

# Shelf<sup>®</sup> LNG

## EQUIPMENT

For manufacture, storage and sale of LNG



### A full complex of equipment from one manufacturer

- Gas treatment systems
- Compressors
- Liquefaction units
- Spiral-wound heat exchangers
- Vertical and horizontal tanks
- Nitrogen units
- Pumps
- LNG dispensers
- Pipelines
- Automation

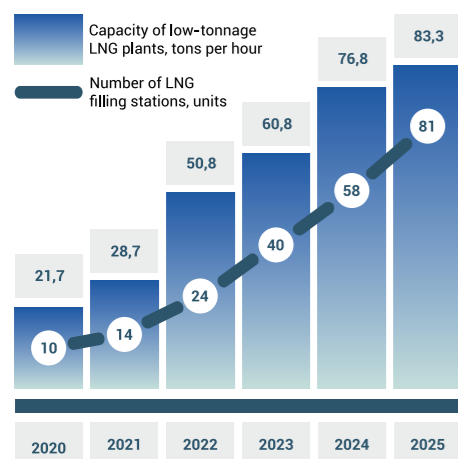
## PROSPECTS FOR THE DEVELOPMENT OF LNG PRODUCTION

The Government of the Russian Federation has approved a long-term program for the development of LNG production. The document provides various measures aimed at improving the competitiveness of the industry.

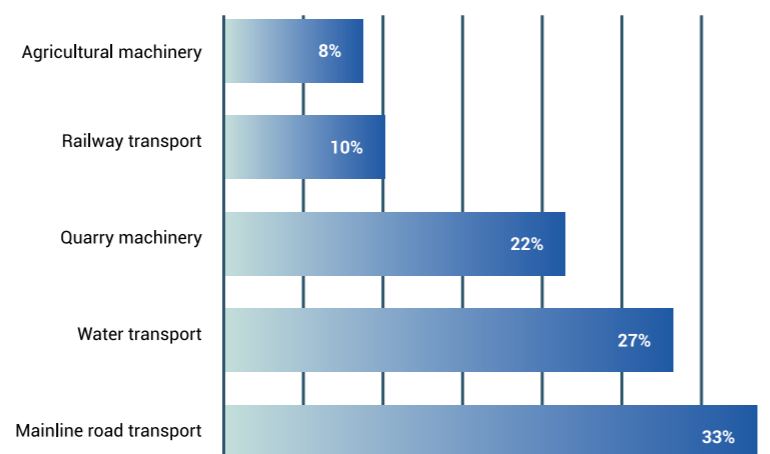
Special attention is paid to low-tonnage LNG production. By the end of 2022, 91.4 thousand tons of LNG were sold in Russia through 20 cryogenic gas stations. The number of such stations will reach 80 units by 2025. By 2030, 300-350 cryogenic gas stations will be operating in Russia. The total LNG sales by this time will amount to more than 1.8 million tons per year. In order to achieve the targets it will be necessary, at the same time, to build 70 mini-plants for production of LNG with a capacity of 1 to 4.5 tons each.

In 2019 a plan which is shown on the graph was adopted. Based on the results achieved by 2022, we see that reality has significantly outstripped plans. There is no doubt that in the future we will observe a similar picture.

The plan for the development of low-tonnage LNG production and gas refueling infrastructure for LNG



Distribution of potential demand for LNG as a motor fuel by transport segments in Russia



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# ABOUT COMPANY

**The Shelf Group holds a leading position in the production of equipment for the manufacture, transportation and sale of LNG**

Having extensive experience in manufacturing equipment for any kind of refueling infrastructure the Shelf Group decided to offer all necessary for working with LNG. Moreover, both for the production of LNG and its sale.

As in the case of equipment for CNG gas stations, we have managed to localize the production of almost all components at our own facilities. This allows us to offer you consistently excellent quality equipment. And the leading position of the Shelf Group ensures an adequate price for our products.

To date, we have mastered the mass production of gas treatment systems, compressors for operation in liquefaction plants, spiral heat exchangers, liquefaction units, vertical and horizontal LNG storage tanks, centrifugal and piston cryogenic pumps, LNG dispensers, Coriolis mass meters, automation of all types for the normal operation of facilities.

Based on all this we offer complex solutions for our partners.

At the same time, we can offer You all this turnkey. In addition to the equipment we offer design solutions, installation of equipment and commissioning.

During the period from October to December 2023 the first plant and several cryogenic gas stations will be built.

