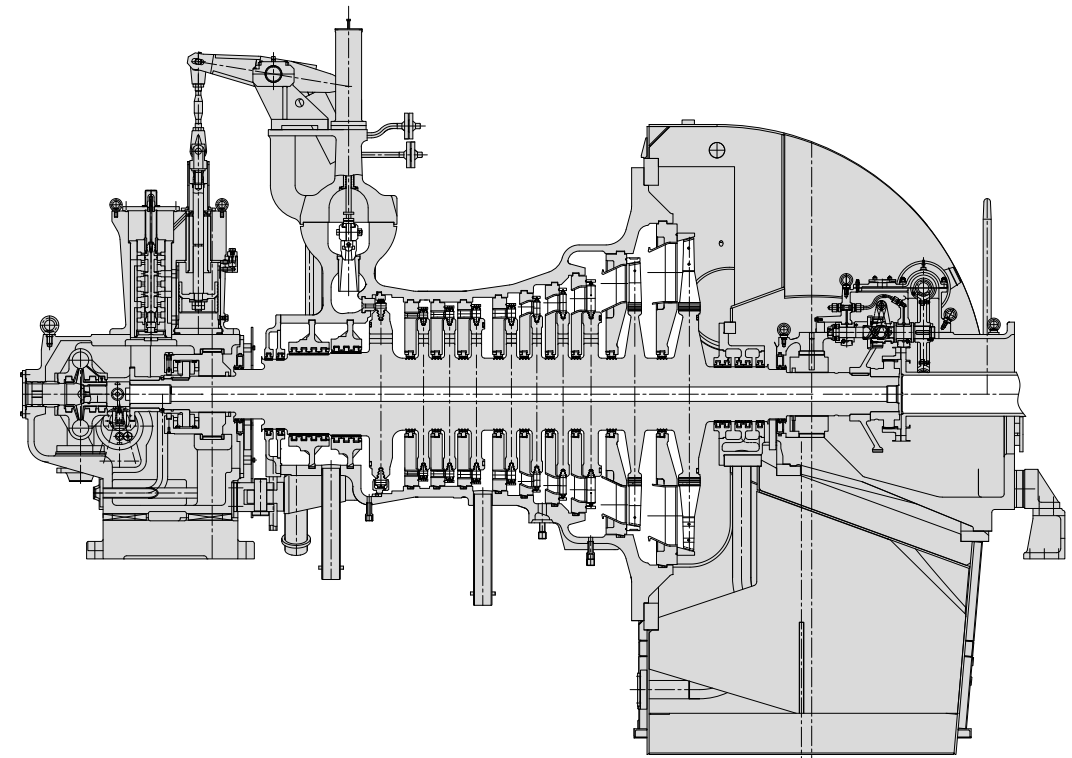


Technical characteristics

Parameter	Conditions	
	Rated	Max
Rated power; MW	12	15
Steam initial rated conditions:		
Absolute pressure; MPa	4	
Temperature; °C	363	
Rotor speed variation range; rpm	2600-3500	
Steam mass flow via turbine; t/h	56,1	70,8
Cooling water rated flow to the condenser; t/h	2500	
Cooling water rated temperature; °C	25	

K-10-3,5 steam turbine

K-10-3,5 steam turbine is designed to drive OK2100-A axial compressor intended to compress atmospheric air in catalytic cracking cycle.



Technical characteristics

Parameter	Conditions		
	Max	Rated	Min
Rated power; MW	11	8,051	3,5
Steam initial rated conditions:			
Absolute pressure; MPa	3,5		
Temperature; °C	300		
Steam mass flow via turbine; t/h	59,6	43,2	19,5
Steam absolute pressure in the condenser; kPa	8,7	6,6	5,2
Speed; rpm	5313	5060	3900
Cooling water flow; m³/h			
To the condenser	2500		
To the oil coolers	105		
Cooling water temperature; °C	25		

Centrifugal compressor machines for process purposes

The equipment for chemical industry makes a sizable contribution to the product line of JSC "NZN".

The units are designed to compress various gases in the production of nitrogen fertilizers, ethylene, propylene, as part of the facilities for isothermal storage of ethylene and propylene, to supply natural gas to combustion chambers of gas turbine units, for the production of sulfuric and nitric acids and in other industries.

K104-101-1 compressor

Purpose

The compressor is designed to compress ethylene and propylene vapors as part of the facilities for isothermal storage of ethylene and propylene.

Design features

The compressor is a two-cylinder, two-section machine with gas cooling between the cylinders. The compressor cylinder casings have horizontal split; the cylinders suction and discharge nozzles are directed downward.

The compressor is driven by an asynchronous electric motor.

The unit oil system provides forced lubrication of the unit bearings as well as oil supply to the step-up gear, toothed couplings, end face seals. Oil accumulators allow for trouble-free shutdown of the unit in case of power supply failure.

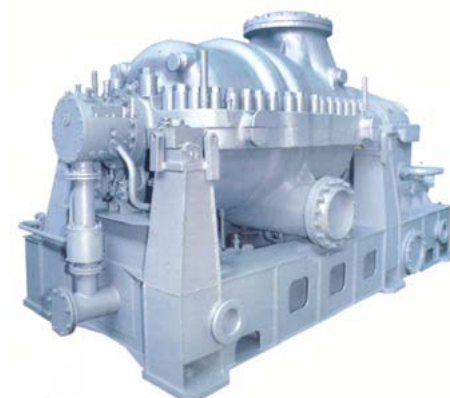
Configuration

- Centrifugal compressor made as two-cylinder.
- Step-up gear.
- Drive el. motor.
- Oil supply system.
- Governing system.
- Hardware set for monitoring, control, protection and signaling.
- Intermediate and bypass gas coolers.

The governing system maintains constant pressure at the compressor suction by gas bypassing.

The compressor is provided with anti- surge protection.

Hardware set is intended to control the compressor and makes it possible to fully automate compressor control both during its startup, shutdown, and during its operation.



Compressor unit K270-61-1

Configuration

- Compressor.
- Step-up gear.
- Drive motor.
- Oil supply system.
- Governing system.
- Hardware set for monitoring, control, protection and signaling.
- Intermediate and end gas coolers.

The compressor is supplied in preassembled modules — the compressor unit and the oil supply unit. The rest of the equipment is supplied as separate assembly units.

The compressor unit includes the compressor cylinder and step-up gear mounted on a common foundation frame. On the frame there are some pipes of the oil pipeline and leakage gas pipeline mounted.

The compressor is a single-cylinder, two-section, six- stage machine. The compressor sections have opposite direction of compressed gas flow. The tightness of the compressor cylinders is achieved by end face seals. Between the compressor and drive el. motor there is a step-up gear installed.

The compressor is driven by an asynchronous electric motor.

Gas cooling is carried out between the sections and downstream of the compressor in the intermediate and after coolers of shell-and-tube type.

Oil accumulators allow for trouble-free shutdown of the unit in case of power supply failure.

The governing system maintains constant pressure at the compressor suction by means of bypassing gas from the compressor discharge to the suction.

The compressor is equipped with anti- surge protection and hardware set providing the compressor operation without permanent presence of attending personnel in the place of the equipment installation.

3300-11-1 и 3300-12-1 compressors

Purpose

The compressors are designed to compress and supply dry sulphur dioxide in the production of sulphuric acid, as well as to compress and supply atmospheric air and other noncorrosive gases close to air in their thermodynamic parameters.

Configuration

- Centrifugal compressor.
- Drive motor.
- Oil system.
- Throttle valve with an electric actuator.
- Monitoring, control, protection and signaling system.

Monitoring, control, protection and signaling system performs the following:

- compressor start and shutdown from a remote panel or locally;
- compressor protection and emergency shutdown in emergency conditions;
- monitoring of the compressor process variables;
- light and audio alarm in case of parameters deviation from the rated values (warning alarm);
- signaling of tripping (emergency alarm);
- light process signaling;
- electric interlockings to switch on/off the compressor auxiliary electric devices.

Design features

The compressor is single-cylinder, single-stage, with two-side suction impeller.

The compressor casing is cast, with a horizontal split. The end shaft seals of the compressor provide its tightness due to supply of inert gas to the seals when operating with sulphur dioxide. The compressor is driven by an asynchronous electric motor.

The oil accumulator provides trouble-free shutdown of the compressor in case of power supply failure.

95-81-1 compressor

Purpose

The compressor is designed to compress natural gas in the production of nitrogen fertilizers.

Configuration

- Centrifugal compressor made as two-cylinder.
- The system of oil supply to the seals.
- Governing system.
- Anti-surge protection system.
- The system of control, monitoring, protection and signaling.

Design features

The compressor cylinders are installed on a common foundation frame. There are four stages in each cylinder. The cylinder casings are made of steel with a horizontal split. The compressor is provided with hermetical end face seals.

Oil is supplied to the end face seals by a screw pump. The pressure differential regulator maintains constant oil-gas pressure differential.

The compressor is driven by the K-4,3-40,8 condensing turbine.

133-21-1 compressor

Purpose

The compressor is designed to compress propylene fraction when it is operating individually for the consumer.

Design features

The compressor is a two-stage unit with radial and tangential arrangement of the respective inlet and outlet nozzles cast integral with the compressor casing.

The compressor cover is made of forged steel and it has an elastic diaphragm relieving the compressor from axial loads during its operation.

The end face seals mounted in the compressor borings, as well as the rings installed on the shaft prevent gas penetration into the machine room.

Rotor speed increase is achieved by means of a step-up gear. The unit is controlled automatically via microprocessor based hardware. The compressor is driven by an asynchronous motor.

175-21-1 compressor

Purpose

The compressor is designed to compress contact gas in the production of ethylene oxide and to replace the compressors that have reached the end of their lifetime.

Configuration

- The centrifugal compressor and step-up gear are installed on a common frame.

Design features

The compressor is a single-cylinder two-stage modular centrifugal compressor machine.

The compressor is equipped with automatic control and protection systems, as well as with control and monitoring facilities.

The compressor is driven by an electric motor. The electric motor is connected to the compressor through a step-up gear by means of toothed couplings.

540-41-1 compressor

Purpose

The compressor is designed to compress nitrous gas in the production of weak nitric acid.

Configuration

- Compressor with a built-in expansion turbine.
- Increasing gearbox.
- Electric drive motor.
- Electrically operated lubrication system.
- Thermal monitoring, control, protection and signaling system.

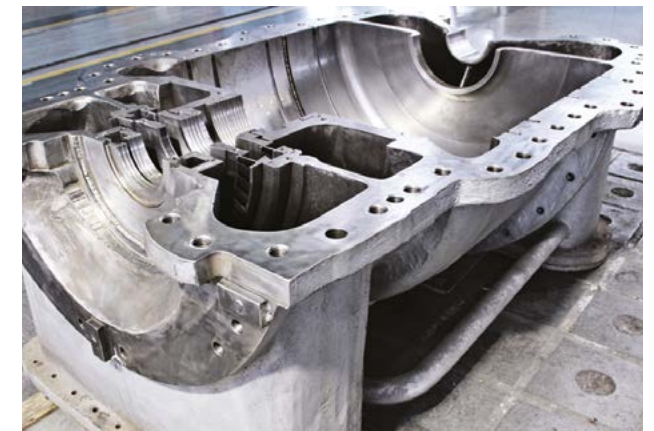
Design features

The expansion turbine is a two-stage impulse turbine and serves to reduce power consumption for compression of nitrous gas in the compressor. The expansion turbine utilizes the power of waste gases, generated in the production of weak nitric acid.

The compressor and expansion turbine components are made of special alloyed steels providing their corrosion resistance.

The compressor is driven by 2A3МП-1600/6000 asynchronous electric motor with a squirrel cage rotor (rated at 1600 kW, 6000 V, 2980 rpm).

The centrifugal compressor, having constant operating conditions, is not equipped with automatic regulation facility. The compressor supply is maintained constant by varying the ratio of nitrous gases and makeup air.



H540-41-1 Casing



H540-41-1 compressor casing

Thermal monitoring, control, protection and signaling system consists of a board on which the following is installed:

- instrumentation for startup and shutdown;
- instruments for remote measurement of CC operational parameters;
- instruments of emergency and warning signaling;
- protective devices against the rotor axial displacement, oil pressure decrease in the lubrication system and gas pressure decrease in the suction line, as well as against temperature decrease in the centrifugal compressor bearings.

Main characteristics of centrifugal compressor for process application

Parameter	Тип		
	45-21-4		K88-101-1
Compressed air	propylene		ethylene
Volume capacity referred to 20°C and 0,1013 MPa; Nm ³ /s	Mode 1 — 8,95	Mode 2 — 10,73	1,56
Mass capacity; kg/s	15,6	18,7	1,817
Volume capacity referred to initial conditions; m ³ /min	45,5	45,5	81
Final gas pressure at the discharge branch pipe outlet; MPa, abs	1,86	2,35	2
Consumed power; MW	0,63	0,82	0,75
Initial conditions			
Initial gas pressure at the suction branch pipe inlet; MPa, abs.	1	1,275	0,102
Initial gas temperature at the suction branch pipe inlet; °C	21	40	-15
Dry gas density referred to 20 °C and 0,1013 MPa; kg/m ³	1,747		1,167
Rotor speed; min ⁻¹	9370		16 122

Upgrading of axial compressors for petrochemical plants

K-3750/3,3 axial compressor

Brief description

The K-3750/3,3 upgraded compressor is designed for operation with K-11-3,4 steam turbine drive as part of FCC unit.

Configuration

The compressor is made as axial, single-shaft, single-cylinder with a foundation frame, without intercooling.

The compressor is driven by upgraded K-11-3,4 steam turbine. The torque from the turbine rotor to the compressor rotor is transmitted by means of a toothed coupling.

The compressor and drive turbine bearing casings are linked together by means of a joint part. In the borings of the suction and discharge chambers, a journal shell taking up radial loads and a journal-thrust shell taking loads both in the radial and axial direction are installed.

The middle part of the axial compressor casing is a carrier containing guide vanes, as well as inlet guide vanes.

Drum type rotor consists of two parts — a drum and a plug joined together by force fitting and additionally secured radially with pins.

In the drum circular slots the compressor rotor blades are installed. On the shaft driven end a toothed hub of the coupling is fitted which joins the compressor rotor with the rotor of the drive steam turbine. The compressor rotor rests with its journals on the inner boring of the journal shell part.

The axial compressor has the designation as K-3750/ 3,3, where:

- K — compressor;
- 3750 — type of compressor casing;
- 3,3 — pressures ratio.

In order to increase the axial compressor capacity, the compressor flow channel is upgraded alongside with simultaneous replacement/upgrading of its bearing assemblies and instrumentation equipment.

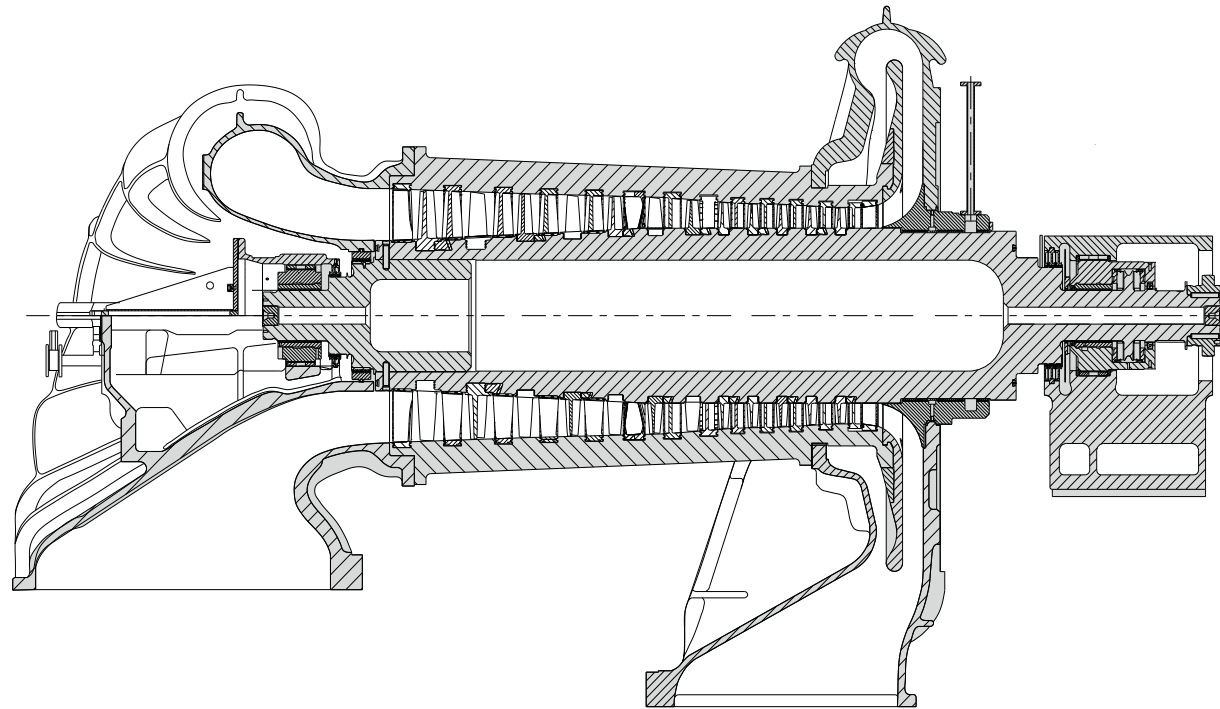
The stator and rotor mutual arrangement is provided by journal and thrust bearing components and the rotor thrust shoulder. In order to prevent oil leakages, oil seals are installed in the casings borings. To avoid air suction into the flow passage (bundle), air seals are installed in the suction and discharge chamber casings.

The new flow passage of the compressor contains a 12-stage cascade of blades which is formed due to introducing newly made assemblies - the rotor and the stator carrier - into the compressor standard version. When upgrading, the stator components - the suction and discharge chambers and the journal - thrust bearing casing - are analyzed, and the decision is made on the necessity of their replacement or they are approved for further use based on the results of the examination performed on site.

In the existing casing borings, shells are installed with the working surfaces made of antifriction heat-resistant carbon fiber reinforced plastic. Babbitted shells are included into the scope of supply as replacement (spare) parts. On the shells surfaces, installation areas are provided for resistance temperature detectors for indoor installation instead of the existing ones for outdoor installation. The welded design of the diffuser is replaced by an assembly consisting of integrally machined diffuser discs and the cowling additionally fixed in the existing fastening holes.

Configuration

The oil seals are replaced by newly manufactured seals, with the former design remaining unchanged. During the process of upgrading, the journal shell design is added with a sleeve in two halves available in two versions of the working surface - traditional, with babbit lining (used as spare one), and with glued-on surface made of antifriction heat resistant reinforced plastic (used as the main one). Lemon type boring of the sleeves inner surface is made similarly, i.e. oil clearances are the same for different versions. The sleeves are interchangeable in pair and do not need additional fit-in operations during installation or replacement.



K-3750/3,3 axial compressor longitudinal section

The compressor main parameters after upgrading, with consideration for the parameters and properties of the process gas (air)

Parameter	Value		
	1	2	3
Operating mode	1	2	3
Mass capacity; kg/hour	261 928	200 921	198 000
Volume capacity referred to 0°C and 0,1013 MPa; Nm ³ /hour	205 112	157 338	155 050
Final air pressure, abs., at the compressor discharge branch pipe outlet; MPa	0,4	0,38	0,33
Compressor power; MPa	12,6	10,6	10,1
Initial air pressure, abs., at the compressor suction branch pipe inlet; MPa	0,1	0,085	0,08
Initial gas temperature at the suction branch pipe inlet; °C	24	24	24
Compressor rotor speed; rpm	4770	4585	4580

* The sense of the compressor rotor rotation is counterclockwise if viewed from the drive side

OK-2100 axial compressor

Brief description

The OK-2100 axial compressor is used as part of an air blower driven by K-10-3,5 steam turbine unit (hereinafter STU) or variable frequency drive (VFD) in FCC unit process line.

