TECHNICAL CONCEPT OF THE SHTOKMAN LNG PROJECT

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ABSTRACT

The gas source for the project - the Shtokman gas and condensate field – is located in the central part of the Barents Sea, 650km north-east of Murmansk. The reserves of the Shtokman gas and condensate field (SGCF) are estimated at 3 660 billion cubic meters.

At the first stage it is planned to arrange the field and to supply of gas to the shore for LNG production.

To supply formation fluid, consisting of natural gas, condensate and water, from the field to the shore, the construction of more than 600 km long submarine pipeline is required. There are still no realized projects of subsea transportation of a multiphase flow for such long distances.

To produce LNG it is planned to build a plant consisting of two trains with capacity of 7.5 mln. t/year each.

LNG transportation to the US market, selected as a target market, is planned by twelve specific vessels - LNG- carriers with capacity of up to 215 000 cubic meters.

Technical concept of development of the Shtokman gas and condensate field proposes creation of an integrated production, transportation and procession complex, including:

- System of subsea field arrangement;
- System of offshore multiphase pipelines;
- Onshore system for support of subsea field arrangement and gas transportation;
- Onshore LNG production complex;
- LNG offshore transportation.

Liquefied natural gas production complex is planned for construction in the area of settlement of Vidyaevo (Murmansk region).

The project may have both big macroeconomic and geopolitical importance and significant potential with regard to the economic region and to the state in whole.
INTRODUCTION

Russia has in possession about one third of the prospected reserves of natural gas. At present the principal export market for the Russian natural gas is Western and Central Europe. Large capacity of the market and increasing demand for natural gas in the USA and countries of the Asia-Pacific region attracted intensive attention of competitive suppliers of natural gas in the Middle and Far East as well as in Central Africa (Figure 1). Creation of a Russian niche in the global gas market is therefore actual macroeconomic and political objective.

![Figure 1. Forecast of demand for natural gas worldwide, in billion cubic meters (re: EIA, 2006)](image)

The main advantage of the liquefied natural gas (LNG) is relative flexibility and possible diversification of markets and supply volumes with the help of LNG-carriers which enables to adapt to the changing conditions of the world market. At present the LNG sales comprise 27.4% of the natural gas world trade. It is expected that LNG share will reach 30% of the gas world trade by 2010.

In Russia LNG is not produced on the large industrial scale. Remote location of countries of the Asia-Pacific region and of the USA from the main Russian gas fields does not allow to use traditional pipeline transportation of natural gas to these regions. The problem of creation of LNG production in Russia and construction of LNG-carriers for gas transportation becomes thus very acute.

The first LNG project in Russia (Sakhalin-2) is of fully foreign origin. Development of the Shtokman gas and condensate field (GCF) in the shelf of the Barents Sea as a strategic objective for JSC Gazprom and for the Government of the Russian Federation was identified by President V.V. Putin at his meeting with the US President G. Bush in Bratislava in spring of 2005.
In view of the high price state of the market more than 40 new LNG projects are being designed and constructed, including liquefaction plants and receiving terminals (Table 1). The objective of the Russian producers is to appear in the LNG market in years 2013 – 2014. This will enable the Russian liquefied natural gas in future to occupy in the world market the place equivalent to that of the pipeline gas.

Table 1 Capacities of LNG terminals and plans for their expansion (in MMtpa)

<table>
<thead>
<tr>
<th>Terminal capacity</th>
<th>Total</th>
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<tbody>
<tr>
<td></td>
<td>Existing</td>
</tr>
<tr>
<td>North America</td>
<td>25.2</td>
</tr>
<tr>
<td>Europe and Eurasia</td>
<td>49.1</td>
</tr>
<tr>
<td>Asian-Pacific</td>
<td>263.5</td>
</tr>
<tr>
<td>Total</td>
<td>337.8</td>
</tr>
</tbody>
</table>

The gas source for the project - the Shtokman gas and condensate field – is located in the central part of the Barents Sea, 650km north-east of Murmansk, 920 km north-east of Arkhangelsk and 290 km west of Novaya Zemlya. The reserves of the Shtokman gas and condensate field (SGCF) are estimated at 3 660 billion cubic meters (Figure 2).