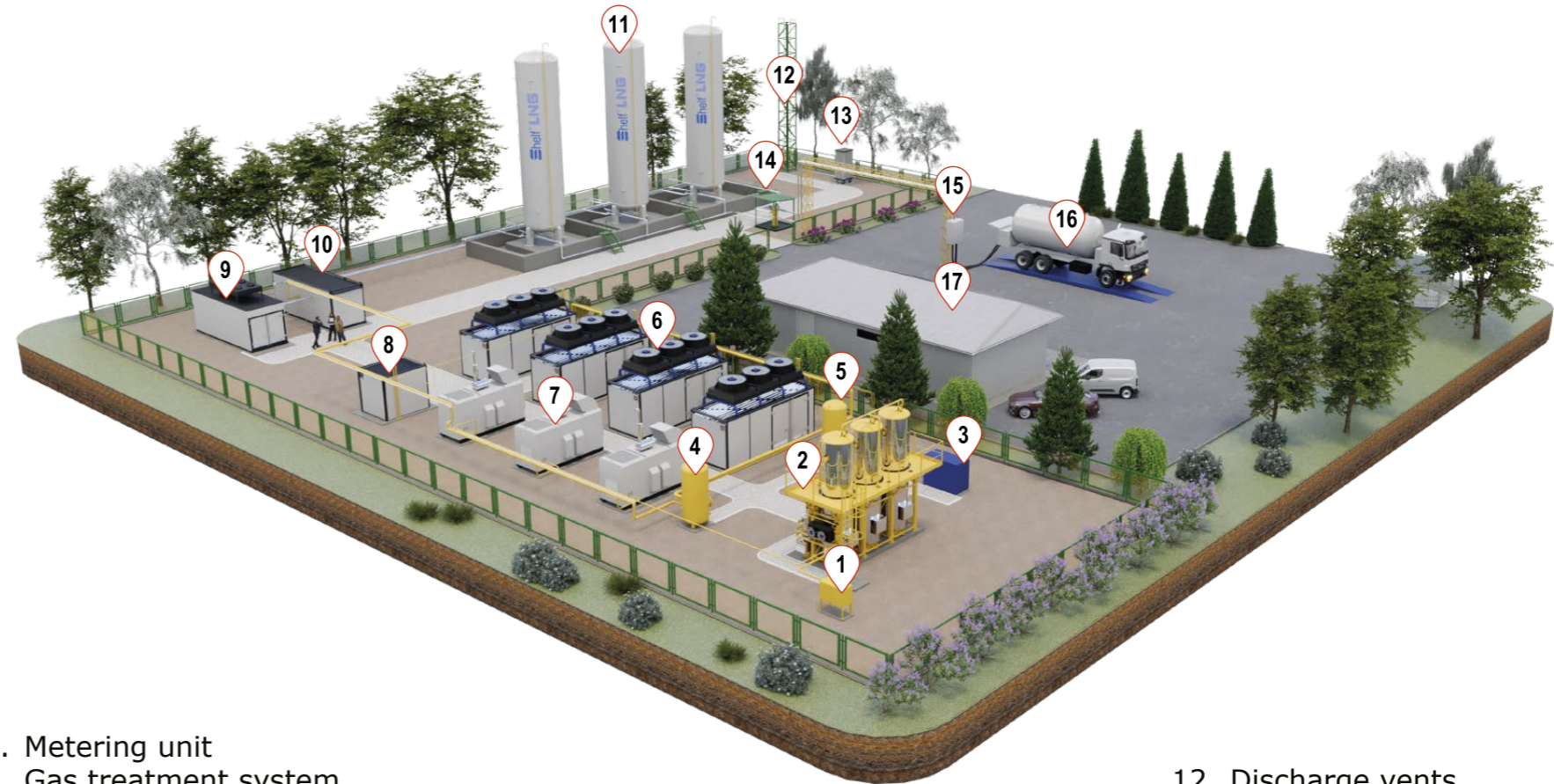
Our equipment for CNG gas stations occupies at least 70% of the Russian market. Starting in 2024 we plan to occupy at least 70% of the LNG equipment market.



# LOW-TONNAGE LNG PLANT

The availability of our own production base, a non-standard approach to solving tasks and, most importantly, a highly professional, motivated team allowed us in a very limited time to develop wide line of mini-plants LNG in various designs and of different capacities from 0.25 to 9 tons/hour.

As an example, the technical characteristics and description of the plant of capacity 1.5 t/h are given.



1. Metering unit
2. Gas treatment system
3. Nitrogen unit
4. Buffer tank
5. Gas collector
6. Compressors
7. Generators

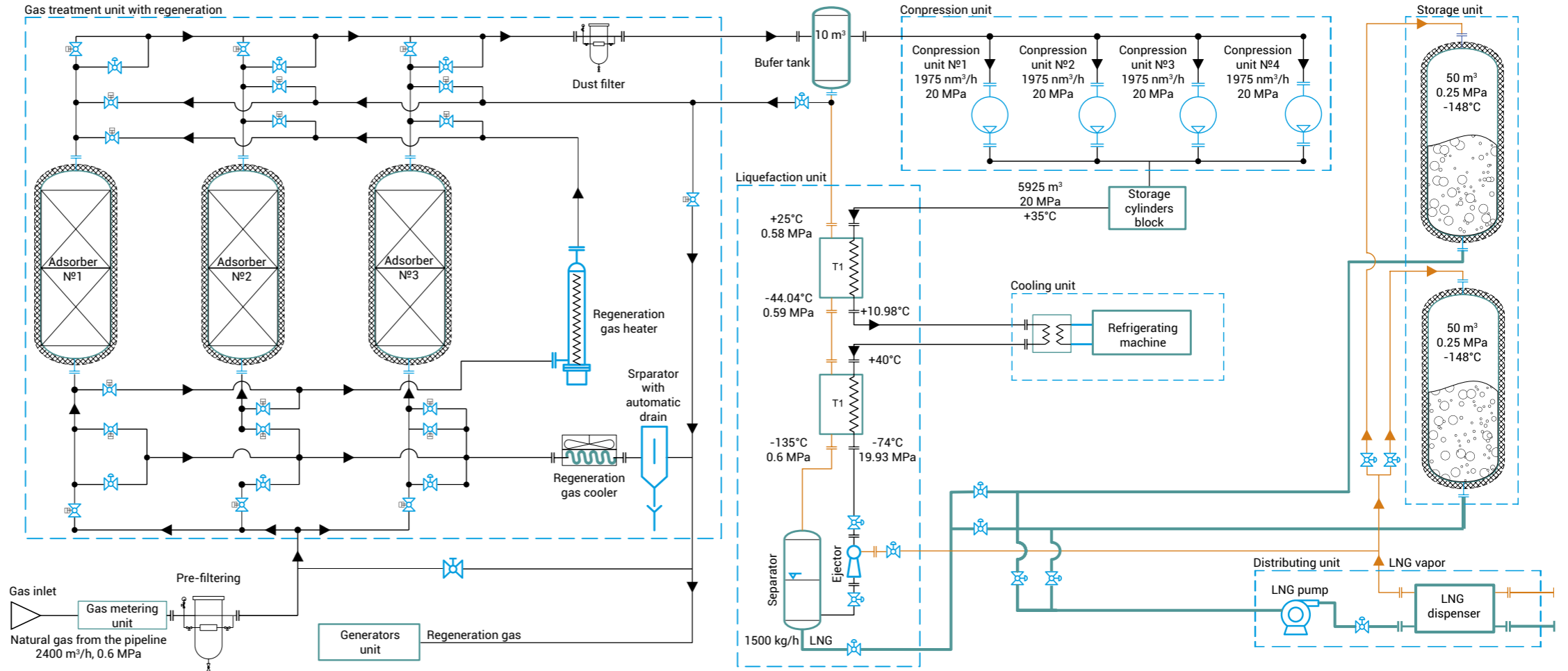
8. Storage cylinders block
9. Cooling system
10. Liquefaction unit
11. Storage tanks