The compressor unit making part of the axial compressor has the following designation: OK-2100- 4,68/4,65-5400/10, where:

- OK — axial compressor;
- 2100 — type of casing;
- 4,68 — pressure ratio;
- 4,65 — final pressure, abs., kg/cm²;
- 5400 — drive speed, rpm;
- 10 — drive power, MW.

Nevskiy Zavod has a considerable experience in designing and production of axial compressors and, today, it is the only company in Russia capable of supplying such type compressors for the industry needs.

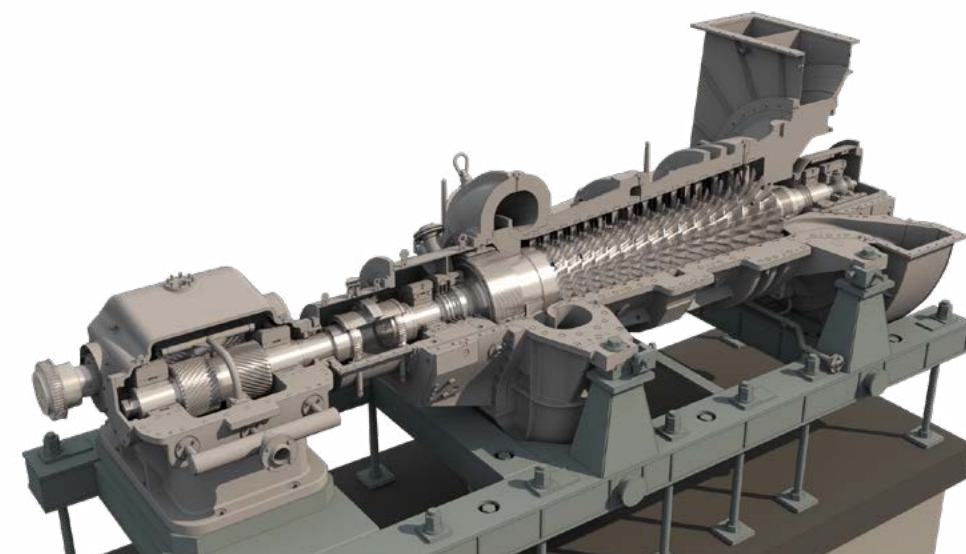
Mastering the new manufacturing technology for this equipment by Nevskiy Zavod is of strategic importance for this industry within the framework of the import substitution program and will make it possible to create a hightechnology competitive Russian product which is on a par with foreign analogs and with great prospects in the framework of its series production.

Purpose

The OK-2100 axial compressor is designed to compress and supply atmospheric air to the process units applied in oil and gas industries, chemical industry and metallurgy.

Key figures

- Polytropic efficiency — 87%;
- Power consumed — 8,1 MW;
- Volume capacity — 106673 Nm³/hour;
- Compressor pressure ratio — 4,68;
- Flow channel — 15 stages with rotor blades and guide vanes;
- Rated speed — 5000 rpm.



Configuration

The compressor is made axial, single-shaft, single-cylinder with a foundation frame and without intercooling. The K-10-3,5 stationary steam turbine unit is used as the compressor drive.

The compressor unit is installed on the foundation frame. Air supply to the compressor flow channel is implemented via inlet duct consisting of two branch pipes - transition and rotary ones. Between the compressor suction chamber and the inlet duct there is an expansion joint installed.

The torque from the turbine rotor to the compressor rotor is transmitted by means of a toothed coupling. The bearing casings of the compressor and the drive turbine are joined together by means of enclosure. To connect the inlet and outlet ducts on site, conerflanges are included in the compressor scope of supply.

The journal - thrust bearing casing shall be provided with a collector for oil drain from its housing.

On the support areas of the compressor casing there are casings of the journal and journal-thrust bearings installed in the borings of which journal bearings to take up the radial load, and the thrust bearing taking up the axial load are installed.

The compressor rotor rests with its journals on the inner boring of the journal bearings. To prevent oil leakages, in the borings of the journal and journal-thrust bearing casings oil seals are installed. Additionally, the casing of the journal bearing is provided with a labyrinth seal with air supply to separate the oil and air cavities. To avoid air suction into the flow channel (from the suction side), and to create a required axial force (from the discharge side) the compressor is provided with labyrinth seals installed in the borings of the suction and discharge casings. On the vertical and horizontal joints of the compressor casings, grooves are made in which silicone cords are laid.

A diffuser with guide vanes is installed in the boring of the discharge casing to additionally equalize the air flow.

Axial compressor main parameters for design composition of compressed gas

Parameter	Standard (Design case)**	Case 1	Case 2	Red. power case
Capacity for P = 0,1013 MPa and t = 0 °C; Nm ³ /h	106 673	90 708	74 164	44 726*
Volume capacity referred to initial conditions; m ³ /h	127 170	95 346	84 367	79 938
Power required for drive, incl. losses; kW	8051	5041	4750	4300*
Initial air pressure, absolute, at the compressor suction branch pipe inlet; MPa	0,0975	0,0975	0,09	0,09
Final air pressure, abs., at the compressor discharge branch pipe outlet; MPa	0,457	0,366	0,357	0,350
Initial air temperature at the compressor suction branch pipe inlet; °C	40	3	3	-34
Final air temperature at the compressor discharge branch pipe outlet; °C	239,5	151	174,9	109,9
Rotor speed; rpm***	5060	4300	4410	4065*

* Operation with release of part of the fluid into the atmosphere

** Guaranteed performance during the factory tests



Equipment for power generation industry

09

Gas turbine equipment	125
Steam turbine equipment	132
Equipment for Combined Cycle Plants	135
Static Compensators	142
Heat Load Governor	144

Nevskiy Zavod offers manufacturing and supply of high-tech packaged equipment for construction of power generating units, based on steam and gas turbines rated from 6 to 32 MW.

The main equipment is unified to the maximum and it is made up of modular assemblies.

In their power category the gas turbine power units of Nevskiy zavod show high efficiency together with low level of harmful emissions.

All GTU systems are designed to provide high performance and ease of maintenance in the operating conditions.

Advantages of power units

- High reliability based on modern design practices, materials and technologies applied in the design of the main component — gas turbine engine.
- Complete life cycle — 200,000 hours.
- Long repair intervals.
- High electric efficiency.
- High economical efficiency in various operating conditions.
- Use of components mostly from the Russian manufacturers with a high share of Nevskiy Zavod.
- Possibility to repair on customer's site
- Possibility of quick GTE removal during repair due to lateral rollout from under the enclosure.

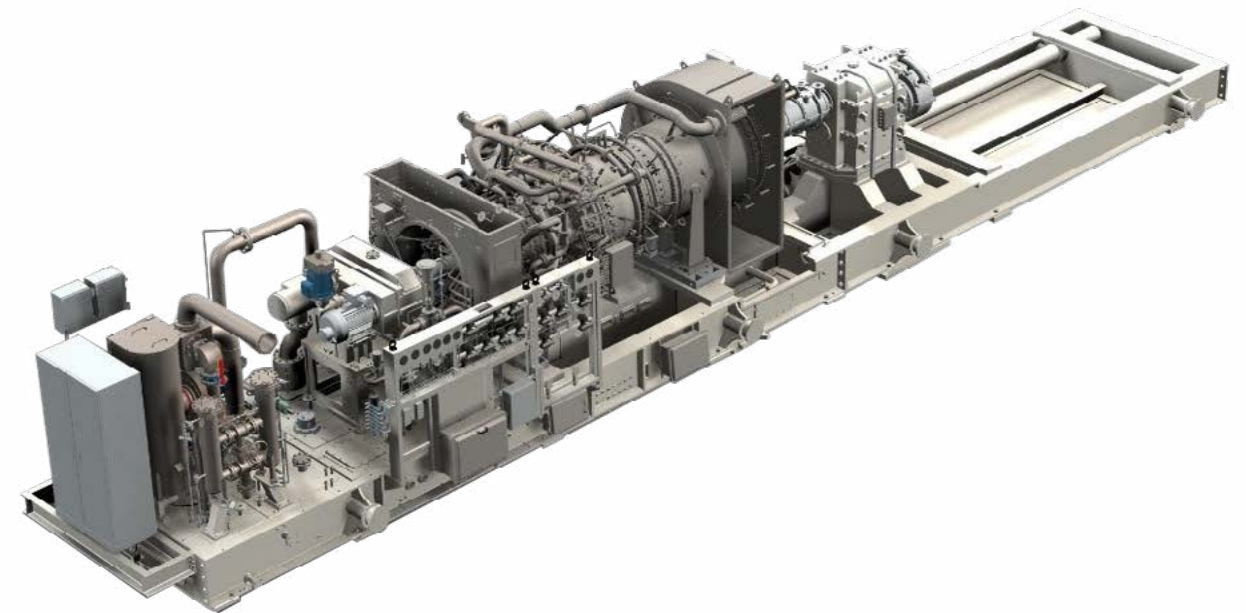
Package supply of equipment by Nevskiy Zavod provides:

- reduced cost of the main and auxiliary equipment due to manufacture directly at production facilities of Nevskiy Zavod;
- application of advanced engineering solutions;
- reduced operating costs;
- ensuring maximum reliability of all gas turbine power station (GTPS) components;
- reduced delivery time;
- comprehensive service maintenance.

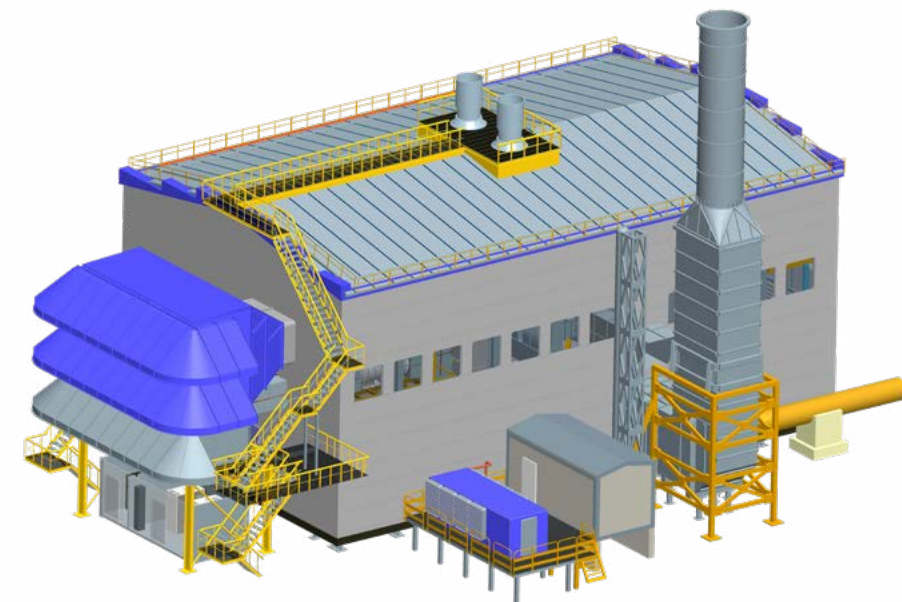


Gas turbine equipment

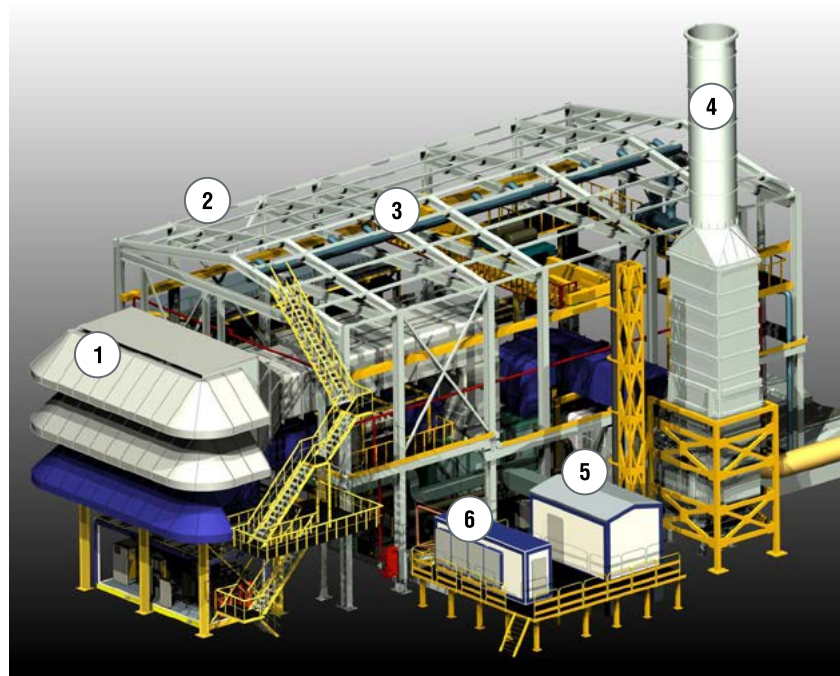
Nevskiy Zavod offers manufacture and supply of packaged equipment for gas turbine power stations based on stationary GTU rated at 16, 25, 32 MW.



External view of GTU T16 power generating version without enclosure



Gas Turbine Power Station (GTPS) with stationary GTU Arrangement in hangar



Gas turbine power station main components

- 1 Filter house
- 2 Hangar
- 3 Crane
- 4 Exhaust duct
- 5 Hangar air heating system
- 6 Oil cooler

Gas turbine power stations rated at 32 MW

Description

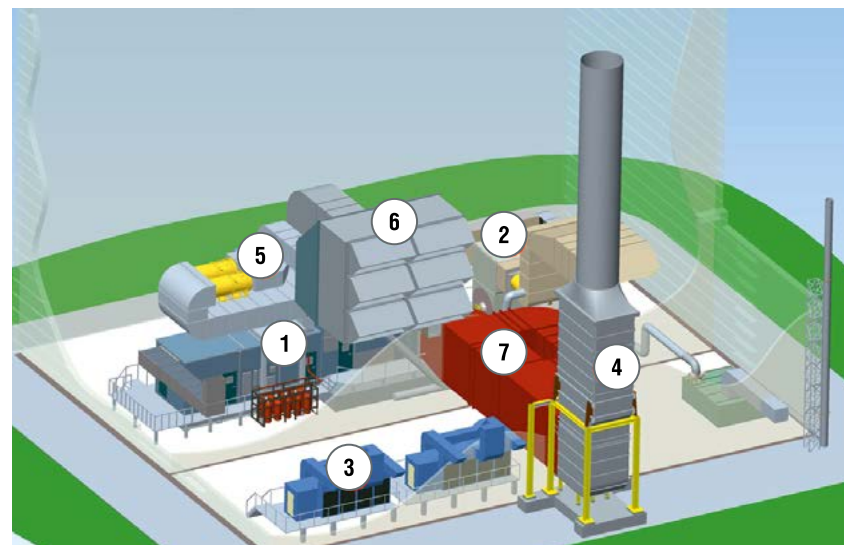
The GTE-32 simple cycle gas turbine power unit is based on the T32 gas turbine engine produced by Nevskiy Zavod under the licence of GE Oil & Gas company (Nuovo Pignone S.p.a., Italy). The unit main equipment is unified to the maximum and it is made up of packaged units.

GTPS-32 configuration:

- T32 gas turbine (GT) (under the licence of GE company);
- turbogenerator (TG) for GT;
- gearbox to transmit power from GT to TG;
- filter house;
- waste heat recovery unit (WHRU) (if required);
- fuel gas booster compressor (if required);
- air and gas ducting system;
- automatic process control system (APCS);
- electric equipment.

Power unit component arrangement (in a single building)

- 1 GTU (gas turbine unit)
- 2 Generator with air cooling system
- 3 Oil air-cooler
- 4 Exhaust pipe with silencer
- 5 Air ducts for cycle air and air cooling systems
- 6 Filter house
- 7 WHRU



GTU-32 main technical characteristics (simple cycle)

Parameter	Value
Power at the generator terminals; MW	31
Electric efficiency; %	35
Exhaust gas flow; kg/s	102,3
Fuel gas flow (natural gas), $Q_{PH} = 50 \text{ MJ/kg}$; kg/s	1,77
Specified service life; h	200 000
Mass of the GTU main equipment (w/o generator and gearbox); t	132
Exhaust gas temperature; °C	450/600
Emission (at 15 % O_2 in dry combustion products):	
nitrogen oxides; mg/m^3	≤ 40
carbon oxides; mg/m^3	≤ 38

Gas turbine power stations rated at 22/25 MW

Gas turbine power unit rated at 22/25 MW*

Nevskiy Zavod offers manufacture and supply of packaged equipment for gas turbine power stations based on gas turbines rated at 22/25 MW.

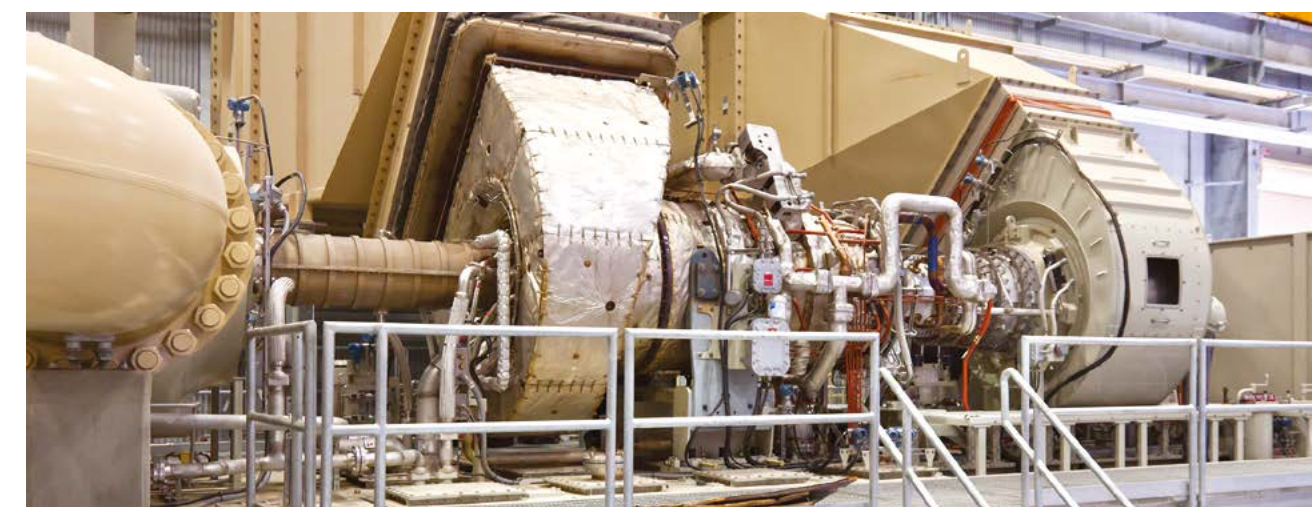
The gas turbine power unit incorporates the following main equipment:

T25 gas turbine

High-tech simple cycle stationary gas turbine. Produced and assembled at Nevskiy Zavod under the licence and in cooperation with Solar Turbines company. In its power category it possesses a high efficient performance (40 %) alongside with a low level of harmful emissions.

- gas turbine engine on skid (GTE);
- turbogenerator (TG) for GTE;
- gearbox to transmit power from GTE to TG;
- inlet air filter unit;
- air and gas ducting system;
- waste heat boiler, WHB (option**);
- automatic process control system (APCS);
- electric equipment;
- utilities;
- metal structures.

* It is planned to increase the GTU power stepwise
 ** It is used for combined generation of heat and electric power

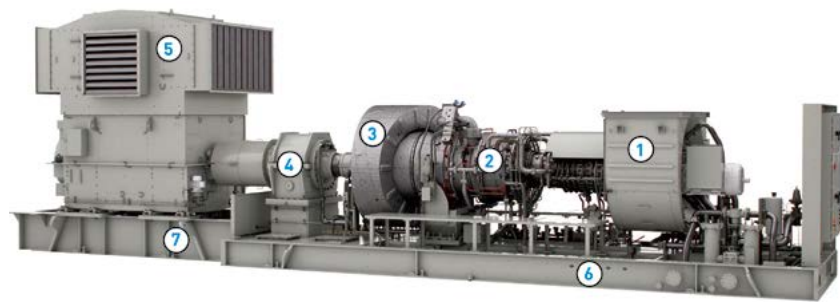


T25 GTU



External view of the power unit under the noise-and- heat insulating enclosure

Main equipment of the power unit on frame (w/o enclosure)



- 1 Inlet duct
- 2 Engine
- 3 Exhaust plenum
- 4 Gearbox
- 5 Generator
- 6 Engine frame (lube oil tank built into the engine frame)
- 7 Generator frame

Performance of GTE-22/25

The gas turbine power unit is operable at outdoor temperature from -55 to +50 °C.

GTE-22/25 parameters at rated operating conditions, ISO (simple cycle)

Parameter	Value
Power at the generator terminals; MW	21,75
Electric efficiency; %	38,9
Exhaust gas flow; kg/s	68,24
Fuel gas flow (Q _{pH} = 50 MJ/kg); kg/s	1,11
Specified service life; h	200 000
GTU main equipment weight (excluding generator and gearbox); t	59
Exhaust gas temperature; °C	465
Emission (for 15 % O ₂ in dry products of combustion):	
nitrogen oxides; mg/m ³	≤ 50
carbon oxides; mg/m ³	≤ 50



Configuration of main equipment for GTU-CHPP

- 1 GTU (gas turbine unit)
- 2 Generator with air cooling system
- 3 Oil air-cooler
- 4 Exhaust pipe
- 5 Air ducts for cycle air and air cooling system
- 6 Filter house
- 7 Waste heat recovery boiler (according to customer requirements)

Gas turbine power stations rated at 16 MW

Description

GTE-16 simple cycle high-tech gas turbine power unit based on T16 gas turbine engine designed by Nevskiy Zavod in cooperation with “GE Oil & Gas” company.

The industrial type gas turbine engine features high efficiency (37 %), long service life, high degree of availability and repairability, low level of harmful emission (NO_x < 25 ppm).

It complies completely with the requirement of GOST R “Gas Turbine Units to Drive Electric Generators”.

If required (under project for reconstruction of a specific power facility), arrangement of the unit in the existing building can be considered.

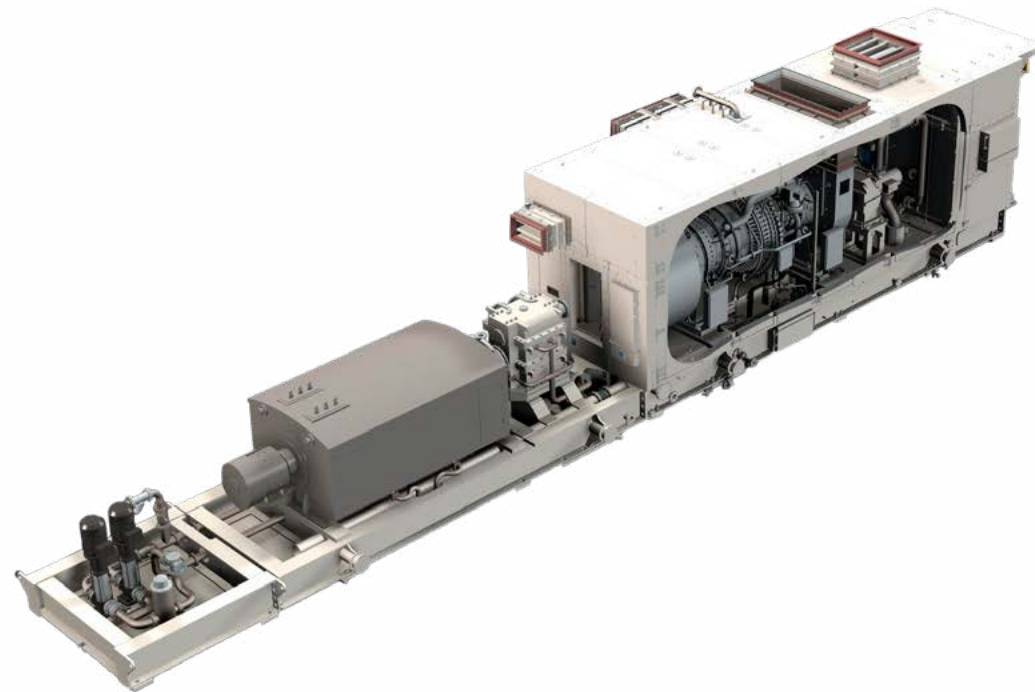
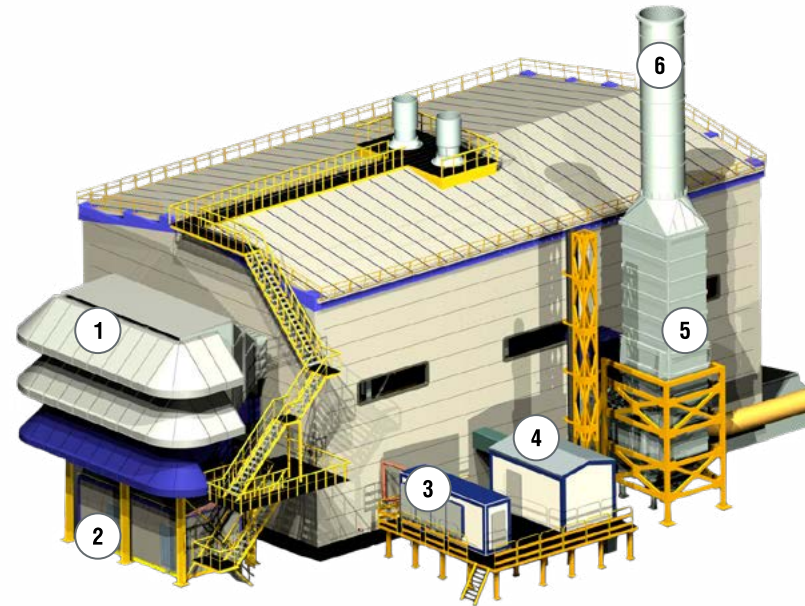
Purpose and field of application

- The power unit is designed for generation of electric and heat power.
- It is used at combined heat and power plants or central heating and power plants.
- As an option, it can be completed with a steam heat recovery boiler (SHRB) or hot water heat recovery boiler (HWHRB) for concurrent generation of electric and heat power (co-generation) with coefficient of fuel utilization, exceeding 80%.
- The GTE-16 power unit is installed in the main building of power station or in an individual easy-to assemble hangar type building.

The main equipment of the unit is unified to the maximum and is completed by modular assemblies

Hangar building for GTE-16 with functional systems

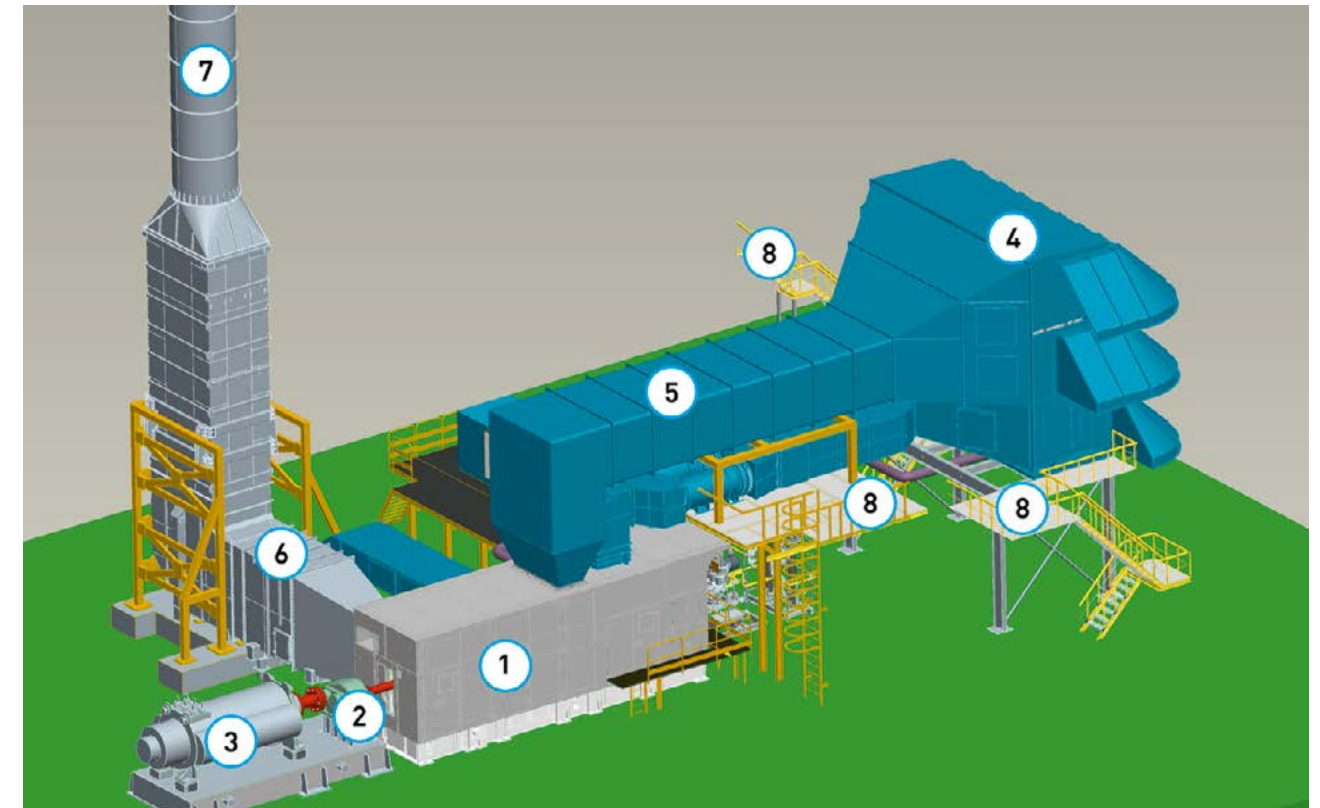
- 1 Filter house
- 2 Fire fighting compartment
- 3 Oil air-cooler
- 4 Hangar air heating unit
- 5 Gas duct with silencer
- 6 Exhaust pipe



Main equipment on the baseplate (the enclosure removed)

GTE-16 configuration:

- Gas turbine (GT);
- Turbogenerator (TG) for GT;
- Gearbox between the GTU and the generator;
- Integrated air filter unit (Filter house);
- Waste heat recovery boiler (option, if required);
- Fuel gas booster compressor (option, if required);
- System of air/gas ducting;
- Automatic control system (APCS);
- Electric equipment;
- Metal structures, service platforms etc.



GTE-16 power unit (the enclosure walls are not shown conventionally)

- 1 Gas turbine
- 2 Gearbox
- 3 Turbogenerator
- 4 Filter house
- 5 Cycle air duct
- 6 Exhaust gas plenum with silencer
- 7 Exhaust pipe
- 8 Service platforms

GTE-16 Operational performances

The gas turbine power unit can be operated at ambient air temperature from -60 to +50 °C.

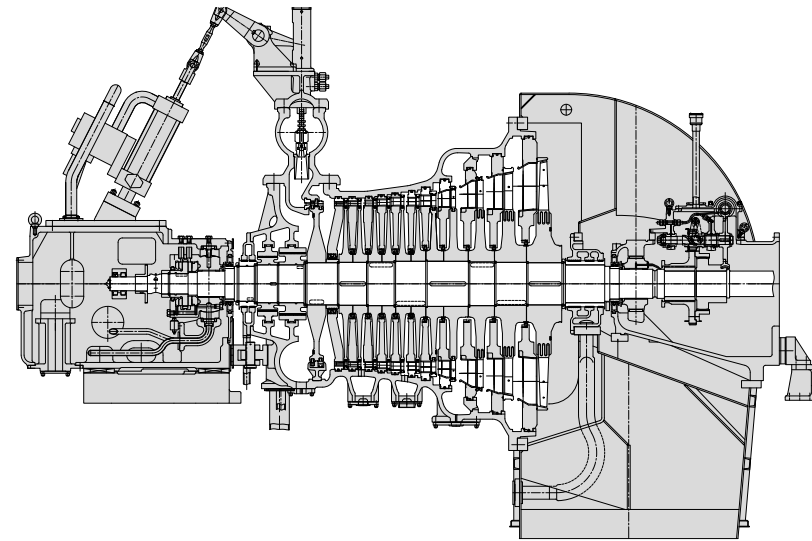
GTE-16 parameters (at design conditions according to ISO conditions in a simple cycle)

Parameter	Value
Output at generator terminals; MW	16
Electric efficiency; %	35,86
Exhaust gas flow; kg/s	54,3
Fuel gas flow rate (Q _{PH} = 50 MJ/kg); kg/s	0,892
Specified service life; h	200 000
Weight of GTU main equipment (without the generator and the gearbox); t	75
Exhaust gas temperature; °C	490
Emission (at 15 % O ₂ in dry products of combustion):	
nitrogen oxides; mg/m ³	≤ 50
carbon oxides; mg/m ³	≤ 40

Steam turbine equipment

Low power steam turbines

Parameter	Type	Power, MW
Power steam turbine to drive the generator	AK-2,5-II	2,5
	AK-4-I	4
	AK-6-I	6
Power steam turbine with heat extraction to drive the generator	AT-4	4
	АП-4	4
	AT-6	6
	АП-6	6
Back pressure power steam turbine to drive the generator	AP-6-11	6
	AP-6-6	6



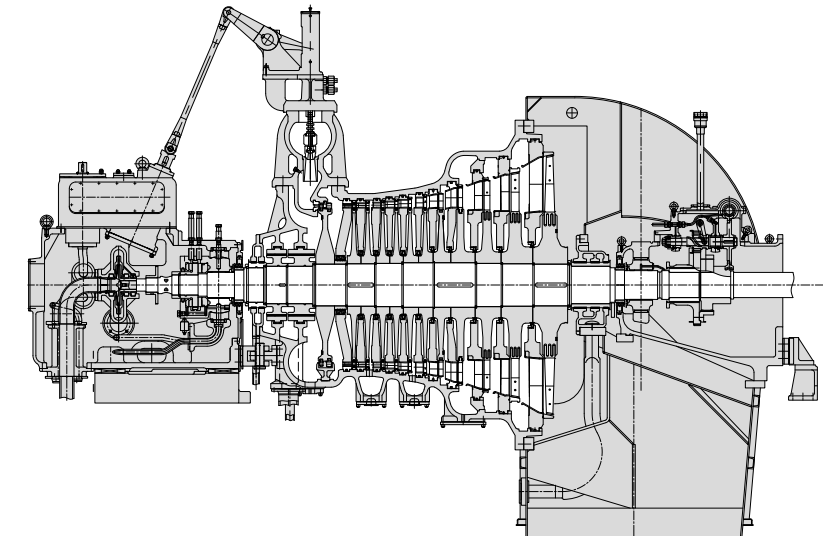
Longitudinal section of K-6-1,2 steam turbine for PJSC "Koks", Kemerovo

Technical characteristics of K-6-1,2 steam turbine

Parameter	Mode 1 (with uncontrolled extraction)	Mode 2 (w/o uncontrolled extraction)
Rated power; MW	6000	
Rated values of steam initial parameters		
Absolute pressure; kg/cm ²	12,2	
Temperature; °C	340	
Steam flow through the turbine; t/h	33,6	32
Turbine rotor speed; rpm	3000	
Rated absolute steam pressure in uncontrolled extraction for LPH; kg/cm ²	1,43	-
Rated steam temperature in uncontrolled extraction for LPH; °C	159	-
Rated steam mass flow in uncontrolled extraction for LPH; t/h	3,1	-
Design steam pressure, abs., in the condenser; kg/cm ²	0,071	0,072

Technical characteristics of K-19-35 steam turbine

Parameter	Base turbine K-19-35-2	Turbine drives for el. generator		
		20	16	12
Coupling power; MW	19	20	16	12
Rated values of steam initial parameters				
Absolute pressure; kgf/cm ²	35	35		
Temperature; °C	435	435		
Steam flow through the turbine; t/h	83,9	80	75,6	56,7
Speed variation range; rpm	2500–3400	3000		
Absolute pressure in the condenser; kgf/cm ²	0,062	0,062	0,062	0,062
Cooling water mass flow to oil coolers and condenser; t/h	5005	5005	3905	3405
Cooling water temperature; °C	25	-	-	-
Heat balance diagram	HPH + D+ LPH	LPH	HPH + D+ LPH	HPH + D+ LPH
Turbine mass; t	42	42		



Longitudinal section of K-19-35 steam turbine

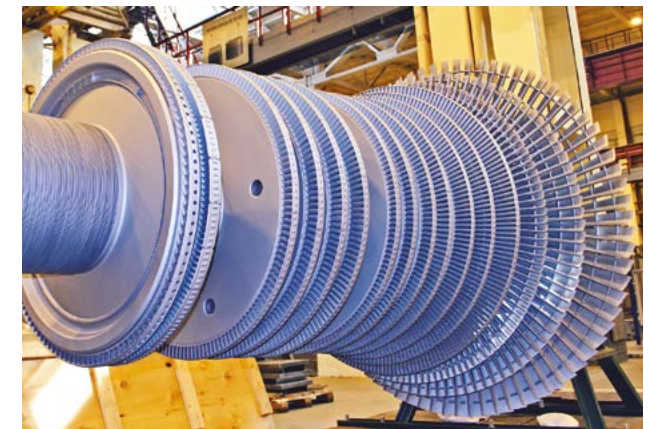
Turbines rated from 20 to 31 MW are designed based on this turbine

T-30-90 and K-22-90 steam turbines and their derivatives

Parameter	Base turbines		Turbine drives for el. generator	
	T-30-90	K-22-90	T-30	K-20
Coupling power; MW	31	20,5	30	20
Rated values of steam initial parameters				
Absolute pressure; kgf/cm ²	90		90	
Temperature; °C	535		535	
Steam flow through the turbine; t/h	122/144	79	122/144	79
Speed variation range; rpm	2500–3450	2500–3500	3000	
Absolute extraction steam pressure; kgf/cm ²	1,2–2,5	-	1,2–2,5	-
Extraction steam flow; t/h	75	-	75	-
Absolute pressure in the condenser; kgf/cm ²	0,09	0,058	0,062	0,062
Cooling water mass flow to oil coolers and condenser; t/h	5605	5605	5605	5605
Cooling water temperature; °C	30	25	-	-
Heat balance diagram	2HPH + D+ 3LPH	2HPH + D+ 3LPH	2HPH + D+ 3LPH	2HPH + D+ 3LPH
Turbine mass; t	60	42	60	42