12. Discharge vents
13. Atmospheric evaporator
14. Cryogenic pump
15. Refueling post
16. Scales
17. Administrative building

The plant for the production of LNG 1500 kg/h (hereinafter referred to as the Plant) is made in a block-modular design and ready-to-operate. This design significantly speeds up and minimizes the process of installation of equipment and commissioning at site.

After passing commercial accounting natural gas from the gas pipeline at a pressure of 0.6 MPa is pre-purified from mechanical impurities and drip water, then it enters the cleaning and drying unit. The gas treatment unit with regeneration consists of three adsorbers filled with zeolites-NaX, in which the adsorption of H<sub>2</sub>O, CO<sub>2</sub> and hydrogen sulfide gas takes place up to necessary technological values. After filling the adsorbent with extractable components, the adsorber switches to regeneration mode. To regenerate the adsorbent a part of the purified gas is used, which is preheated to 250°C in an electric heater and, passing through the adsorber in the opposite direction relative to the flow in the adsorption mode, cleanses it step by step from H<sub>2</sub>O, CO<sub>2</sub> and hydrogen sulfide. The hot regeneration gas, coming out of the adsorber, passes through a cooler, in which moisture condenses due to a temperature difference and then droplet moisture with impurities dissolved in it is separated from the regeneration gas in the separator. The purified regeneration gas goes to the power generator unit.

After cleaning and drying the gas is compressed to 20 MPa in the compression unit consisting of three compressor modules. Then the gas is filtered from possible oil ingress and sent to the



gas accumulator unit to extinguish pulsation from the operation of the compressors. Then the high-pressure gas enters the liquefaction unit (direct flow), where it passes the block of technological measurement of direct the flow gas consumption, then the gas enters the heat exchanger T1. In this heat exchanger the direct flow gas is cooled by the reverse

flow gas to a temperature about +10°C and enters the cooling unit where it is cooled by freon to about -40°C in the evaporator heat exchanger of the refrigerating machine. In the T2 heat exchanger the direct flow gas is additionally cooled by the reverse flow gas to a temperature of -74°C. A further decrease in the temperature of the direct flow gas occurs

in the ejector due to a decrease in pressure from 20 MPa to 0.6 MPa. At this stage the gas passes into a vapor-liquid state and enters the separator.

In the separator the vapor phase of LNG is separated from the liquid phase of LNG and forms a «reverse flow», which, after passing through the inter-tube space of the heat

exchangers T2 and T1, gives its «cold» to the direct flow during the recovery process and, after passing the reverse flow gas consumption measurement unit, returns to the compression unit through a buffer tank. After that the cycle repeats.

After the separator LNG enters the receiving and distributing unit and then accumulates in a storage unit consisting of two technological storage tanks, with a pressure of 0.25 MPa and a temperature of 148°C below zero. The tanks are equipped with a pressure boosting unit. From the storage unit LNG goes to the cryogenic pump through the receiving and distributing unit, then it enters the LNG dispenser. The LNG dispenser ensures the connection of the Plant systems with the transport tank. The connection is carried out by metal sleeves with flexible external thermal insulation.

For safe operation of the Plant the technological equipment includes a nitrogen unit for gaseous nitrogen producing. The nitrogen unit provides the production and storage of gaseous nitrogen for use in the technological system as a working fluid by remotely controlled valves, as well as provides purging of gas pipelines and «warming up» of cryogenic equipment.

The liquefaction scheme and working algorithm of the Plant do not imply technological gas discharges into the atmosphere. In emergency situations it is possible to release natural gas or LNG vapor through appropriate safe drainage devices of the gas spillway system.

The Plant operation is controlled by an Automated Process Control System.