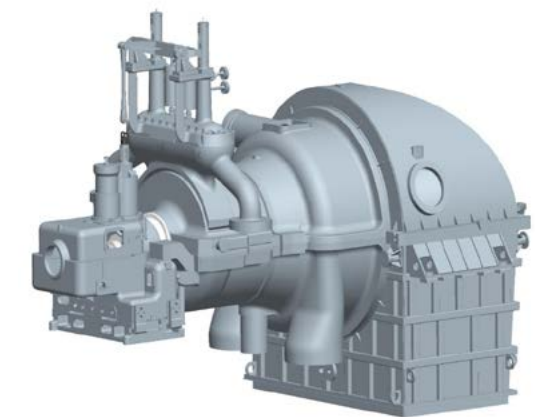


K-22-90-2M steam turbine



Turbine rotor K-22-90-2M

Parameter	HP/LP value
Coupling power; MW	24,5
Steam flow; t/h	76,3/14,4
Steam pressure; MPa	5,9/0,54
Steam temperature; °C	480/220
Speed; rpm	3000
Back pressure; MPa	< 0,007
Turbine mass; t	60
Mass of condenser; t	32

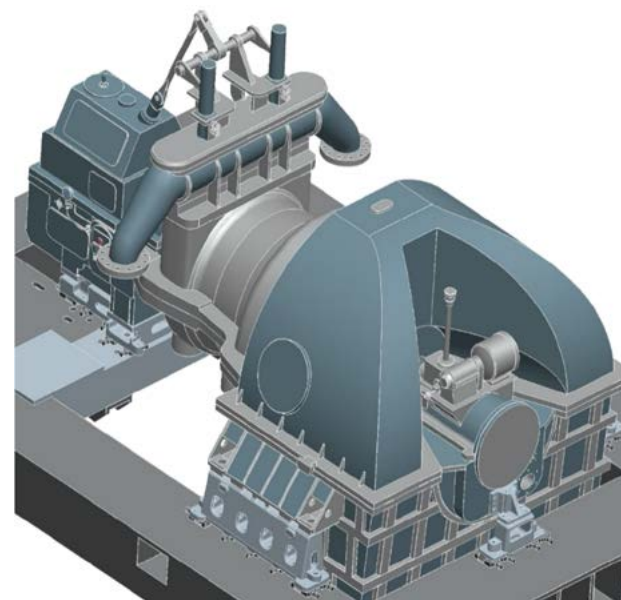


3D-model of K-25-6,0 double pressure steam turbine based on T-30-90 turbine with condenser

Steam turbine for CCP 42 MW

Double pressure turbine with condenser

Parameter	HP/LP value
Coupling power; MW	12,2
Steam flow; t/h	38,2/7,2
Steam pressure; MPa	5,9/0,54
Steam temperature; °C	480/220
Speed; rpm	3000
Back pressure; MPa	< 0,007
Turbine mass; t	42
Mass of condenser; t	30–34



K-12-9,0 steam turbine (based on K-22-90)

Equipment for Combined Cycle Plants

Nevskiy Zavod performs packaged supply of combined cycle power units rated at 42 and 84 MW, applying stationary gas and steam turbines, as well as a package of electric equipment produced in-house.

Combined heat and power plants are designed to increase to the maximum economical efficiency of electric and heat energy generation, while maintaining flexible and reliable supply of electric power, heat and process steam to permanent consumers.

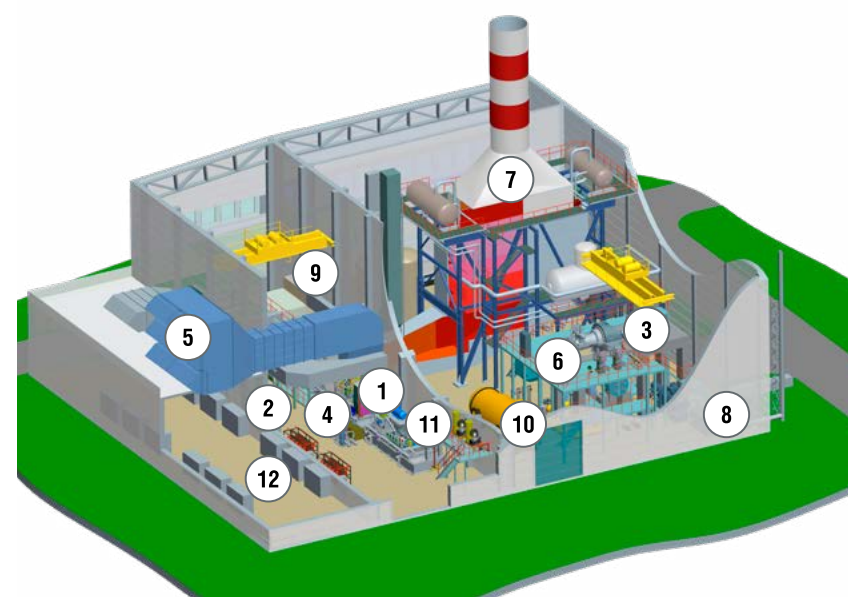
Advantagees

- Enhanced economical efficiency and flexibility of electric power generation due to gas turbine exhaust gas heat recovery in the CCP steam circuit.
- Electrical efficiency 46,7 %.
- Possibility of heat power generation.

Combined heat and power plant rated at 42 MW (CCP-42)

Single-unit CCP-42 includes:

- Gas circuit equipment: gas turbine unit (GTU) based on T32 gas turbine engine produced by Nevskiy Zavod and complete with gearbox and turbogenerator;
- steam circuit equipment: waste heat recovery boiler and T-12-6,0/0,12 steam turbine unit produced by Nevskiy Zavod, with turbogenerator.



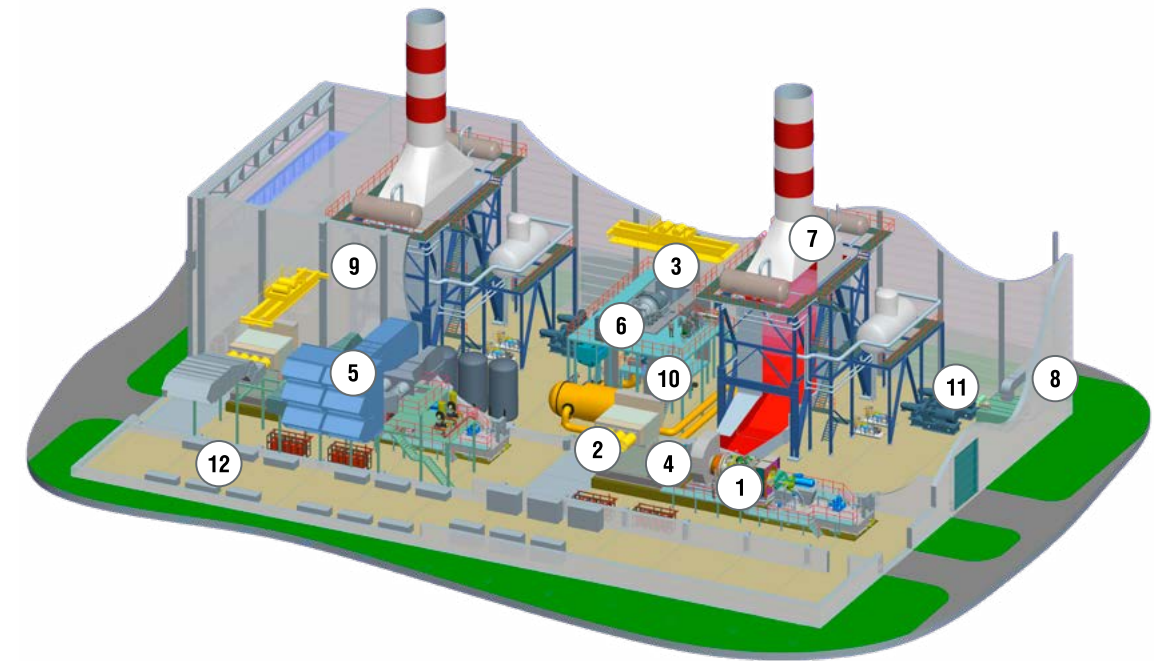
Arrangement of the power unit components (in a single Building)

- 1 T32 gas turbine engine
- 2 GTU turbo-generator
- 3 STU turbo-generator
- 4 Gearbox
- 5 Filter house
- 6 Steam turbine
- 7 Waste heat recovery boiler
- 8 Hot air heating system
- 9 APCS
- 10 Line heater
- 11 Auxiliary baseplate
- 12 Electrical equipment compartment

Technical characteristics of CCP-42 (single- unit)

Parameter	Value
Rated electric power; MW	42
GTU power; MW	30,4
STU power; MW	11,5
GTU electrical efficiency; %	34,5
Gas flow at the GTU exhaust; kg/s	102
Gas temperature at the boiler exhaust; °C	120
Fuel consumption (natural gas); kg/s	1,795
STU steam production capacity; kg/s	12,6
STU electrical efficiency; %	46,7
Fuel gas required pressure at the STU inlet; kg/cm ² (g)	31
Turbounit lubrication system	forced
Used oil	ТП-22С
Specified service life; h	for GT and ST = 200 000
Time between overhauls; h	for GT = 48 000
Mass of the main equipment; t	675

Combined Heat and Power Plant rated at 84 MW (CCP-84)



Double-unit CCP-84 includes:

- Gas circuit equipment:
two gas turbines based on T32 gas turbine engine manufactured by Nevskiy Zavod with gearboxes and turbo-generators;
- Steam circuit equipment:
two waste heat recovery boilers and one T-22-6,0/0,12 steam turbine unit produced by Nevskiy Zavod, with turbogenerator.

Arrangement of the power unit components in a single building

- 1 T32 gas turbine engine
- 2 GTU turbogenerator
- 3 STU turbogenerator
- 4 Gearbox
- 5 Filter house
- 6 Steam turbine
- 7 Steam waste heat recovery boiler
- 8 Hot air heating system
- 9 APCS
- 10 Line heater
- 11 Line pumps
- 12 Electrical equipment compartment

CCP-84 technical characteristics (two -unit) plant

Parameter	Value
Rated el. power; MW	84
GTU power (total); MW	60,8
STU power; MW	22,9
GTU electrical efficiency; %	34,5
Gas flow at the GTU exhaust; kg/s	204
Gas temperature at the boiler outlet; °C	120
Fuel flow (natural gas); kg/s	3,6
STU steam production capacity; kg/s	25,1
CCP electrical efficiency; %	46,7
Rated flow of fuel gas per 1 GTU; kg/s	1,795
Required pressure of fuel gas at the CCP inlet; kg/cm ² (g)	31
Specified service life; h	for GT and ST = 200 000
Time between overhauls; h	for GT = 48 000
Mass of the main equipment; t	1150

Configuration

The two-unit CCP consists of the following main equipment, included in the scope of supply:

- gas turbine (GT) T32 (under the licence of "GE")-2 pcs.;
- turbogenerator (TG) for GT — 2 pcs.;
- gearbox to supply power to TG from GT — 2 pcs.;
- filter house (FH) — 2 pcs.;
- double-pressure heat recovery steam boiler — 2 pcs.;
- steam turbine (ST) — 1 pc.;
- ST condenser — 1 pc.;
- turbogenerator (TG) for steam turbine (ST) — 1 pc.;
- fuel gas booster compressor (if necessary);
- air-gas ducting and steam piping system;
- automatic process control system (APCS);
- electric equipment.

Delivery sites

The power-generating and electrical equipment of Nevskiy Zavod is supplied to the facilities of major power and energy generating companies, to the enterprises of nuclear industry, fuel and energy complex and integrated power grid.

Among the key clients there are PJSC "OGK- 2", JSC "Rosenergoatom", PJSC «FGC UES», "Gazprom energoholding LLC", PJSC "Inter RAO UES" etc.

Advanced Development. Pre-fabricated modular CCP

Combined heat and power plants are designed to maximize economical efficiency of electric and heat power generation, while maintaining flexible and reliable supply of electric power, heat and process steam to the permanent consumers.

Application areas

- Heat and power supply to small and middle size inhabited localities, modular superposed plant for district boiler-houses as a source of auxiliary power.
- Power supply for industrial facilities with a possibility of integration in the process cycle and production site due to modular supply.
- Temporary energy source for construction and covering temporary peaks (for example, emergency situations, carrying out of various activities) etc.
- Easy-to-set up source of energy for hard-to-reach facilities (as an alternative to capital construction facilities).
- Substitution of worn-out power generating capacities of Territorial Generating Companies (when there are no free areas and when it is required that power generation at existing Central Heating and Power Plants be continued).

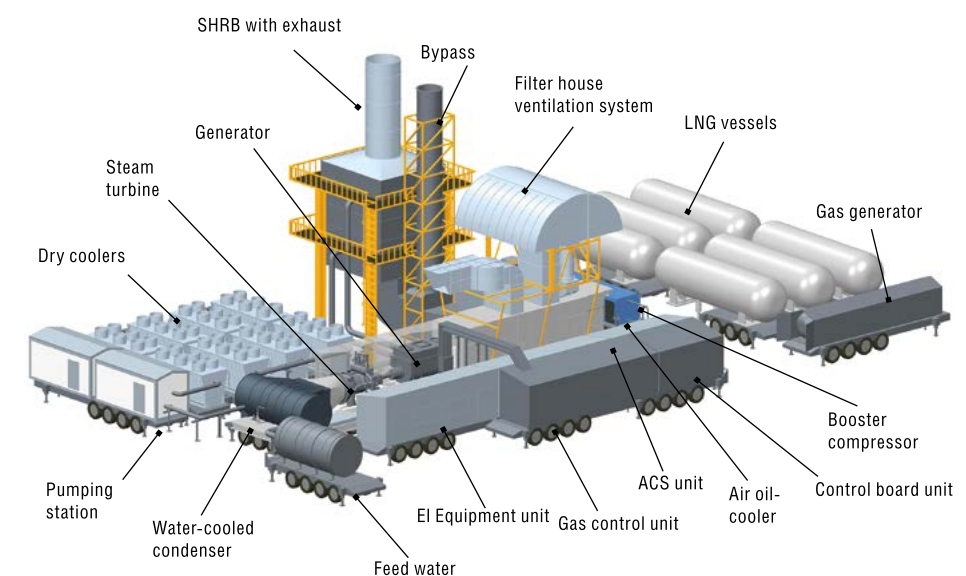
3 Operation Modes

- Simple cycle: electric power — 16 MW
- CCP mode: electric power — 20 MW.
- CCP mode with combined heat generation: electric power — 18 MW; heat power — up to 25 MW.

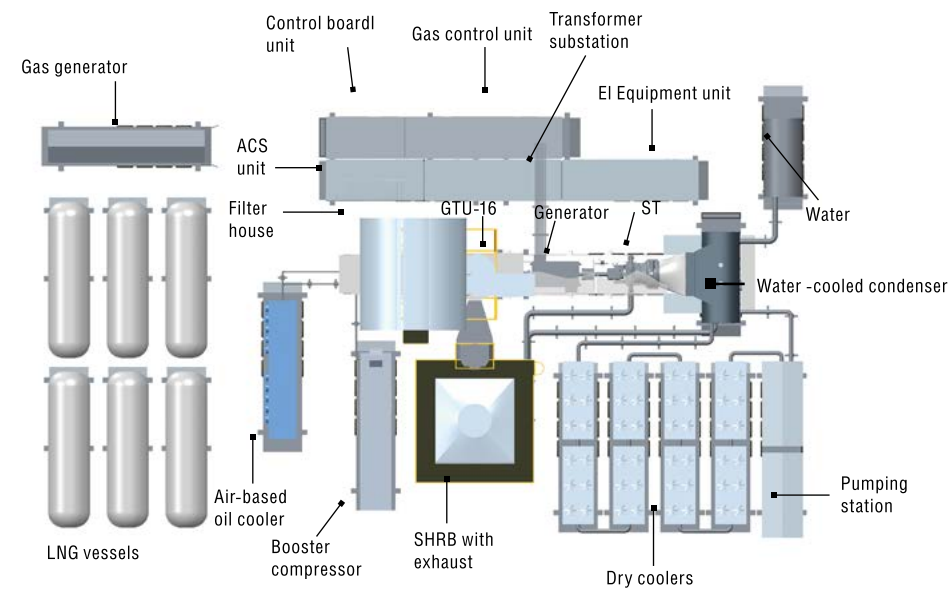
Advantages

- Modular concept of CCP supply as a single platform.
- Execution flexibility.
- Maximum operational readiness.
- Fit-up assembly at Nevskiy Zavod.
- Reduction in installation and pre-commissioning time and capital investment cost.
- CCP-22/25 portability to another site (in case of project force majeure).
- Transportability and independence.
- Limited manning.
- Small size.
- Reduction in installation area and construction costs (by 80 %) due to dispensing with some buildings, structures and foundations.
- Reduction in construction and installation activities volumes up to 80 %.
- Possibility of stepwise commissioning and completing with additional modules.
- Transportation by any kind of transport.
- Short lead time of installation and commissioning in a simple cycle mode (up to two weeks).
- All mode operation.

General View



Top View



The main parts

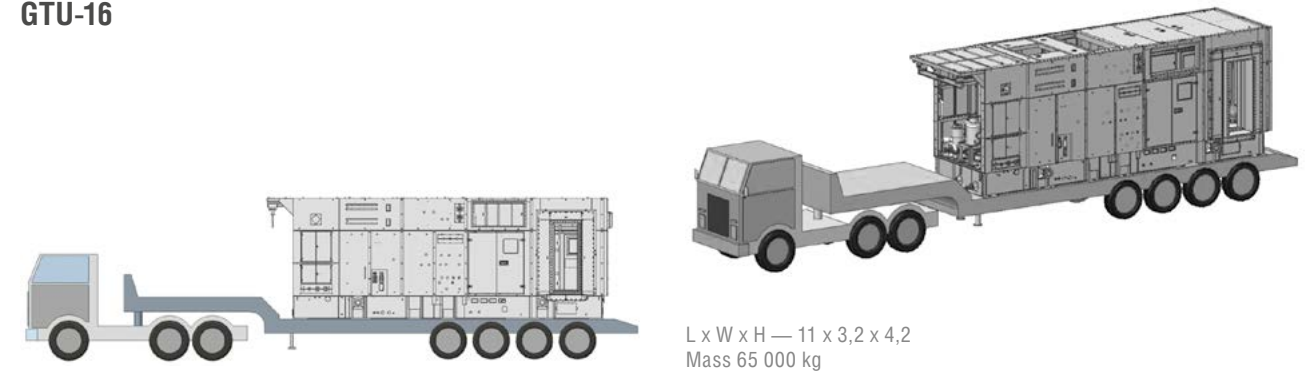
- GTU-16 MW gas turbine unit.
- Gearbox.
- TTK-25-2PY3-Π Turbogenerator.
- T 4,5-3,0 Steam turbine
- Water-cooled condenser.
- Steam heat recovery boiler with exhaust.
- Filter house.
- Ventilation system.
- Dry coolers.
- Gas compressor unit.
- Control board unit.
- Transformer substation.
- ACS unit.
- Electrical unit.
- Gas control unit.
- Pumping station.
- Air oil-cooler.
- Feedwater vessel.
- LNG vessels.

Technical Characteristics of CCP 22/25 MW

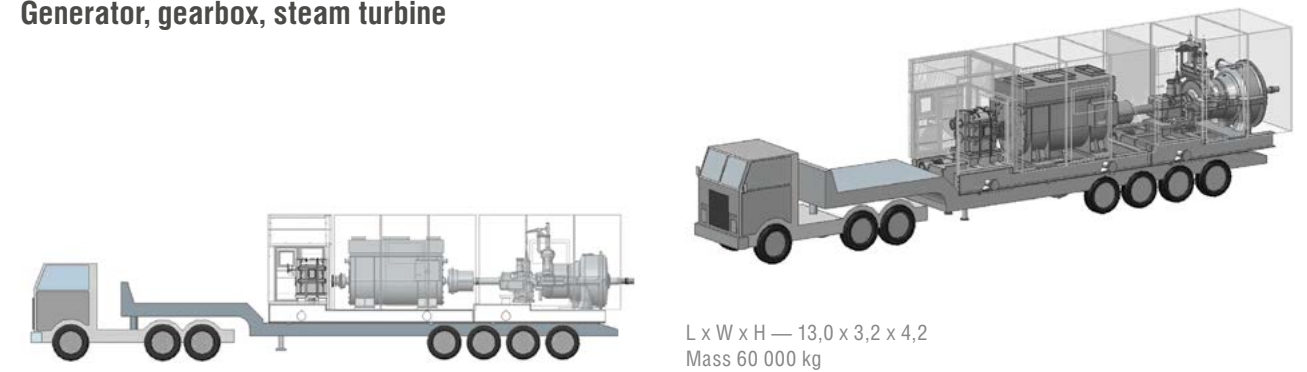
Parameter	Value
Total electric power (ISO); MW	up to 21,3
GTU power; MW	16
STP power (steam condensing mode); MW	up to 5
GTU Electric efficiency; %	36
Waste gas flow at the exhaust; kg/s	54
Waste gas temperature at the exhaust	490
Fuel consumption (natural gas $Q_{PH} = 50MJ/kg$); t/h	0,892
Gas temperature at the boiler outlet; °C	120
STU steam production capacity (SHRB efficiency %); t/h	25
Steam pressure; MPa	4
Steam temperature; °C	450
Heat power (heat extraction mode); Gcal/h	152
STU electric efficiency (ISO); %	46

Transportation by truck

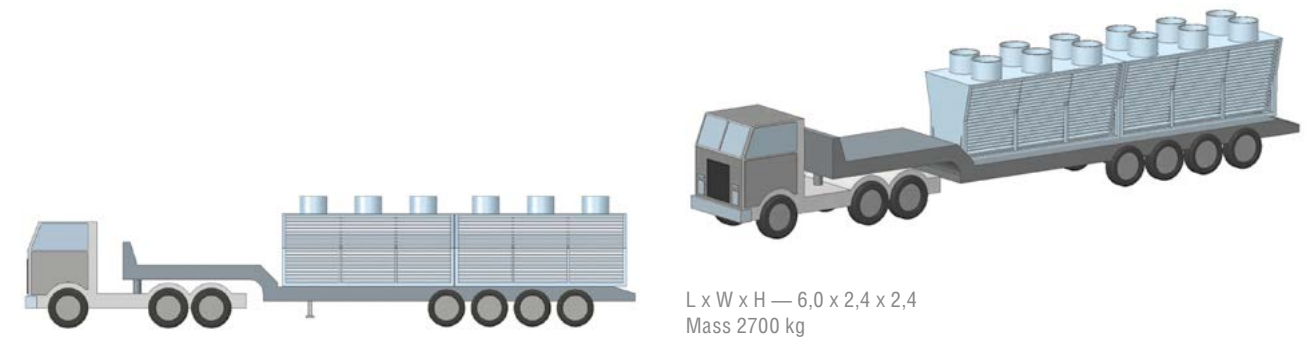
GTU-16



Generator, gearbox, steam turbine



Dry coolers



Static compensators

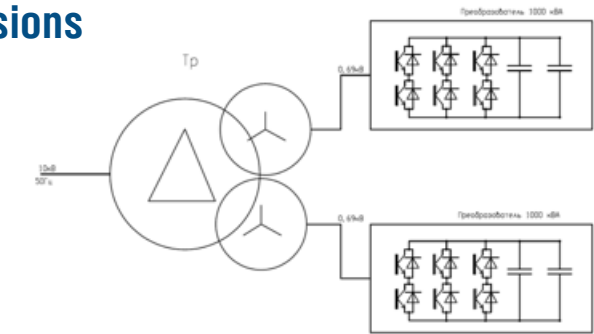
BCK 2000/10-B is a high-voltage static compensator (STATCOM), rated at 2000 kVAr for voltage of 10 kV, provided with forced air cooling. BCK 2000/10-B is intended to compensate for reactive power, voltage fluctuations and power supply harmonic distortions.

Technical Characteristics

Parameter	Value	Remarks
Full rated power; kVA	2000	-
Nominal input voltage; kV	10	range of 85–115 %
Type of matching transformer	TPC3 2000 10/0,69	-
Phase current rated value; A	116	-
Current overload allowable value; %	110	within 3600 s
	120	within 60 s
Rated output frequency; Hz	50	range of 45–55 Hz
Type of inverter power devices	IGBT	-
Cooling	forced air cooling	-
Efficiency at rated conditions; %	98	-
Enclosure protection degree	min IP41	-
Ambient temperature: in operation; °C in storage; °C	+1 to +40 -40 to +60	with power derating 1,65 % per 1°C within 40–45 °C
Rated supply voltage of the auxiliary power network	380±38	-
Arrangement: Above sea level elevation; m Relative humidity; % Level of environment contamination	up to 1000 from 5 to 95 2	w/o condensate drop-out
Noise characteristics; dB (A)	< 75	at a distance of 1 m
APCS connection	Ethernet	-
Mean time between failures; hours	20 000	-
Mean time to recover after failure: Power module; min. Control module; min. Fan; min.	60 10 30	Without time of capacitors discharge and troubleshooting, if SPTA is available
Time, required for capacitors precharge; min	less than 1	-
Time required for capacitors discharge; min	less than 10	-

BCK 2000/10-B structure and dimensions

BCK 2000/10-B is made based on two ПЧТ 1000-B low voltage converters, 1000 kVa each. ПЧТ 1000-B low voltage converters are connected to power supply network via matching transformer and operate under control of the common control system located in a separate compartment inside the power cabinets.



BCK 2000/10-B structure

BCK 2000/10-B main regulation and control functions

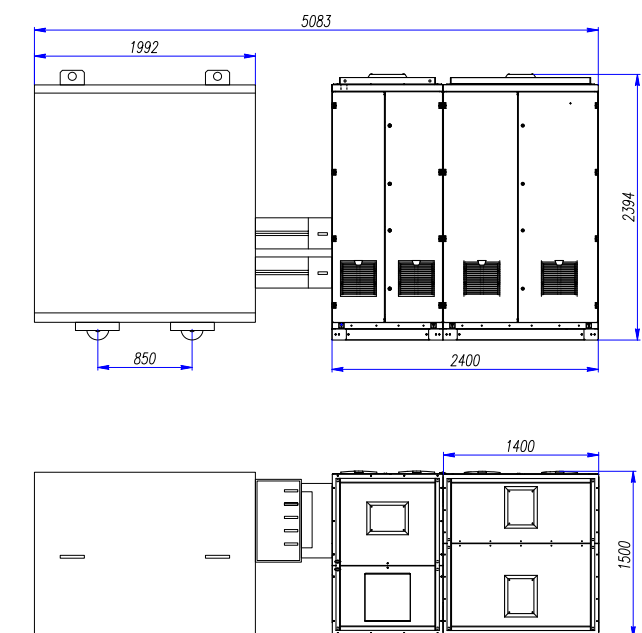
- Capacitors initial charge.
- Mains switch control.
- Cooling system startup and shutdown.
- Capacitors voltage stabilization.
- Mains reactive power control (inductance-capacitance) (accuracy of control < 0,1 %).
- Compensator restrictive current control.
- Mains voltage restrictive regulation in the connection point.
- Minimization of THD mains voltage harmonics in connection point (5 and 7, 11 and 13 — optionally).

BCK 2000/10-B main information functions

- Monitoring of low voltage converter current status.
- Monitoring of main energy parameters of the power supply network.
- Remote control by external digital, discrete and analog inputs.
- Local control from the operator's control panel.
- Local and/or remote input of setpoints, the compensator operation modes and storage thereof in nonvolatile memory.
- Event log.
- Formation of emergency memory buffer in nonvolatile memory and record of the emergency buffer to the flashdrive).
- Failures acknowledgement.

BCK 2000/10-B main protection functions

- Against short circuits in the compensator and the load.
- Against inadmissible compensator current overloads of the 1st harmonic (with integrally dependent protection).
- Against the compensator equipment overheating.
- Against critical supply undervoltage or overvoltage followed by automatic reclosing.



BCK 2000/10-B overall dimensions

BCK 25000/10-Ж is a high-voltage static compensator (STATCOM) with power of 25,000 kVAr for voltage of 10 kV, equipped with liquid cooling. The static compensator is purposed to increase the throughput capacity of MV power lines and to increase the energy supply of power generating enterprises. It provides an uninterruptible compensation of reactive power (inductance - capacitance) up to ± 25 MVar and active harmonic neutralization and electric power supply voltage (5 and 7, 11 and 13, 17 and 19). It allows for a parallel operation with other compensation and filtering devices.

BCK 25000/10-Ж is made based on two high-voltage converters,- ПЧТ 6-12500-Ж rated at 12,5 MVA each. ПЧТ 6-12500-Ж high-voltage converters are connected to power supply networks via a matching transformer and they operate under common control system, located in a separate compartment inside the power cabinets.

ПЧТ 6-12500-Ж configuration

- Control cabinet (100 % localization).
- Liquid cooling cabinet.
- Bank of capacitors cabinet.
- Inverter cabinet (3-level inverter).
- Filter cabinet (sinus filter).

Heat duty regulator

ПЧТ6-2600-В frequency converter

ПЧТ6-2600-В frequency converter is designed for quantitative changes of heat duty for Combined Heat and Power Plants (Central Heating and Power Plants, CHPP). It provides variable frequency control of pumps and fans with asynchronous and synchronous motors. It maintains control of and stabilization of pressure, flow, amount of heat and other process parameters.

Regulator configuration

- 4-level inverter with floating capacitors.
- 12-pulsed rectifier.
- Filtering equipment.
- Control cabinet (100% localization).
- Matching transformer.



GRPP at CS "Kazachya"

Technical characteristics

Parameter	Value
Supply rated voltage; kV	6/10
Supply rated frequency; Hz	50
Frequency converter rated power; MVA	2,6
Converter output rated voltage, 3 phase; V	6000
Converter minimum output frequency; Hz	2,5
Converter output rated frequency; Hz	50
Converter efficiency in the rated conditions (w/o transformer), no less than; %	97
Converter efficiency in the operating frequency range (taking into account transformer efficiency), no less than; %	95
Converter power factor*	no less than 0,95
Converter enclosure corresponds to protection degree	IP 21
Ambient temperature for converter storage; °C	5–40 minus 20–50
Converter auxiliary power supply rated voltage; V	3ph., 400 \pm 10 %
Converter placing: height above sea level; m relative humidity; %	up to 1000 5–85
Converter noise characteristics; dB (A)	Less than 85 at a distance of 1 m
Accuracy of el. motor speed control; %	> 0,4 of the rated speed w/o sensor
Control method	a) vector b) nonvector
Time required for the converter capacitors precharge; min	Less than 0,5
Time required for the converter capacitors discharge; min	Less than 10



Equipment for metallurgical industry

10

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Turbocompressor units

Basic advantages

Package supplies of all machine components manufactured by Nevskiy Zavod makes it possible to achieve the following:

- cost reduction of the main equipment due to the fact that it is manufactured directly at Nevskiy Zavod;
- application of advanced technical solutions;
- operating cost reduction;
- reliable operation of all components;
- equipment delivery time reduction;
- full package of service maintenance.

For metallurgical industry, Nevskiy Zavod manufactures blast furnace turbocompressor units, exhausters, general and special purpose centrifugal compressors

Electrically-driven units for sintering cycle

Purpose and application

This group includes compressors designed to draw the air through the layer of the sintering mixture sintered by the sintering machine and to remove resulting sintering gas during dry and wet gas cleaning.

Configuration

The unit consists of a compressor with the casing welded or cast and with a single double suction impeller, lube oil system, drive el. motor connected to the compressor either directly or via step-up gear. The unit is equipped with protective and control devices providing its reliable operation.

Typical completeness

- Centrifugal compressor with rotor, foundation frame, tie-rods and base plates.
- Reduction gear (in case the compressor speed differs from the the drive motor speed).
- Lube oil system.
- Monitoring and protection instruments, instrument transducers.
- Panel of thermal monitoring, control, protection and signaling.
- Tools for the compressor assembly and disassembly.
- Tools for the lifting and alignment of the compressor rotor and casing upper part.
- Electric motor.
- Operational documents.

Design Features

The group of units for sintering cycle includes the following types of machines: 15500-11-1, 15000-11-1, 13000- 11-1, 12900- 11-1, 12000-11-1, 9000-11-5, 9000-11-4, 6700-12-1, 7700-12-1.

Configuration

Compressors consist of the compressor proper, a drive motor, lube oil system, monitoring, protection and signaling system and thermal control panels. The shafts of the compressor, gearbox and motor are connected by means of toothed couplings. Plate couplings can be used.

The lube oil system of the compressor provides forced lubrication of bearings of the compressor, reduction gear and electric motor and oil supply to the geared transmission and couplings (in case of their application in the compressor). Control of the machine start and shutdown as well as its operation monitoring is performed from the remote control panel, located in the operator room.

The unit control panel is equipped with emergency and warning sound and light signalling systems and process lamp signaling.

Centrifugal compressors

The compressors are centrifugal, single-stage, single-cylinder units with a double suction impeller. The compressor casings are either welded or cast, consisting of two suction chambers and a volute. The suction branch pipes (nozzles) are directed upwards and the discharge - sideways. The volute is lined inside with removable protection plates. The compressor impeller is welded, with an anti-wear protector installed at its inlet. The protective plates and anti-wear protector prevent respectively the volute and the impeller internal surface from wear by abrasive dust. The protective plates and the anti-wear protectors can be replaced.

13000-11-1 compressor

Purpose

The compressor is designed to provide air passage through the layer of sintering mixture sintered and further removal of the flue gases from the gas exhaust duct after their cleaning via the stack.

Design features

The compressor is driven by СД3-900S-4 synchronous motor completed with ПЧВС-5/10-12У3Л4 frequency converter.

Oil is supplied by the main (starting) oil pump. The oil pump with an AC drive motor is mounted on a skid. Another similar pump is standby. Power to the main (starting) pump and the standby pump is supplied from two independent power supply sources.

The control, monitoring, protection and signaling systems include thermal monitoring panels which are equipped with the unit start and shut-down control instruments, instruments to measure the unit operating parameters and emergency and warning signaling devices.

12000-11-1 compressor

Purpose

The compressor is designed to provide air passage through a layer of the sintering mixture sintered and further removal of flue gases from the gas exhaust duct of the sintering machine after their cleaning via the stack. Compressed medium is sintering gas with dust content up to 200 kg/m³.

The compressor can be used for sintering machines with an area from 84 to 312 m² (in the latter case two parallel operating compressors are installed).

Design features

The step-up gear installed between the compressor and the motor is single-stage, with herring-bone gear (nitrated teeth). On the lube oil tank frame the oil system basic components are installed: starting and standby pumps, oil cooler, oil filter.

Oil is supplied by the main oil pump installed on the step-up gear. The oil system basic components are installed on the lube oil tank frame - starting and standby pumps, oil cooler, oil filter.

The control, monitoring, protection and signaling system provides the compressor stepwise startup and shutdown as well as the main parameters monitoring.

6700-12-1 and 7700-12-1 compressors

Purpose

The compressors are designed to provide air passage through a layer of sintering mixture sintered and subsequent removal of flue gases from the gas exhaust duct of the sintering machine after their cleaning. These compressors are also applied to remove by suction combustion products with dust content up to 80-100 mg/m³ from open hearth furnaces. The compressors operate in dry and wet gas cleaning conditions and they can be used for sintering machines with an area up to 75 m².

The compressors are highly unified and generally they differ in impellers (different number of blades) and in a drive motor type.

Electrically-driven units for Basic Oxygen Steelmaking

Purpose and field of Application

This group includes compressors designed to remove converter gases from the steelmaking converters of various capacity after wet gas cleaning.

Configuration

The units consist of the compressor with a welded casing with a single double-suction impeller, lube oil system, bearings assembly, electric drive motor.

Design features

The group of compressors for basic oxygen steelmaking includes machines of the following types: 10000-11-1, 8500-11-1, 7600-13-1, 7500-13-1, 4500-11-1. A number of units (10000-11-1, 8500-11-1, 4500-11-1) are equipped with a starting frequency converters. The unit is provided with protective and control devices procuring its reliable operation.

The compressor unit lube oil system provides forced lubrication of the compressor and el. motor bearings.

The unit startup and shutdown control as well as its operation monitoring is performed from the remote control panel located in the operator's room. The unit control panel is equipped with emergency and warning sound and light alarms and process light signaling.

Typical completeness

- Centrifugal compressor with rotor, foundation frame, tie rods and base plates.
- Lube oil system.
- Monitoring and protection instruments, measuring transducers.
- Thermal monitoring, control, protection and alarm panels.
- Tools for the compressor assembly and disassembly.
- Tools for lifting and alignment of the compressor rotor and casing upper part.
- El. motor.
- Operational documentation.

Compressors

Configuration

The compressors consist of the compressor proper, an electric drive motor, step-up gear, lube oil system, monitoring, protection and alarm system as well as thermal monitoring panels.

Design features

The compressor is single-cylinder, single-stage, with a double-suction impeller. The compressor casing is welded, consists of two suction chambers and a volute. The compressor suction branch pipes (nozzles) are directed upwards, the discharge one - sideways. The compressor end seals prevent air ingress in the compressors flow channel and compressed gas ingress in the engine room due to supply of sealing nitrogen thereto. The step-up gear is installed between the compressor and motor.

10000-11-1 compressor

10000-11-1 centrifugal compressor is designed to remove converter waste gas from the converter of 400 tons with combined blowing of oxygen supplied from top and inert gas supplied from below after wet gas cleaning without carbon oxide reburning in case of controlled output.

The compressor is designed for installation in explosion hazard area of B-1A class with PA-P1 explosive mixture category and group. The compressor is driven by СДЗ-900S-4 motor with ПЧВС-5/10-12УХЛ4 frequency converter.

7600-13-1 compressor

7600-13-1 centrifugal compressor is designed to remove converter waste gas from the converter of 300- 350 tons and supply the same to a gasholder for further utilization as a fuel. The compressor is designed for installation in explosion hazard area of B-1A class with PA-P1 explosive mixture category and group. The compressor is driven by СДЗ-900S-4 motor with ПЧВС-5/10-12У ХЛ4 frequency converter.