# GAS TREATMENT SYSTEM



It can have different designs depending on the initial characteristics of natural gas. As an example, a 0.5 ton per hour gas treatment system is shown, it provides the following product characteristics at the output: CO<sub>2</sub> content - no more than 50 ppm, H<sub>2</sub>O content - no more than 1 ppm.

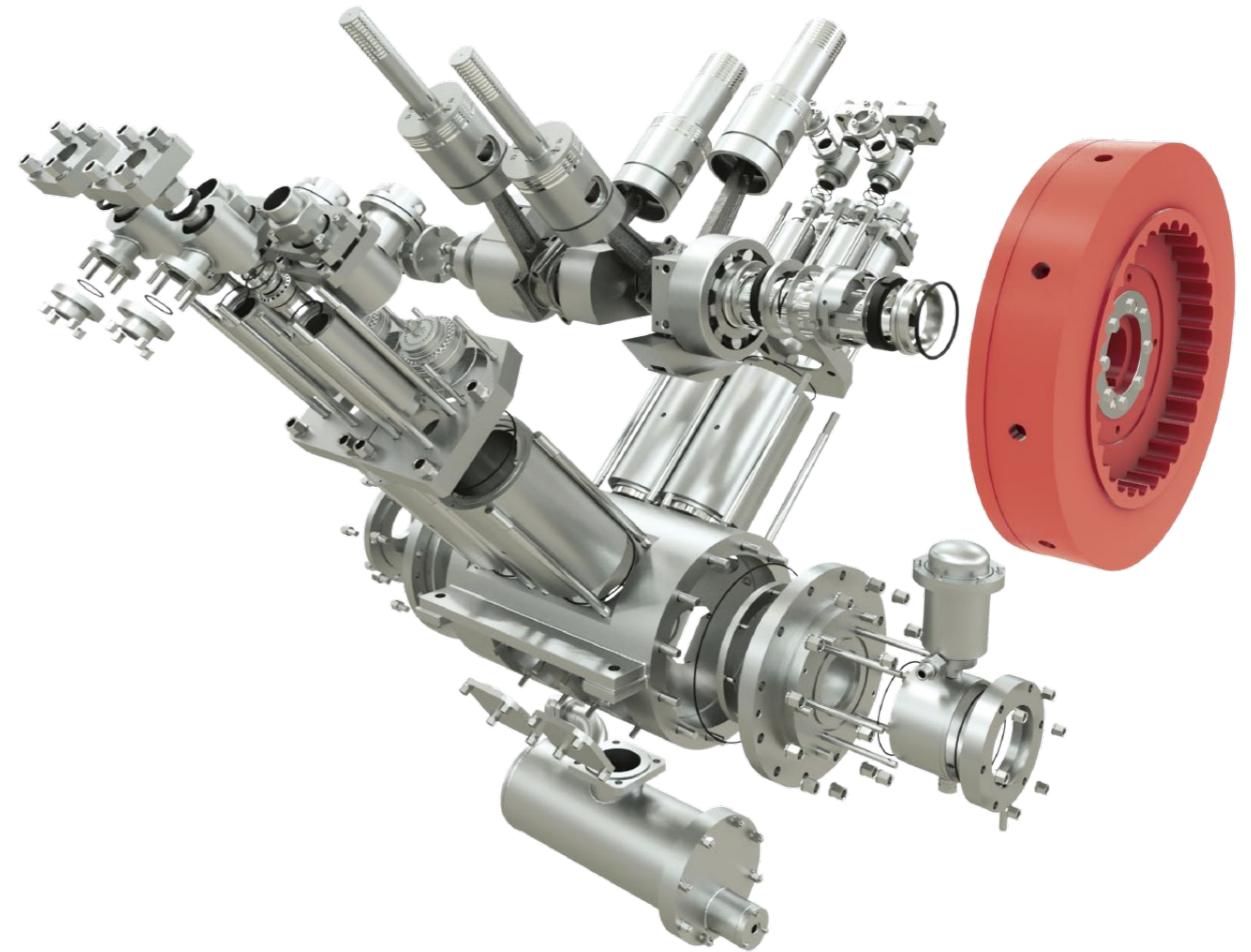
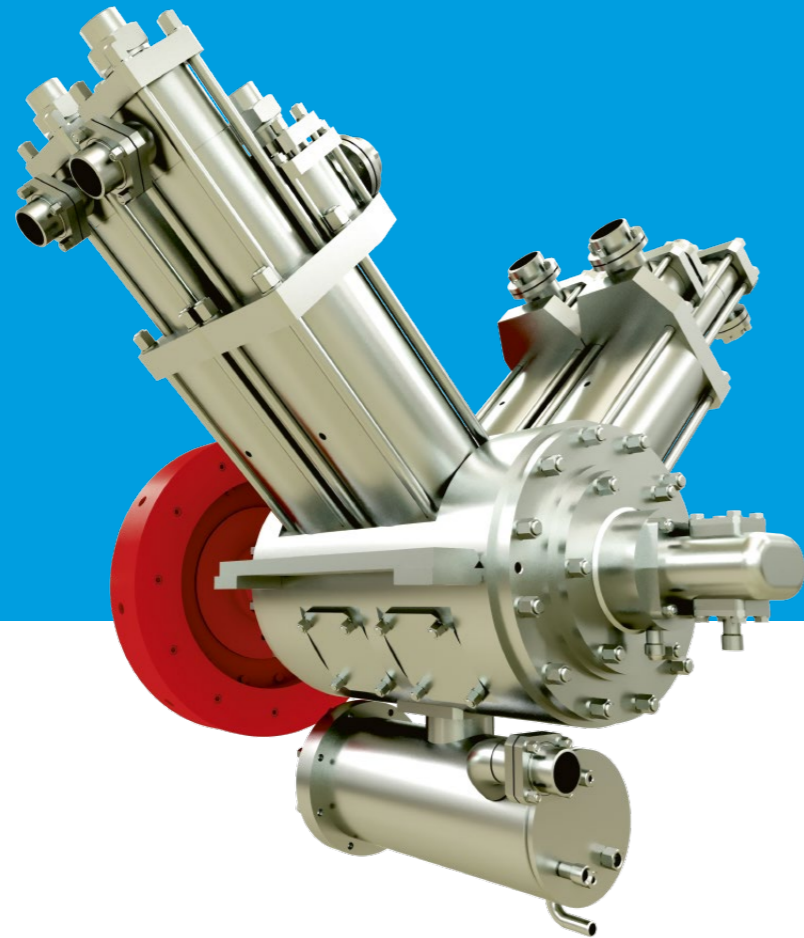
# LIQUEFACTION UNIT