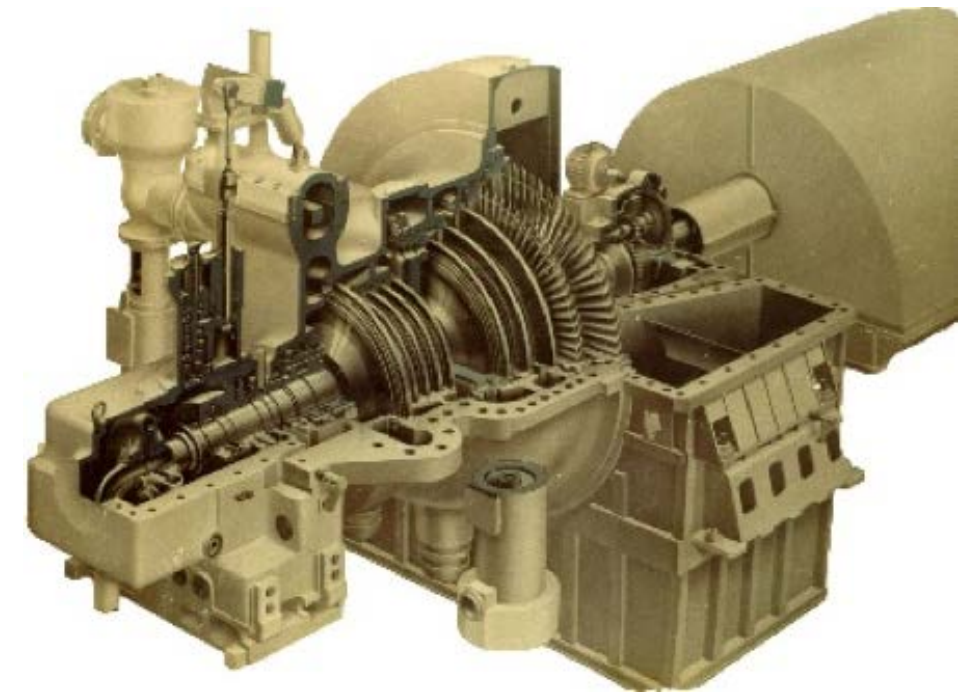
7600-13-1 compressor

7600-13-1 centrifugal compressor is designed to remove converter waste gas from the converter of 300–350 tons and to supply the same to a gas holder for further utilization as a fuel. The compressor is designed for installation in explosion hazard area B-1A class with PA-T1 explosive mixture category and group.

The compressor is equipped with a vaneless diffuser specifically designed to enlarge the compressor operation area. The compressor is driven by СДЗ-900S-4 motor completed with ПЧВС-5/10-12У ХЛ4 frequency converter.

7500-13-1 compressor

7500-13-1 centrifugal compressor is designed to remove converter gas from a steel melting converter with oxygen supplied from top and to remove gas without carbon oxide reburning. The compressor is driven by an electric motor.



3D Model of Steam Turbine Drive

Turbocompressors for air supply to blast furnaces

Main technical characteristics

Types	Power, MW	Speed, rpm,	Steam Initial Parameters		Steam flow for district heat supply, t/h
			Pressure, MPa	Temperature, °C	
K35-8,8-1	35	2850–3150	8,83	535	-
K22-8,8-2	20,5	2500–3500	8,83	535	-
K19-3,4-2	19	2500–3500	3,43	435	-
K15-4,0-1	15	2500–3400	4	363	-
K12-3,4-2	12,8	2500–3500	3,43	482	-
K12-3,4-3	11,6	2500–3400	3,43	482	-
T30-8,8-1	31	2500–3450	8,83	535	75
П30-10,0/4,0-1	29,4	9300–9960	10,1	482	280
П23-8,8/0,8-1	23,6	4600–5260	3,43	535	86,4
П18-3,4/0,8-1	18,7	4600–5260	3,43	435	114,5
П16-3,4/0,8-1	15,8	3900–5400	3,43	435	94,7
П10-3,4/0,8-1	11	3900–5300	3,43	435	66,5
П28-10,0/1,2-1	26,5	4600–5850	9,81	500	80
K-10,0-0,7	10,1	3900–5200	0,56	250	-

Steam turbine drives of Nevskiy Zavod for metallurgy industry

Steam turbine drives	
Types	Power, MW
K35-8,8-1	35
K22-8,8-2	20,5
K19-3,4-2	19
K15-4,0-1	15
K12-3,4-2	12,8
K12-3,4-3	11,6
T30-8,8-1	31
П30-10,0/4,0-1	29,4
П23-8,8/0,8-1	23,6
П18-3,4/0,8-1	18,7
П16-3,4/0,8-1	15,8
П10-3,4/0,8-1	11
П28-10,0/1,2-1	26,5

Steam turbines place of Installation	
Russia	Foreign Countries
Azovstal (Mariupol)	Bulgaria
Krivoy Rog Steel Works	Romania
Nizhny Tagil Steel Works	Yugoslavia
Orsko-Khalilovskiy Steel Wrks	Iran
Magnitogorsk Steel Works	India
Severstal Steel Works	China
Chelyabinsk Steel Works	Turkey
Karaganda Steel Works	Egypt
Kstovo Chemical Plant (Nizhny Novgorod)	Poland
Makeevka Steel Works	Nigeria
Tulachermet	Pakistan
Zapadno-Sibirsky St. Works	Ukraine
etc.	etc.

Parameter	Value
Rated power (max)	26 000
Rated values of steam initial parameters	
Absolute pressure; kg/cm ²	30
Temperature; °C	400
Maximum mass steam flow; t/h	116
Turbine rotor speed range; rpm	2500–3500
Design value of steam absolute pressure in the condenser; kg/cm ²	0,128
Design value of cooling water temperature; °C	35

Centrifugal compressors for blast furnaces

The centrifugal compressor group for blast furnaces includes: K5500-41-1, K5500-42-1M, K6600-6,0/5,7-3000/31,5.

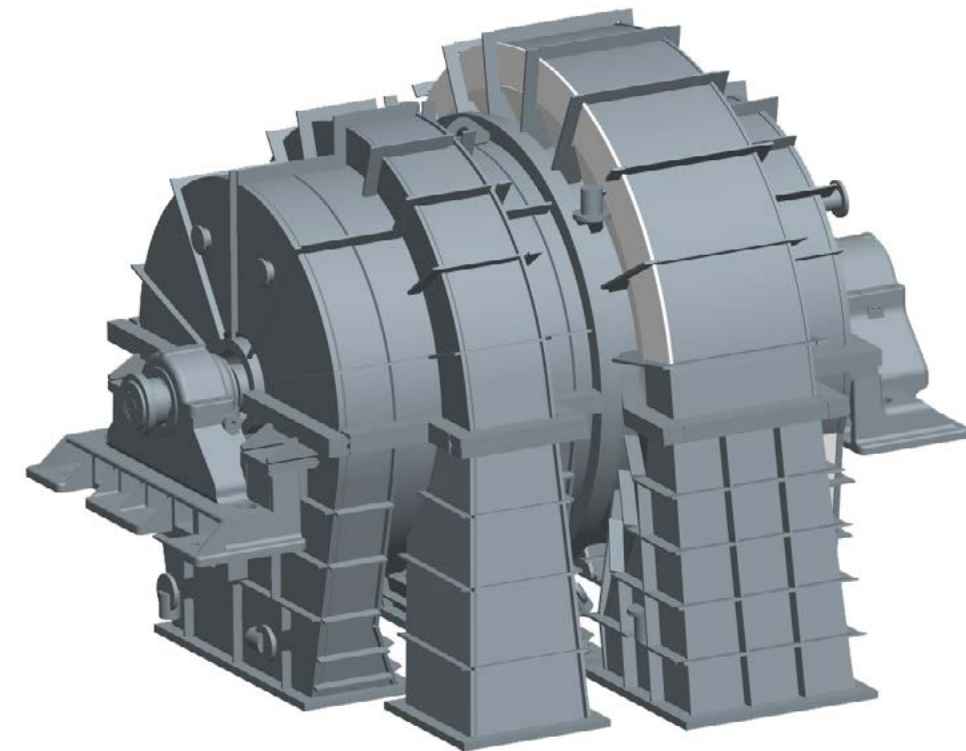
Technical characteristics

Parameter	Value				
	K5500-41-1		K5500-41-1M		K6600-6,0/5,7-3000/31,5
Type of Unit					
Volume capacity referred to 20°C and 0,1013 MPa; Nm ³ /min	4000	4000	5000	5500	6600
Volume capacity referred to initial conditions; m ³ /min	4155	4230	5285	5713	6850
Final air pressure (abs) at the discharge branch pipe outlet; MPa	0,5	0,6	0,51	0,57	0,73
Compressor consumed power; MW	16,5	19,5	20,5	24,7	29,2
Initial air pressure (abs) at the suction branch pipe inlet; MPa	0,098	0,098	0,098	0,098	0,098
Initial gas temperature at the suction branch pipe inlet; °C	20	25	25	20	20
Cooling water temperature; °C	35	35	35	28	35
Rotor operating speed; rpm	3400	3530	3400	3450	3275

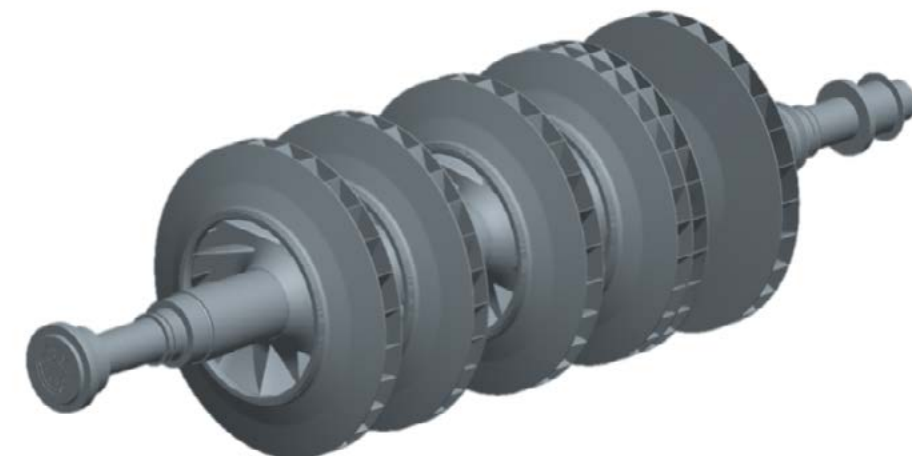
Design Features

Centrifugal compressors (CC) for blast furnaces are single-cylinder, two-section, four-stage direct-driven machines with one intermediate cooler. They are driven by steam turbines rated at 8–30 MW making it possible to change the operating mode by changing the rotor speed.

The compressors have a high degree of unification and they differ from each other in channel width of impellers, vaned diffusers and return-circuit rig. The compressors are equipped with automatic protective and control facilities providing their reliable operation.



3D model of compressor type K5500



3D model of rotor type K5500

Axial compressors for blast furnaces

Types of compressors

Parameter	K3750-1	K4300-1	K4950-1	K7100-1	K03000
Volume capacity; m ³ /min.	3750	4280	4930	7220	3330
Final pressure; MPa	0,46	0,48	0,54	0,57	0,75
Initial temperature; °C	30	30	30	30	30
Initial pressure; MPa	0,098	0,098	0,098	0,098	0,098
Power; MW	15,8	18,7	23,6	35	15,9
Rated speed; rpm	5400	5100	5200	3000	5000
Speed; rpm	3900–5400	4600–5200	4600–5200	2850–3150	4800–5300
Type of steam turbine drive	П-16	П-18	П-23	K-35	П-18



Axial compressors for blast furnace air K 3750-1

Parameter	Rated Value
Volume capacity; m ³ /min	3330
Final pressure; MPa	0,75
Initial temperature; °C	30
Initial pressure; MPa	0,098
Power; MW	15,9
Rated speed, rpm	5000
Type of steam turbine drive	П-18/П-23

2 to place the axial turbounit on the existing foundation with the same overall dimensions and with minimum design changes in the foundation construction solutions. In so doing, the following is achieved with the pressure constant:

- increased compressor capacity (240,000 Nm³/hour versus basic compressor capacity — 180,000 Nm³/hour – increase by 33 %);
- sufficiently deep flow control in the range from 160 000 to 240 000 Nm³/hour;

3 to perform modular supply consisting of two parts:

- modular steam turbine on skid;
- modular axial compressor on skid;

4 to increase compressor specific capacity from one square meter of footprint by 33 %;

5 to achieve low values of specific indicator for configuration with one intermediary air cooler — 0,195 Gcal/1000 Nm³/min;

6 to decrease substantially the turbocompressor unit mass in general at the expense of the axial compressor mass decrease from 122 tons to 40 tons (Specific indicator = 0,195 Gcal/1000 Nm³/min), which, in its turn, reduces specific quantity of metal per structure and the overall cost.

Note. In addition, the following is excluded from the configuration:

- 1 intermediary air cooler in the compressor part;
- 2 heaters LPH1 and LPH2 in the STU configuration, which will also result in a significant mass decrease of the unit;

7 to apply round finned tubes in the air-cooler tube bundles cooled by the condensate, to install elliptical finned tubes in the water cooling bundles;

8 to test the compressor and steam turbine on two existing full-scale test beds on the premises of Nevskiy Zavod;

9 to consider application of the magnetic bearing system for the turbocompressor unit;

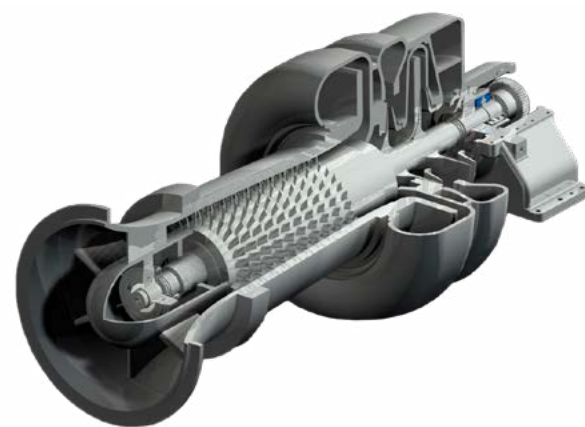
10 to reduce significantly pre-commissioning time and make the pre-commissioning cheaper due to supply of pre-fabricated modular steam turbine and axial compressor.

Conclusions and advantages of a turbogenerator based on axial compressor

Application of axial compressor for turbocompressor units (TCU) will make it possible:

1 to simplify significantly the heat balance diagram of the turbo-unit and, consequently, make cheaper the TCU cost due to:

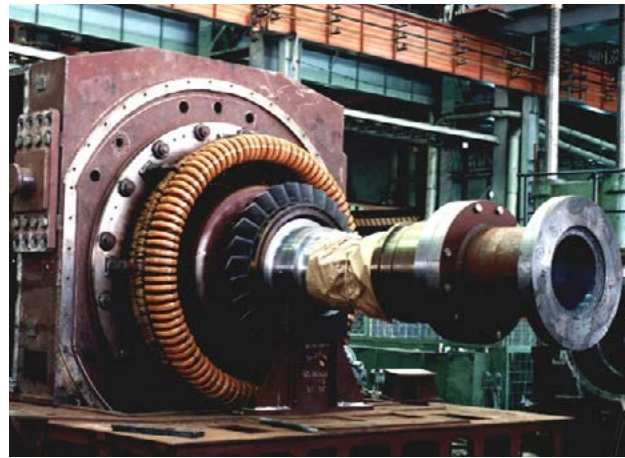
- simplifying the STU heat balance diagram;
- reduced number of the compressor intermediary and final air coolers;
- reduced number of regeneration system heaters (excluding heaters LPH-1 and LPH-2);
- less flow of cooling water;



KO-3000 axial-centrifugal compressor

Top pressure recovery turbines (TPRT)

Name of Parameter	TPRT-8	TPRT-12	TPRT-16	TPRT-25
Volume flow of gas at 0.101 MPa and 0°C; Nm ³ /h	300 000	450 000	600 000	900 000
Gas pressure in the inlet duct; MPa	0,304	0,304	0,317	0,304
Gas temperature in the inlet duct; °C	50	50	50	50
Gas pressure downstream of the turbine; MPa	0,112	0,112	0,116	0,108
Speed; rpm	1500	1500	1500	1500
Total power on the turbine coupling; MW	7,6	11,6	15,6	22,9
El. generator efficiency	0,97	0,97	0,97	0,975
Power at generator terminals; MW	7,4	11,2	15,1	22,3



TPRT advantages for the Customer

- Generation of additional electric power at the expense of utilized blast furnace gas.
- TPRT can be easily built in the process cycle of both newly commissioned and existing blast furnace equipment.

Advantages of TPRT manufacture

- No high-tech materials.
- Experience in design and manufacture.
- Low competition on the RF market (JSC "UTZ").

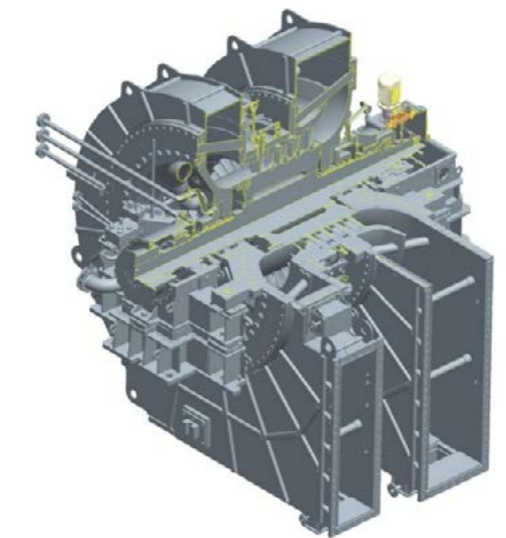
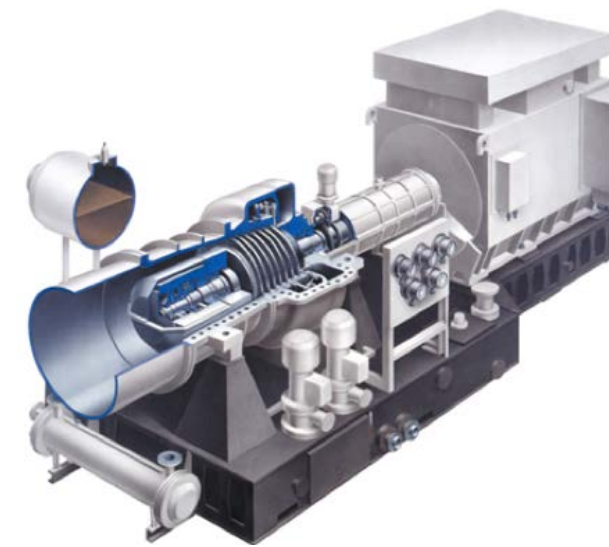
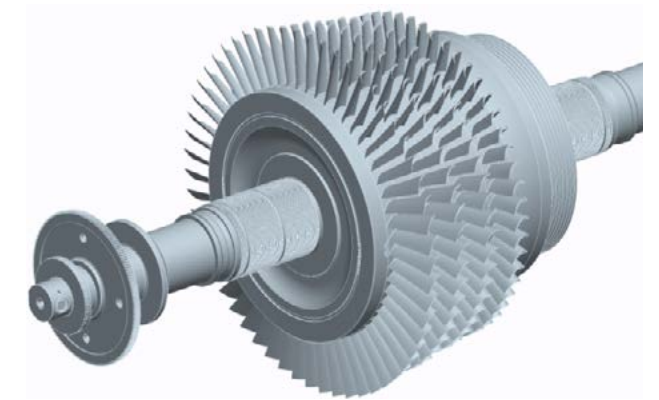
TPRT thermodynamic calculations in operating mode points

TPRT power calculation results

Parameter		TPRT "Severstal"				TPRT "Evraz"	
		1	2	4	4	1 (rated)	2 (max)
Dry gas volume flow at the inlet; Nm ³ /h	Q dry	590 520	585 268	585 285	523 586	460 000	550 000
Wet gas volume flow at the inlet; Nm ³ /h	Q wet	621 500	621 500	556 000	556 000	487 384	582 514
Upstream turbine temperature; °C	T0	55	55	55	55	55	57
Upstream turbine pressure (g); kgf/cm ²	P0 exc.	2,2	1,7335	2,2	1,7335	1,8519	2,1578
Upstream turbine pressure (abs.); MPa	P0	0,3156	0,2699	0,3156	0,2699	0,28	0,31
Downstream turbine pressure (g); kgf/cm ²	P2 exc.	0,12	0,12	0,12	0,12	0,1184	0,1184
Downstream turbine pressure (abs.); MPa	P2	0,1116	0,1116	0,1116	0,1116	0,11	0,11
Gas mass flow at the inlet; kg/s	G1	204,1	203,4	182,6	182	165	197,3
Gas mass flow at the outlet; kg/s	G2	200,3	200	179,3	178,8	162,1	193,6
Gas constant; kJ/kg*K	R cm	0,2924	0,2933	0,2924	0,2933	0,2836	0,2835
Polytropic coefficient	n	1,15	1,14	1,153	1,136	1,139	1,146
Effective efficiency	Turbine efficiency	0,845	0,83	0,82	0,86	0,86	0,83
Outlet gas temperature; °C	T2	19,9	26,9	20,3	26,6	24,6	23,2
Turbine shaft power; MW	Nt	16 085	13 595	13 945	12 619	11 660	14 877
Generator Efficiency	Generator efficiency	0,97	0,97	0,97	0,97	0,97	0,97
Power at generator terminals; MW	N gen.	15 603	13 187	13 527	12 240	11 310	14 431

The top pressure recovery turbine is designed to generate electric power at the expense of blast furnace gas excessive pressure at metallurgical plants. Practically, without fuel costs, it allows to return up to 40% of the energy consumed for blast furnace air.

Potential customers: metallurgical plants.



Expander-Generator Units (EGU) for power generation at the expense of utilization of natural gas pressure

Numeric Values for EGU

Parameter	TPRT-4-1,2/0,2	TPRT-4-1,2/0,4	EGU-6000-1,3/0,25	EGU-6000-1,85/0,2	EGU-7000-5,7/1,7
Rated power; kW	2300	4000	6000	6000	7000
Gas preheater inlet pressure, abs.; MPa	1,2	1,2	1,3	1,85	5,7
Initial temperature; °C	80	80	100	160	90
Speed; rpm	3000	3000	3000	3000	3000
Downstream expander rated pressure, abs; MPa	0,2	0,4	0,25	0,2	1,7
Max mass gas flow; kg/s	13,3	31,8	35	21,4	49,6
Turbine efficiency; %	70	75	85	85	85
Overall dimensions; m	8,4 x 3 x 2,9				

Steam turbines for generator drive

Type of steam turbine	Power, MW	Application	Year of Design Documentation Development
AK-2,5-II	2,5	Power steam turbine for generator drive	1950
AK-4-I	4	Power steam turbine for generator drive	1949
AT-4	4	Power steam turbine with heat extraction of steam for generator drive	1954
АП-4	4	Power steam turbine with process steam extraction for generator drive	1952
AK-6-I	6	Power steam turbine for generator drive	1951
AT-6	6	Power steam turbine with heat extraction of steam for generator drive	1952
AP-6-11	6	Power back pressure steam turbine for generator drive	1949
AP-6-6	6	Power back pressure steam turbine for generator drive	1950
АП-6	6	Power steam turbine with process heat extraction for generator drive	1950

Auxiliary equipment for steam turbine units

Accessory equipment for steam turbines

Ejector unit

Technical requirements for ejector unit

- The ejector unit shall consist of the main and starting ejectors.
- Exhaust air flow shall be in compliance with “Technical Operation Rules” and shall not exceed 9 kg/hour.

For automatic monitoring of the unit operating conditions, the unit is equipped with instrumentation and controls of Metran type with a possibility of visual control on the instrument display.



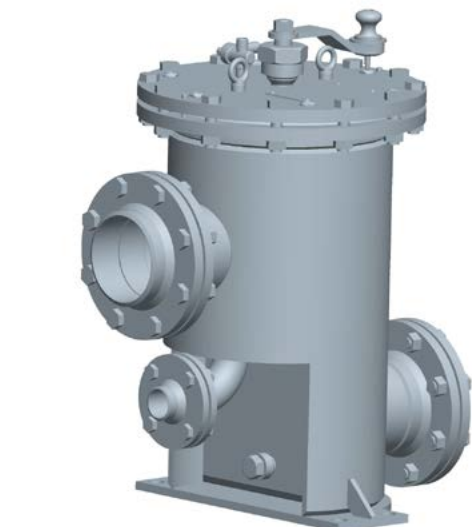
3D-model of КП-1300-V condensor



3D-model of bleeder valve



3D-model of suction unit



3D-model of rotating water filter

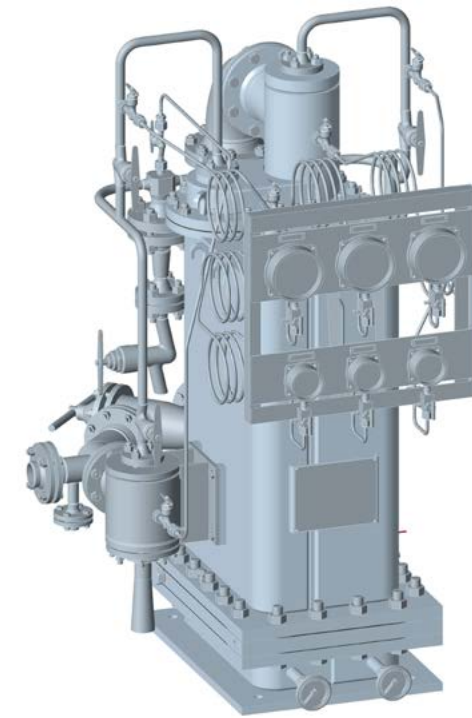
Direct-operated pressure relief valve prevents pressure increase higher than the atmospheric pressure in the condenser chamber.

When pressure in the condenser is lower than atmospheric pressure, the valve disc is pressed to the seat by the force caused by pressure difference in the pipeline connected with atmosphere and in the condenser.

To prevent air ingress in the condenser, the space above the contact surface of the seat and disc seals is filled with water which is continuously supplied and drained.

When pressure in the condenser is higher than atmospheric pressure, the valve disc goes up and steam is vented. When pressure is reduced to atmospheric pressure, the disc, under the weight of the valve moving parts, goes down, shutting off steam vent.

The filter is designed for preliminary treatment of the water coming to the oil coolers.



3D-model of ejector unit

Water enters the filter through the inlet duct and it fills the space between the lattices from which it goes out into the annular space between the filter body and filter cartridge, and thereafter, via the outlet duct, it enters the system main pipe. Mechanical particles contained in the water are retained on the lattice surface.

To clean the filter cartridge of the dirt deposited on its external surface one should turn the filter handle and the dirt will be flushed off from the lattices surface by water backwash, sink to the bottom and leave the filter through the drain hole.

Air centrifugal compressor units for general and special purpose

K3000-61-1 compressor

Design Features

K3000-61-1 compressor is two-cylinder, three-section, six-stage, direct-drive with two intermediate coolers. The compressor is driven by a steam turbine rated at 22 MW making it possible to change the CC operating mode by changing the rotor speed.

K1290-121-1 compressor

Purpose

The compressor is designed to compress atmospheric air for production of weak nitric acid.

Design Features

The compressor is two-cylinder, twelve-stage (each cylinder has six impellers), four-section. The air, having passed each section, is cooled in an intermediate outboard air cooler.

The compressor is driven by K15-41-1 steam turbine rated at 15 MW making it possible to change the rotor speed in the range of 2500–3400 min⁻¹. The rotor of the low-pressure cylinder is driven directly by the steam turbine while the rotor of the high pressure cylinder is driven by a step-up gear.

K1700-61-1 compressor

Purpose

The compressor is designed to compress atmospheric air and to supply it to oxygen units.

Design Features

The compressor is six-stage, three-section. Each section consists of two compression stages.

The air is cooled in intermediate air coolers mounted downstream of the first and the second sections. They are placed in a basement room. To cool the air downstream of the compressor a circular air cooler is installed. The compressor is driven by СТД-10000-2УХЛ4 synchronous motor rated at 10 MW.

K905-62-1 compressor

Purpose

The compressor is designed to supply air to air headers and to blast furnace blocks.

Design Features

The compressor consists of the single-cylinder compressor proper, an electric drive motor and control, monitoring protection and signaling systems.

The compressor is six-stage, three-section. Air coolers are arranged between the sections. Each section consists of two compression stages. The step-up gear is single-stage, with double helical gear. The compressor is driven by СТД-6300-2УХЛ4 synchronous motor rated 6300 kW, 6 or 10 kV and speed of 50 s⁻¹.

Delivery sites

The compressor equipment of Nevskiy Zavod is supplied to large-size metallurgical plants and enterprises of Russia and abroad among which there are Magnitogorsk Iron and Steel Works, Novolipetzk Steel Works, Nizhny Tagil Iron and Steel Works, Severstal Iron and Steel Works, to the metallurgical plants of Mechel Group of Companies, “EVRAZ”, “Kazakhmysk” (Kazakhstan) corporation, “Metinvest” Group (Ukraine), Bocaro Steel Plant, Bhilai Steel Plant, Durgapur Steel Plant (India), Pakstil Iron and Steel Works (Pakistan), Baotou Iron & Steel (Group) company (China) etc.

Technical characteristics

Parameter	Type of Compressor													
	K3000-61-1	K1290-121-1	K1700-61-1	K905-62-1	K384-61-1	K590-41-1	K390-112-1		K420-91-1/2	H1000-31-1	H1000-32-1	K3000-63-1	K525-61-1	
Compressed medium	air						nitro- gen	air	air					
Volume capacity at suction; m ³ /min	3000 (2700)	1210	1700	950	403	580	370	390	395	925	1025	3300	525	
Final air pressure; MPa abs.	0,6	3,53	0,736	0,375	0,883	0,431	3,24	3,24	1,6	0,284	0,334	0,706	0,88	
Initial parameters: temperature; °C	20	20	30	20	20	30	30	30	20	25	25	30	20	
pressure; MPa abs.	0,098	0,092	0,095	0,095	0,098	0,098	0,103	0,0953	0,098	0,0981	0,0981	0,095	0,098	
Rated rotor speed; rpm	3250 (3280)	3300/ 9240	4554	5690	9100	7628	9100 16 333	9100 16 333	9008	4600	5070	3000	7628	
Compressor consumed power; MW	20,5 (18)	12	8,35	4,6	2,3	2,3	3,65	3,7	2,9	2,4	3,15	15,5	3	
Type of drive: el. motor	-	-	СТД-10 000 2УХЛ4	СТД-6 300- 2УХЛ4	СТД-3 150- 2УХЛ4	СТД-2 500- 2УХЛ4	СТД-5 000- 2УХЛ4		4А3М- 3 150/ 6 000	СТД- 3 150- 2У4	СТД- 4 000- 2У4	ТДС- 10 000 2УХЛ4	СТД- 3 150- 2УХЛ4	
Steam turbine	K-22- 90-2 (K-19- 35-3)	K-15- 41-1	-	-	-	-	-	-	-	-	-	-	-	
Cooling water flow; m ³ /h	1000	560	1024	650	315	295	326	326	373	-	-	1572	352	
Overall dimensions- Foundation length; m	17,8	15	13,15	11,6	9	2,3	11,5	11,5	10,7	8,75	8,75	15	9,7	
Foundation width; m	6,9	6,8	5,1	5	3,15	3,4	3,5	3,5	3,15	3,8	3,8	7	3,5	
Floor level of the Engine room (Basement height)	7,2	6	4,8	4,2	3,6	3,6	4,8	4,8	3,6	3,6	3,6	6	3,8	
Crane hook lifting height from the Engine room floor level	5,5	6,5	5	5,5	2,5	3,5	3,5	3,5	2,5	4,5	4,5	7	3,5	
Mass of compressor as delivered; tons	122	122	82,1	60,5	27,25	30	54,1	54,1	38,3	25,9	25,98	224	35,9	
The heaviest assembly unit														
In installation	12,9	-	45,2	37,5	12,72	10,9	13,67	13,67	13,7	17,5	17,5	40,5	13,34	
In operation	9	-	17,5	12	2,9	4,5	4,7	4,7	4,7	6,7	6,7	39	4,7	

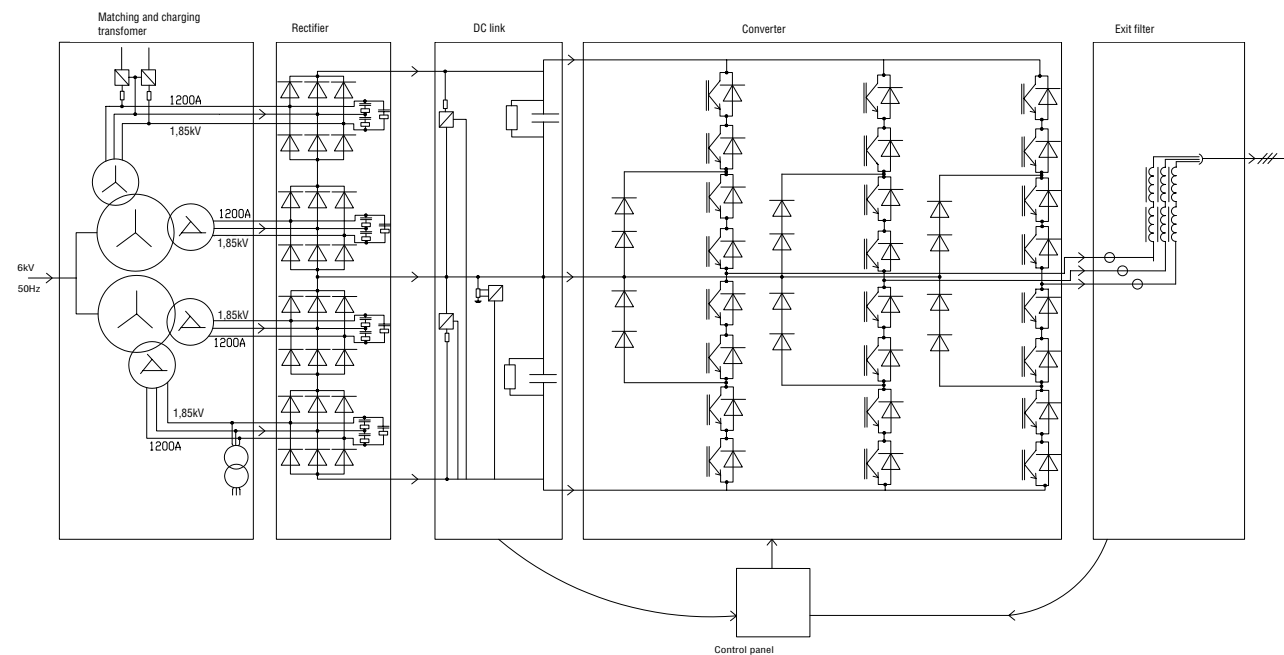
Frequency converters for standby air blowers

Advantages of Variable Speed Drive are:

- construction of high-speed dry compressor units (CU);
- short time (some minutes) of CU preparation and startup;
- a high number of CU startups and shutdowns;
- lower starting loads on electric mains.
- CU survival in case of power supply loss for up to 10 s;
- wide range of pressure, flow and other process parameters control;
- participation of electric drive in CU anti-surge control;
- high efficiency;
- easy automation.

ПЧТ 6-10000-6-Ж-01 frequency converter is designed to control motors with a speed up to 8600 rpm, voltage up to 6 kV and power up to 10 MW. It is used as part of variable speed drive of standby air blowers and gas pumping units. The converter is power supplied via transformer from 6/10 kV mains. The converter cooling is two-circuit, liquid.

The converter is powered via transformer from 6/10 kV mains.



Structural Diagram of ПЧТ 6-10000-6-Ж-01 frequency converter electronics

ПЧТ 6-2600-B Frequency Converter technical characteristics

Parameter	Value
Output voltage; kV	0–6
Rated power; MW	10
Rated current; A	1205
Maximum power; MW	13
Maximum current; A	1600
Operating range of the converter output frequency; Hz	0–50
Converter rated output frequency; Hz	50
Efficiency; %	> 98
Type of Invertor	3-level, IGBT based
Type of motor	Asynchronous Synchronous
Input voltage; V	Voltage transformer for operation with 24-pulsed rectifier, input 6±10 %, output 4 x 1850
Power frequency; Hz	50
Supply mains converter	24-pulsed diode rectifier
Transformer	2 x ТРСЗП-6 300/10-У3
Cooling	Heat exchanger between internal loop deionized water and clean liquid of external loop
Auxiliary power supply voltage; V	380±10 % (3 phases)
Switching frequency; H	up to 1000
Storage temperature; °C	from -20 to 60 (no water in cooling system)
Noise; dB	< 80 (A) at a distance of 1 m from the converter
Ambient temperature (in the shop/container); °C	from 5 to 45
Humidity, %	from 5 to 95 w/o condensation
Above sea level elevation; m	< 1000 above sea level
Installation	Indoors
Protection Index	IP41
Electric protection	Excess current, current limitation, increased or decreased voltage in the DC link, motor seizure (blocking), ground fault, phase break
Control sources	Local and remote control
FC overall dimensions without filters; mm	6800 x 2200 x 1400

Automated control and monitoring systems for power machines

Proposed solutions

- Automated system for control and monitoring of compressor station process.
- Automated control and monitoring system of the unit.
- Anti-surge control system;
- Process parameter control system.

Automation objects

- Steam turbines to drive blast furnace blowers, turbocompressors and turbine generators.
- Gas pumping units (gas turbine and natural gas compressor).
- Centrifugal and axial compressors to compress various gaseous media with a turbine or el. motor drive.

Purposes of automation

Ensuring safe, reliable, efficient and cost-effective operation of the unit by using up-to-date hardware, advanced algorithms of control and monitoring, and vast experience in systems integration.



5200/25 Turbocompressor Unit with automatic control and monitoring system at Magnitogorsk Iron and Steel Works

Automation tasks

Turbocompressor control functions

- Actuators remote control;
- Process loops functioning:
 - speed regulation (using an electrohydraulic transformer or hydraulic speed governor);
 - compressor capacity regulation (both suction and discharge);
 - pressure regulation in the compressor discharge;
 - regulation of oxygen flow or oxygen percentage content of air blasting;
 - bumpless switching from capacity regulation to pressure regulation and vice versa (for instance, when receiving signals on switching of Cowper blast heaters);
 - bumpless switching from process parameter regulation in the limiting control mode.
- Functioning of the compressor protection circuits:
 - the compressor antisurge control by using the bypass line (if available) and venting line; pressure-limiting control in the compressor discharge;
 - surge detector.
- Functioning of the turbine circuits:
 - steam pressure limitation in the governing stage chamber;
 - steam pressure limitation in the turbine seals;
 - regulation of condensate level in the condenser;
 - lube oil temperature regulation;
 - automatic activation of standby condensate pump.
- Control of the unit individual mechanisms and process equipment in all mode of their operation in compliance with the preset algorithms or in the remote control mode by the operator with protection against wrong actions.
- Automatic emergency shutdown of the unit upon reaching limit parameters for:
 - speed;
 - axial displacement of the turbine and compressor rotor;
 - bearing temperature of the turbine and compressor;
 - bearings lube oil pressure;
 - vibration of bearing housings of the turbine and compressor;
 - vacuum in the condenser;
 - air pressure in the compressor discharge;
 - other parameters according to the operational documentation for the unit.
- Changes in the unit operation mode:
 - verification of the unit readiness for start;
 - automated startup of the unit;
 - tripping, normal and emergency shutdown of the unit by the commands of the attending personnel.
- Service functions provide:
 - prompt changes in setpoints and settings;
 - control of the measuring channel status (unfaulty/faulty); simulation of the measuring channel value;
 - changing the status of process interlocks.