The gas liquefaction unit is a complete factory product in a heat-insulating casing. Depending on the model, it is equipped with spiral-wound methane-methane and freon-methane heat exchangers, separator, flow meters of various types, shut-off valves and a process control cabinet.

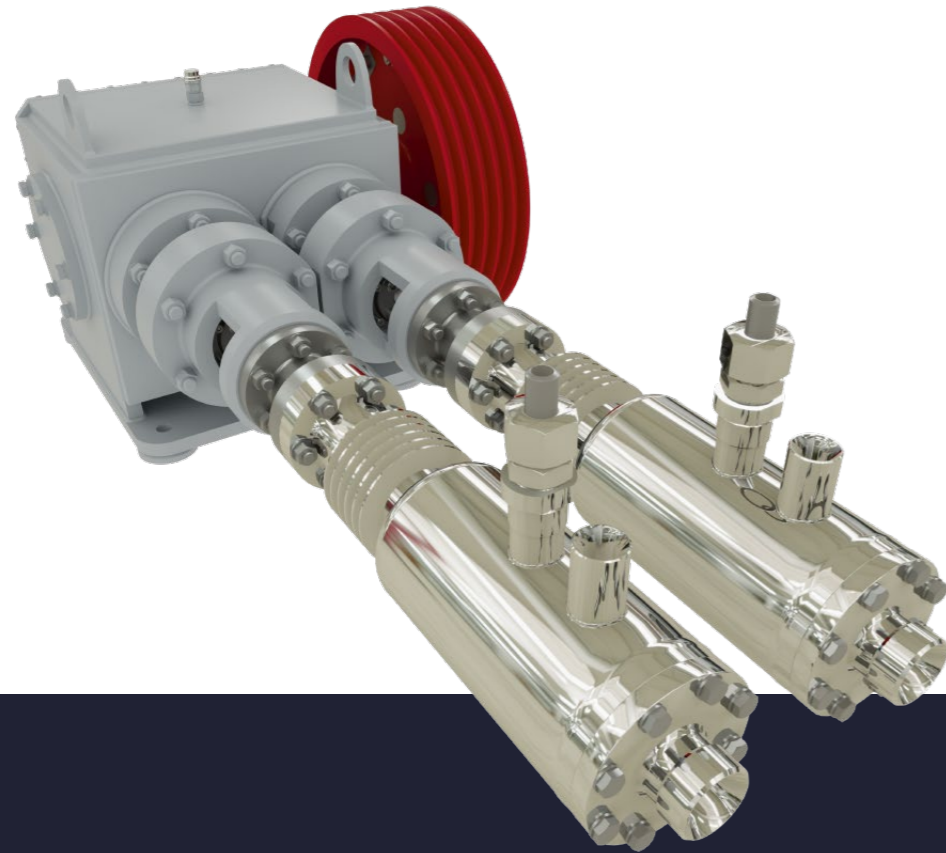
# COMPRESSORS

A compressor unit with a capacity of 2000 m<sup>3</sup>/hour was created specifically for operation as part of LNG production complexes. According to all characteristics, this unit can compete with the best compressors from the world's leading manufacturers and even surpasses them in many ways. The patented gas compression technology allows us to guarantee the reliability of our compressors, which is confirmed by the long-term successful operation of «Shelf» compressors at hundreds of CNG gas stations in Russia and abroad.gg





# PISTON PUMP



A piston pump is one of the types of volumetric hydraulic machines in which one or more pistons are used as displacers. Cryogenic piston pumps are designed to fill cryogenic tanks and operate as part of high-pressure regasification plants.

A wide range of models, which is determined by performance and maximum outlet pressure, allows us to use our pumps effectively as part of various equipment.

# CENTRIFUGAL PUMPS

## OF LOW PRESSURE DROP «SHELF»



They are designed for pumping liquefied gases from one cryogenic or isothermal reservoir to other, as well as for operation as part of Cryogenic gas stations.

The pumps have a wide range of capacities from 50 to 500 l/min. The centrifugal pump consists of a cryogenic part and an electric motor connected by a coupling and mounted on a common frame. Pumping centrifugal units can additionally be equipped with a control panel, a cooling temperature control system, etc.

In addition, we offer submersible centrifugal pumps. Technically, this is an assembly of a pump and an electric motor that is immersed in a small cryogenic tank.

# SPIRAL-WOUND HEAT EXCHANGER

Spiral-wound heat exchangers developed by Shelf Group specialists cope with heat exchange processes very effectively. At the same time, the selected materials and technologies allow to achieve maximum effect at compact sizes of the heat exchangers.



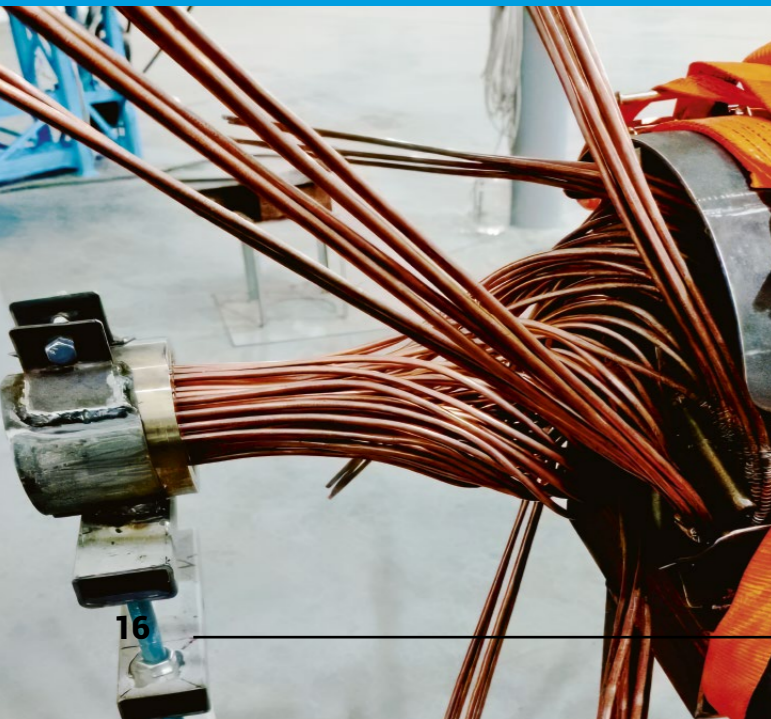
# ATMOSPHERIC EVAPORATORS

The production line includes atmospheric evaporators of two versions:

- of medium pressure up to 4.0 MPa for cold cryogenic gasifiers.
- of high pressure up to 40 MPa for operation as part of cryogenic gasification plants.

As a basis in both types of evaporators, an aluminum profile of the «Snowflake» type is used, it allows to increase significantly the heat exchange area and ensure the necessary productivity.

The production line includes evaporators with a capacity of 5 up to 4000 m<sup>3</sup>/hour at ambient temperatures from -50 to +50°C in horizontal and vertical designs.



# CRYOGENIC TANKS



[www.shelf.su](http://www.shelf.su)

Cryogenic tanks and reservoirs can be both stationary and mobile. Stationary tanks are available in both vertical and horizontal designs.

We produce tanks with a volume from 2 to 50 m<sup>3</sup>. Two-shell tanks are produced by us in both perlite vacuum and multi-layer vacuum versions.

By design, a cryogenic tank is a vessel enclosed in another vessel. As standard we make both internal and external vessels from cold-resistant stainless steel. This design of tanks allows in most cases to avoid the need to organize irrigation at the site. Cryogenic equipment also includes measuring and control devices, piping, evaporator, shut-off and safety valves.