The tasks of units joint operation in a single process cycle

- Bumpless withdrawal of the operating unit and putting a standby unit into the process loop.
- Ensuring minimum energy losses caused by air venting or gas recycling due to redistribution of the load between the units.
- Symmetrization of the units gas dynamic operation modes to optimize the operation mode in terms of safety and efficiency.

A typical system includes:

- microprocessor-based monitoring and control system (MMCS);
- central control panel (CPU);
- local control cabinet (LCC).

Operator's Workstation functions

- Presentation of process data in the form of mnemonic diagrams;
- Presentation of information on design and measured parameters of the controlled object;
- Remote/automatic control of actuators;
- Simultaneous monitoring and control of several objects from one workstation (WS);
- Signaling panel to generate warning and emergency alarms;
- Specialized triggering screens of the unit preparation to startup, normal and emergency shutdown;
- Changing set-points and settings;
- Enabling and disabling of interlocks;
- Tools to check out alarms, interlocks and protection;
- Unauthorized access protection;
- Protection against the operator's incorrect actions;
- Parameter and event archiving in the system;
- Trending;
- Reporting system (shift/daily/monthly/annual reports);
- Presentation of the compressor operating point on its gas dynamic characteristic;
- Data export to Microsoft-compatible formats for further analysis and storage.

Scope of the offered works

- Engineering:
 - development of requirements specification for a system engineering;
 - selection of instrumentation and control valves;
 - development of specifications and electrical diagrams;
 - development of operational documentation;
 - development of application software;
 - development of detailed design documentation for automation of technological process.
- Manufacture of electrical cabinets and panels.
- Factory tests of the system.
- Installation supervision activities on site.
- Training of maintenance and operating personnel.
- On site pre-commissioning, start-up activities and commissioning of the system.
- Warranty and service maintenance.

Automation equipment

- Programmable logic controller (PLC): "TREI", "Tekon", "Regul", "Allen Bradley", "Simatic S7".
- External network infrastructure - Ethernet/IP (integration in all-factory network is based on Ethernet network, using OPC standard).
- Constructs: "Rittal" and Russian-made products.
- Instrumentation: "Metran", "Elemer", "Valcom", "Fisher-Rosemount", "Endress+Hauser", "Yokogawa" (transducers with unified electrical output serve as instruments for measuring physical quantities; if the automation object is located in explosion hazard zone, the transducers are supplied in the relevant enclosure and signals from them are received via intrinsically safe barriers).
- Vibration measurement system: IT14, "Vibron", "Diamekh", "Vibrobit", "Bently Nevada", EntekXM.

Actuated equipment

- Electrohydraulic governor of the steam turbine speed.
- Fuel governor valve for the gas turbine.
- Fast-operating antisurge valve with an electric, hydraulic or pneumatic drive.
- Throttle butterfly valve.
- Control valve for process media.
- Non-return valve with a mechanism for working up and down.
- Variable frequency converter.



Service

11

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Nevskiy Zavod performs upgrading and repair of the main and auxiliary equipment, including development, integration and implementation of measures to increase products reliability.

To carry out service activities, Nevskiy Zavod has the following resources available:

- certificated service personnel (including blue collar and technical engineering personnel);
- special diagnostic hardware (gas analyzers, video endoscopes, certified electric laboratory, frequency generators etc.);
- engineering center providing 24 /7 technical support.

Focal areas of Service

Presales Service

- Customer consulting.
- Demonstration of equipment to the customer with simulation of its operation on the shop stand.
- Preparatory training of operating personnel at the Customer's request.
- Providing the customer with required operational and technical documentation.
- Elaboration of the list of spare parts needed for the equipment uninterrupted operation during the warranty period.
- Product delivery to the customer with warehouse, storage and preservation.
- Arrangement of feedback from the customers operating similar equipment.

Aftersales Service is performed both in the Warranty Period and Post-Warranty Period of operation

The Warranty Period of operation includes

- Technical supervision of installation.
- Technical supervision of pre-commissioning activities.
- Support in string load tests.
- Training of the operating personnel.
- Technical support and periodic control of the equipment operating time.
- Scheduled technical maintenance activities.

Service in Post-Warranty Period

In the Post-Warranty Period the activities and services listed below are performed within the framework of the contracts concluded:

- equipment condition diagnostics;
- scheduled preventive maintenance;
- factory overhauls;
- supply of spare parts and tools;
- upgrading to improve performance parameters;
- remote monitoring of the equipment operation;
- 24-hour technical support for the customer.

Offered services

The Service Department of Nevskiy Zavod has at its disposal qualified personnel who perform a whole scope of activities during routine and overhaul repair, assuming all responsibility for the work performed.

The Service Department is responsible for planning, management, arrangement and performance of the works on site.

Comprehensive Service is performed under the contract concluded with the customer for a certain type of activity

This includes the following:

- technical and process audits with recommendations issued to eliminate the revealed defects;
- routine maintenance and overhauls of the main and auxiliary equipment in full scope;
- extended reports on the work performed and results obtained, including photo and video materials;
- technical support and training of the attending personnel.

Moving from the scheduled maintenance in compliance with PJSC "Gazprom" Standards (STO) and Regulations to Long-Term Service contributes to:

- elaboration of the MRO (maintenance, repair and overhaul) program to the highest standard;
- optimization of service maintenance parameters;
- improvement of equipment performances;
- implementation of long-term planning of the works.

Long-Term Service

Conclusion of long-term service agreements which provide the best conditions to maintain the equipment operation is the priority area of cooperation with the customers.

The key points and advantages of long-term service agreements are:

- 1 customized approach to equipment maintenance;
- 2 flexibility in selection of service volume and service payment;
- 3 24-hour customer technical support;
- 4 remote monitoring and diagnostics of the equipment operation;
- 5 permanent presence of the company representative on the customer's site;
- 6 optimization of spare parts warehousing on the customer's site;
- 7 optimization of financial expenses and timing budget saving.

Long-Term Service Concept

- 1 A Service Contract provides for scheduled maintenance of contract equipment, including spare parts supply and carrying out activities at site.
- 2 Nevskiy Zavod carries out unscheduled maintenance of the main equipment in the shortest possible time.
- 3 Scope of work provides for engineering consulting and customer technical support.
- 4 At the customer's request, training of operating and maintenance personnel, its upgrade training and certification is arranged at the training center of "Gazprom Energoholding LLC".
- 5 As agreed by the parties, an extended warranty is offered for completed works and supplied spare parts, as well as for guaranteed performances (operational availability factor, technical and economic performances).
- 6 Payment of works and services is made according to the agreed upon payment schedule.
- 7 As agreed, to reduce the equipment downtime, Nevskiy Zavod will arrange a spare parts warehouse to meet the customer's needs.

The format of Long-Term Service provides the following main advantages:

- Equipment parameters are reliably compliant with the declared specifications;
- Equipment is in the condition providing its reliable and safe operation;
- The customer obtains guarantees for the product, understanding of its lead time and minimum cost for the total package of services;
- The manufacturer controls the equipment condition and provides competitive price.

* Long-term service (hereinafter – LTS):

STS1 – blanket service contract providing for optional maintenance.

STS2-STS4 – comprehensive service;

LTS 2020 – Nevskiy Zavod offers GPU scheduled maintenance for the whole lifecycle of equipment with restricted use of a spare parts warehouse, without remote monitoring system and without guarantees for technical and economic performances;

LTS 2022 –Nevskiy Zavod offers a full range of services under the current contract conditions.

Technical characteristics

Service conditions	Essential conditions			Short-term service				Long-term service *	
				STS1	STS2	STS3	STS4	LTS 2020	LTS 2022
Term and Subject of Contract	Contract validity/Operating time in equivalent operating hours			1 year				Product life cycle /184 000	
	Maintenance category	Scheduled	Supervision	+	+	+	+	+	+
			Materials supply	+	+	+	+	+	+
			Repair of spare parts	+	+	+	+	+	+
			Workforce	+	-	+	+	+	+
			Minor works	-	-	-	+	+	+
			Capital spares stock	-	-	-	-	+	+
	Maintenance category	Unscheduled	Supervision	+	-	+	+	+	+
			Materials supply	+	-	+	+	+	+
			Workforce	+	-	-	+	+	+
			Spare parts stock	-	-	-	-	+	+
	Maintenance category	Maintenance of auxiliary equipment	Subsuppliers work management	-	-	-	-	+	+
			Materials supply	-	-	-	-	+	+
			Technical maintenance	-	-	-	-	+	+
	Maintenance category	Routine	Emergency works	-	-	-	-	-	+
			Spare parts supply	-	-	-	-	+	+
	Maintenance category	Start-up and commissioning	Technical maintenance	-	-	-	-	+	+
			Supervision	+	-	+	+	+	+
			Participation in tests	+	-	-	+	+	+
	Maintenance category	Start-up and commissioning	Start-up and commissioning activities	-	-	-	-	+	+
Responsibility and parameters	Maintenance contour			GTU, compressor				GPU	
	One contractor is responsible for the work results			-	-	-	-	+	+
	Training of operating personnel			+	-	-	+	+	+
	A single spare parts warehouse			+	+	+	+	+	+
	Response time for unscheduled maintenance			As agreed by the parties				24 hours	Hot line 24/7
	Use of remote monitoring and diagnostics system			-	-	-	-	-	+
	Engineering consulting, technical support			-	-	-	+	+	+
	Transfer of competencies to operating personnel within the framework of contractual obligations			-	-	-	-	+	+
	Compliance with scheduled dates for GPU maintenance			+	+	+	+	+	+
Warranty obligations	Warranty for replaced spare parts			Under contract				12 months	
	Warranty for the works			Under contract				12 months /4000 eq.op.h	
	MTBF and operational availability guarantee			-	-	-	+	+	+
	Guarantee of technical and economic performances (efficiency and power, etc.)			-	-	-	-	-	+
Financing	Drawing up acts and payment			Under contract				As per schedule	



Plant laboratory

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Interplant Laboratory

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Metrological Service

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Interplant Laboratory

The Product quality control is performed by a specialized unit of Nevskiy Zavod — interplant laboratory.

The Laboratory controls the quality of fabricated metal products involved in the Plant manufacturing cycle by means of destructive and non-destructive testing.

The Laboratory performs control in two ways:

- destructive testing (mechanical testing, metallographic examination, chemical and spectrographic analysis etc.);
- product nondestructive testing (radiographic, ultrasonic, liquid penetrant testing etc.).

The laboratory is equipped with up-to-date equipment from the leading manufacturers

- ARL 3460 Advantage Spectrometer.
- LECO CS-744 Carbon and sulphur automatic analyzer.
- EPMAГ 1000 AC/DC Stationary unit for magnetic particle test (MPT).
- SIAMS 800 Structure image automatic analyzer.
- Zwick (Germany) equipment to determine metal mechanical properties (strength, impact strength — testing machine Z250 and impact testing machine RKP450).

The Laboratory carries out a wide range of examinations — mechanical testing, radiographic testing, chemical and spectrographic analysis, liquid penetrant testing, magnetic particle test, ultrasonic testing etc.



RKP450 impact testing machine and Z250 testing machine CMM)

Metrological Service

Metrological support of the company activity is performed by the Metrological Service accredited by the Federal Accreditation Service for verification of measuring instruments.

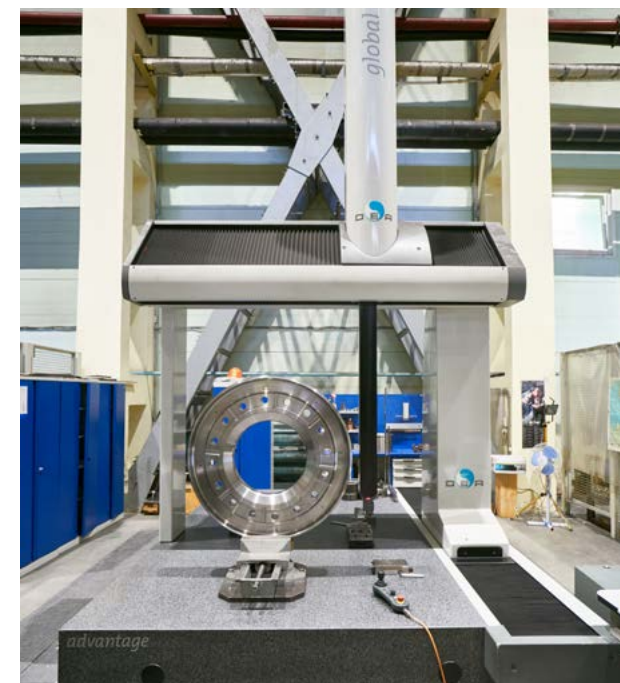
The metrological service is equipped with up-to-date calibration and verification instruments from the leading manufacturers

- CarlZeiss Jena (Germany), SYLVAC, Mitutoyo (Japan), plant “Kalibr” (Russia) — verification of measuring instruments of linear dimensions.
- “Shatki Instrument-Making Plant” LLC (Russia) — verification of pressure and vacuum measuring instruments.
- “Elemer” LLC (Russia), Digital Process Measurement (Pty) Ltd. (RSA) — verification of measuring instruments for thermophysical values.
- THE Modal Shop, INC (USA), Bently Nevada LLC (USA) - verification of vibroacoustic measuring instruments.
- CMM COORD3 (Italy), CMM HEXAGON Manufacturing Intelligence (Italy) — 3D, high-precision measurements of geometric parameters for irregular-shaped parts.

Metrological Service performs:

- verification of vibroacoustic, thermophysical measuring instruments, pressure and vacuum, geometric quantities measuring instruments;
- metrological examination of regulatory documentation;
- high-precision measurements on coordinate measuring machines, as well as with hand-held measuring tools.

The Metrological Service is accredited by the Federal Accreditation Service for verification of measuring instruments



DEA Measuring machine



Measuring on Coordinate Measuring Machine



Integrated Management System

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Certificates

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IMS certificates

Nevskiy Zavod competences in ensuring high quality of products are confirmed by certificates for the current integrated management system (IMS):

- quality management system;
- occupational health and safety management system;
- environment management system.



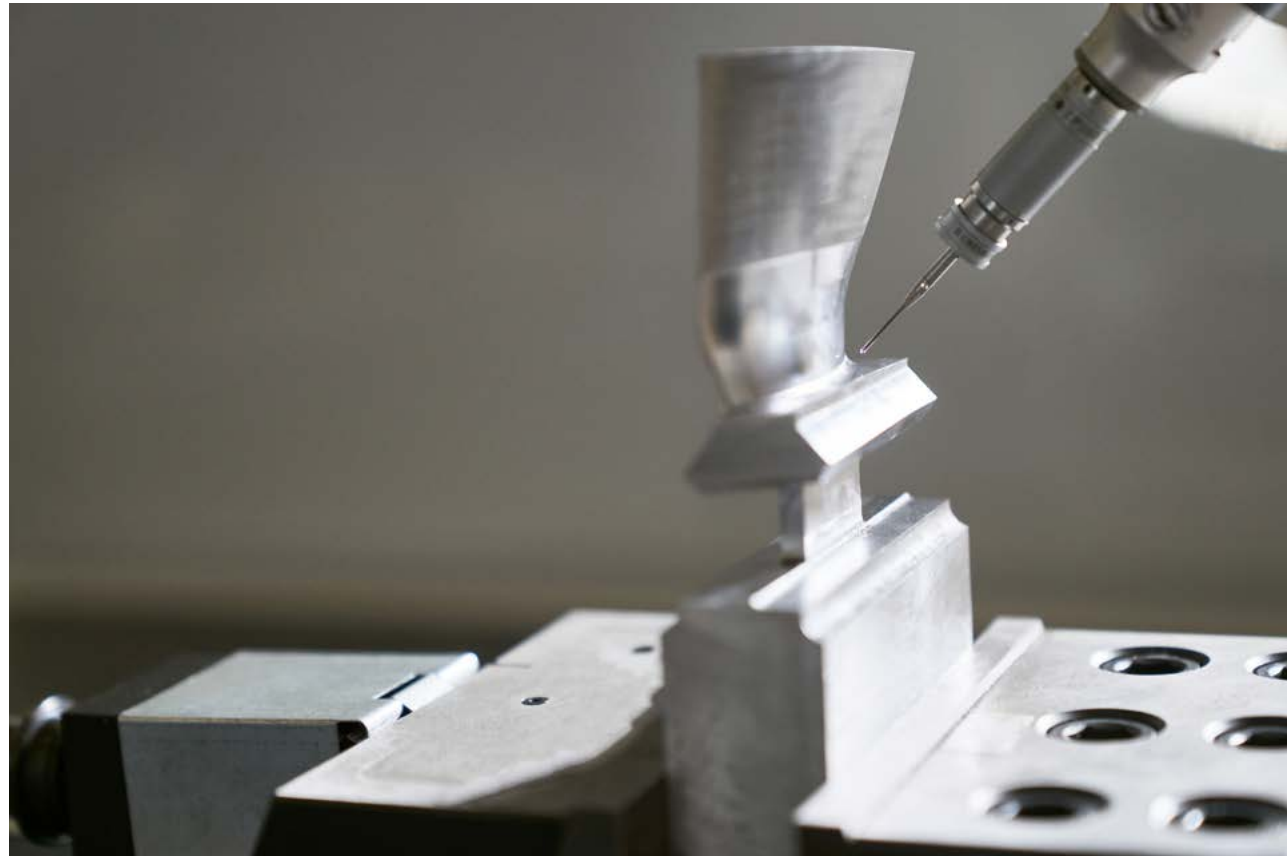
Quality Management System Certificate of Conformity with GOST R ISO 9001-2015 (ISO 9001:2015)



Environment Management System Certificate of Conformity with GOST R ISO 14001-2016 (ISO 14001:2016)



Occupational Health and Safety Management System Certificate of Conformity with GOST R ISO 45001-2018 (ISO 45001:2018)



The quality management system has been also certified in the Voluntary Certification System INTERGAZCERT of PJSC "Gazprom".





Career

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Human resources management

Nevskiy Zavod is a company with a long history and a solid wealth of knowledge. Our company consists of highly qualified, purposeful and creative people.

For us, the basic value is people. It is thanks to the contribution of each employee that the overall result of the company is achieved. Each of our projects is a challenge. Every challenge for us is an opportunity to develop and gain new knowledge and experience. When a prototype of innovative equipment is created, it seems to us that it is impossible to implement this. When we go through all the stages together, it seems that everything was easy and simple. This is a common success and a common merit.

Employees of Nevskiy Zavod are a team of highly qualified professionals who develop unique design projects, solve the most complex production tasks, create a high-tech product to provide key industries with modern equipment.

We create comfort labor environment and provide a competitive level of wages, benefits package, meal allowance, and voluntary medical insurance.

We always give our people the opportunity to show one's worth, to find new non-standard ways to solve complex problems. We give a sense of drive.

Production facilities and scientific and technical potential are a competitive advantage of Nevskiy Zavod.



Young specialists training


Nevskiy Zavod has developed a set of actions for recruitment, training and development of career paths of employees. Particular attention is given to training young specialists. Together with a number of technical universities of St. Petersburg, targeted training of students in disciplines that are highly-demanded in production is carried out.

Training and development of employees

Our company pays great attention to the development of professional skills of the employees, we do everything to ensure that they are certified on time and pass all the necessary training. We provide an opportunity for cross-functional exchange of experience, the opportunity to learn from professionals and grow continuously both linearly and upward in their career.

The task of the near future is to introduce continuous training and development of managerial and professional skills of each employee.





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