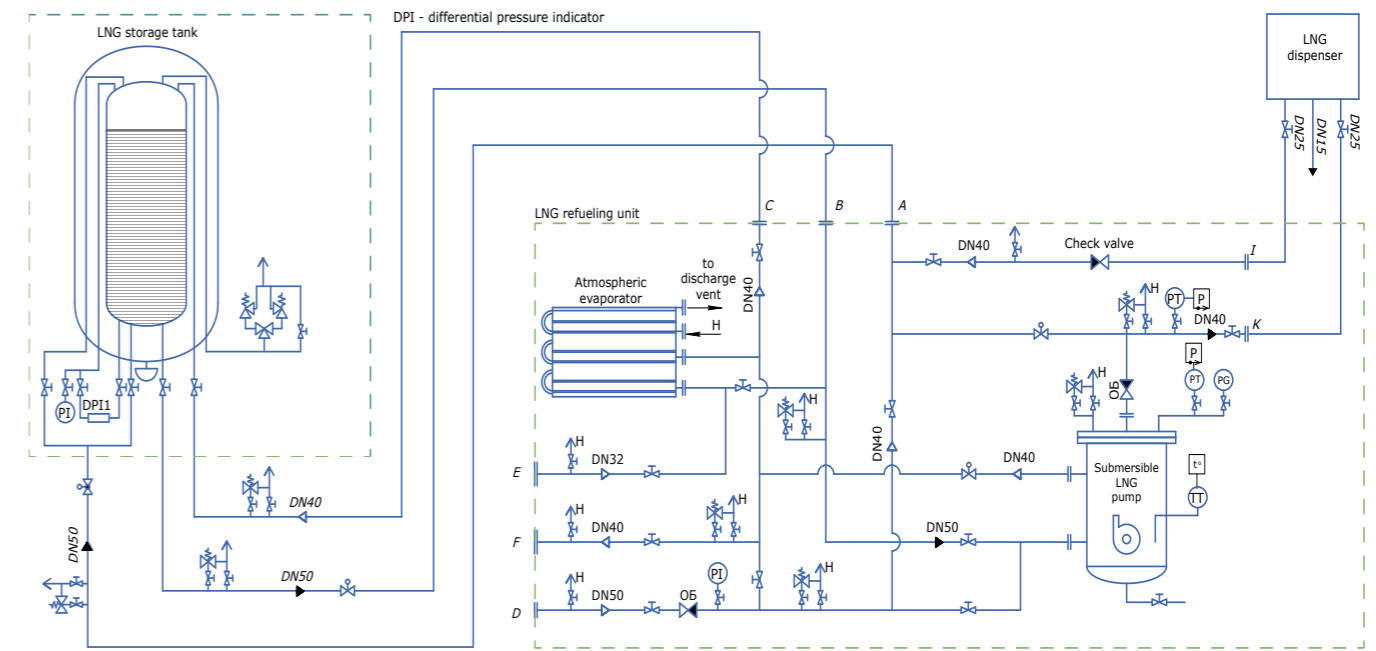
# CRYOGENIC GAS STATION

Cryogenic gas station is designed for receiving of liquefied natural gas (LNG) from mobile LNG filling stations and cryogenic tanker trucks into an LNG store tank, for storing, for distributing LNG through LNG dispenser into cryogenic fuel tanks of vehicles, as well as for carrying out auxiliary technological operations. Cryogenic gas station is made in a block-modular design and ready-to-operate. This design significantly speeds up and minimizes the process of installation of equipment and commissioning at site.



## The flow chart description

The LNG storage system includes a cryogenic tank, cryogenic shut-off and control valves, a liquid level indicator, a pressure gauge and safety valves. The inner vessel of the tank is designed for LNG storing. Thermal insulation material and vacuuming are provided in the inter-wall space. The internal vessel is protected from overpressure by safety valves. The outer casing is equipped with a bursting membrane or a destruction preventing device (for the LNG tank in the casing).



LNG gas station flow chart

### List of equipment

Name of the equipment	Parameters	Quantity, pcs
Discharge/injection device	300 nm <sup>3</sup> /hour, 1.6 MPa	1
Atmospheric evaporator	75 nm <sup>3</sup> /hour, 1.6 MPa	1
LNG submersible pump	50-250 l/min, 15 kW	1
LNG dispenser	one-hose	1
LNG storage tank	25 m <sup>3</sup> , 0.8 MPa	1

For two-shell tanks: the external vessel ensures that the liquid phase of LNG is retained in the inter-wall space when the internal vessel is depressurized and that discharge of LNG vapors into the atmosphere will be under the control.

The tank pumping system supplies LNG to an atmospheric evaporator, after which gas in gaseous state returns to the tank's vapor space to increase the pressure in the tank to the normal operating range.

The LNG refueling system uses a submersible pump to supply LNG from the tank to the LNG dispenser. At the same time, LNG dispenser performs automatic measurement and calculation of the released fuel consumption with the help of flow meters.

A gas discharge system is provided through the heater to the discharge vents.

The air control and measuring devices system provides the production of pulse gas to power the actuators (valves). The pressure at the outlet of the air compressor ranges from 0.4 to 0.8 MPa. It consists of an air compressor, dehumidifiers, filters, pipelines and valves.

Additional set of equipment can be installed to the cryogenic gas station that will allow the filling not only with LNG but with CNG also at such cryogenic

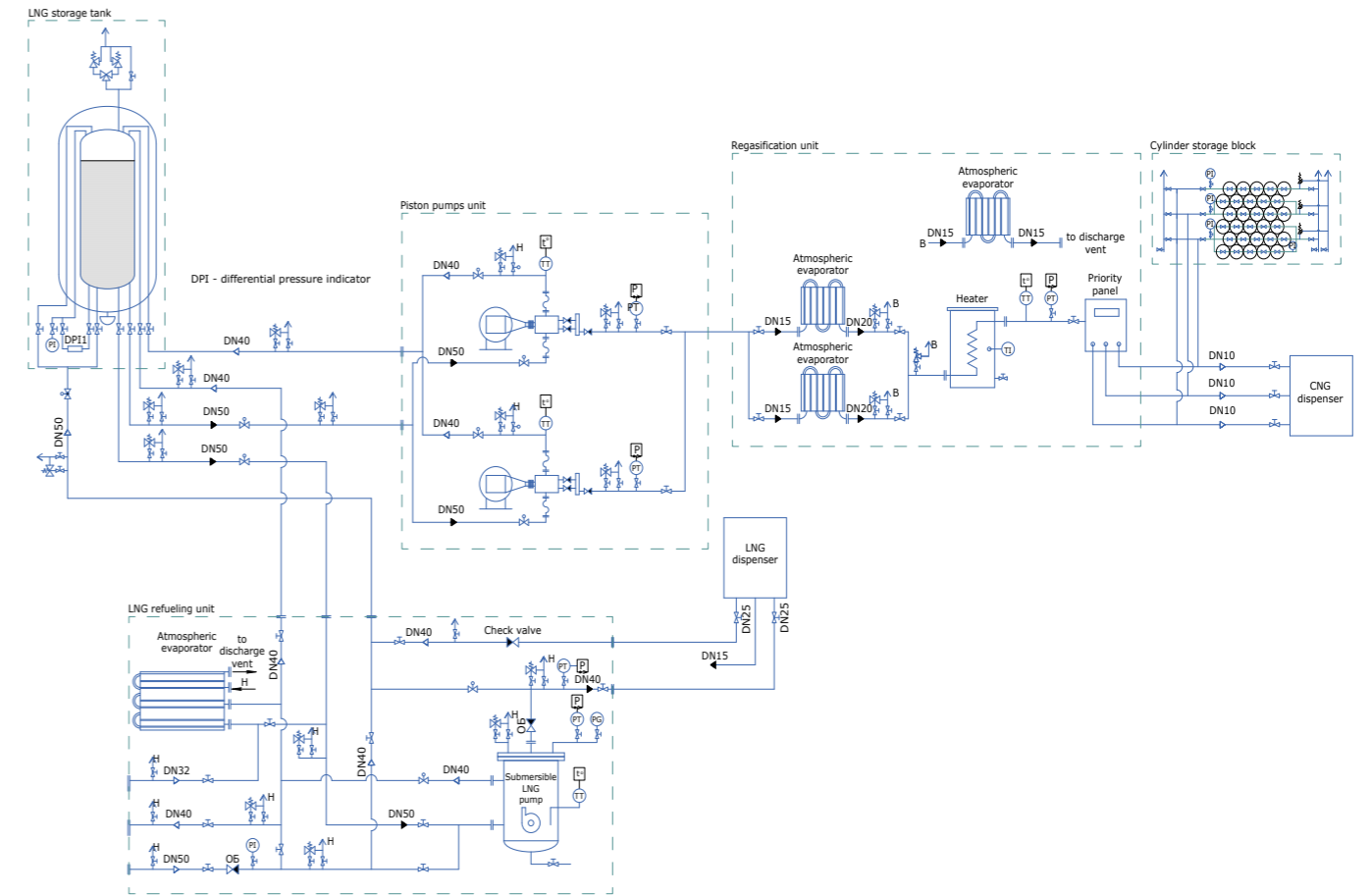
station. In this case, LNG is supplied from a cryogenic tank to a piston pump, after which, at a pressure of 220-250 bar, the product enters a high-pressure atmospheric evaporator. Then this gas is heated, odorized (if necessary) and fed through a CNG storage cylinders block to the CNG dispenser. Because of the underdevelopment of the cryogenic gas stations network and the possible shortage of LNG consumers at this stage in most regions, this scheme will be the most promising.

#### List of equipment for the low-pressure section

Name of the equipment	Parameters	Quantity, pcs
Discharge/injection device	300 nm <sup>3</sup> /hour, 1.6 MPa	1
Atmospheric evaporator	75 nm <sup>3</sup> /hour, 1.6 MPa	1
LNG submersible pump	50-250 l/min, 15 kW	1
LNG dispenser	one-hose	1
LNG storage tank	25 m <sup>3</sup> , 0.8 MPa	1

#### List of equipment for the high-pressure section

Name of the equipment	Parameters	Quantity, pcs
High pressure pump	1500 l/hour, 22 kW	1
Atmospheric evaporator	1000 nm <sup>3</sup> /hour, 25 MPa	1
Atmospheric evaporator	50 nm <sup>3</sup> /hour, 25 MPa	1
Heater	1000 nm <sup>3</sup> /hour, 25 MPa	1
Control panel		1
CNG dispenser	Two-hose	1



LNG+CNG gas station flow chart

# LNG DISPENSER



Dispensers for delivery of liquefied natural gas «Shelf ... LNG» are designed to measure the mass of distributed LNG when refueling cryogenic reservoirs, including cryogenic fuel tanks of vehicles.

The dispensers are made in one- and two-hose designs.

«Shelf ... LNG» dispensers parameters

Parameter	Value
Maximum gas consumption through one fuel hose, kg/min	80
Minimum gas consumption, kg/min	5
Minimum dose of gas delivery, kg	20
Limits of the relative error of measurements of the mass of released LNG, %	±1,0
Maximum working pressure, MPa	1,6
Ambient temperature, oC	-40... +50
Working medium temperature, oC	-196...-55
Maximum weight, kg	600
Overall dimensions (LxWxH), mm	2500 x 800 x 2150



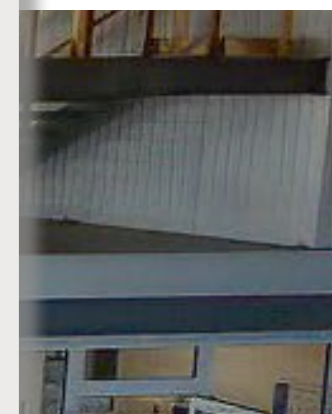
**OUR COMPANY**

In this booklet we were not able to show all of what we offer now and will start offering in the near future:

- pipeline systems with multi-layer vacuum insulation;
- storage and regasification modules for nitrogen, oxygen, carbon dioxide, LNG;
- cryogenic transport tanks;
- cryogenic semi-trailers;
- nitrogen generators;
- refrigerating machines;
- gas piston electric generators.

Cooperation in the development of the LNG market can provide many opportunities for the growth and evolution of Your company, especially in the context of the increasing demand for LNG as an alternative and more environment friendly energy source.

We will be glad to be Your partners in any even the most non-standard projects!





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