![Figure 2. Geographical location of the Stokman Gas Condensate Field](image)

At the first stage it is planned to arrange the field and to supply 22.5 bln. cub. m/year of gas to the shore for LNG production.
Long distance from the coast, arctic ice and hydrometeorological conditions create a number of technical and economic problems which may be effectively solved by using modern technical and technological solutions.

One of the principal aspects of the field arrangement is implementation of subsea technologies with systems of subsea well completion located on the sea bottom. The modern technologies of natural gas production in the shelf, proposed in the technical concept, plan to use subsea systems of well arrangement equipped with fittings, automatically controlled gates, inhibitor injection systems of hydrate forming. The equipment is mounted on the bottom supports – templates. The wells are connected by subsea pipelines and manifolds (Figure 3).

Figure 3. Subsea development of Shtokman Field

To supply formation fluid, consisting of natural gas, condensate and water, from the field to the shore, the construction of more than 600 km long submarine pipeline is required. The route profile has significant difference in depth and maximum depth of about 350 m.

The concept envisages a number of options for gas transport to the shore, namely its one-, two-, and multiphase flow. It should be noted that there are still no realized projects of subsea transportation of a multiphase flow for such long distances. However, the modern research methods and new technologies of subsea gas transportation control indicate technical feasibility of realization of multiphase gas transportation concept in principle.

For the first stage of the deposit development, the concept envisages producing of liquefied natural gas. To produce LNG it is planned to build a plant consisting of two trains with capacity of 7.5 million t/year each (Figure 4). The total area of LNG production plant will be more than 100 hectares. The site will incorporate production, off-loading, administrative and service complexes.
The following distribution of LNG supply volumes was accepted to define offshore transport system parameters: to the USA north-east - 4,35 MM tpy, to the Gulf of Mexico region - 8,51 MM tpy, to Europe - 0,95 MM tpy. When performing the transport system above optimization we have been studying variants of mixed fleet of gas carriers with the capacity of 155 Mm3 and 215 Mm3 and of fleet of only 215 Mm3 capacity gas carriers.

Gas carriers with the capacity of 155 Mm3 with bifuel diesel and electrical power plants and vessels with the capacity of 215 Mm3 with low speed diesels and re-liquefaction plants were accepted as the base variant. Gas containment systems with sphere type and membrane type tanks were considered as acceptable at that stage of work.

Nevertheless, the possibility of membrane type tanks use in hard wave conditions of Barents sea and Atlantic Ocean shall be the subject of further studies at the next stages of work. Low air temperature, ice availability at gas carriers routes during winter period are the main challenges to be taken into account during design and operation of gas carriers for Shtokman project.

Economic efficiency and flexibility of offshore LNG transport system are the principal criteria for definition of optimal gas carrier capacity. Gas carriers of lower capacity could be compatible with the majority of receiving terminals but transport expenses shall increase. The increase of gas carrier capacity result in decrease of LNG transport expenses.
Vessel dimensions analysis aiming to ensure the approach to existing and prospective terminals of USA north-east coast and mathematical simulation of transport operations have permitted to make a conclusion that the fleet of 12 vessels with the capacity of 215 Mm3 shall be the optimal solution for LNG export within the framework of Shtokman project.

With development of the Shtokman gas and condensate field the favorable conditions will be created in the region for arrangement of the whole complex of industrial and social infrastructure having big strategic and geopolitical importance. Implementation of the project will enable to develop economy of the region intensively with high economic effectiveness.

Technical concept of development of the Shtokman gas and condensate field proposes creation of an integrated production, transportation and procession complex, including:

- System of subsea field arrangement;
- System of offshore multiphase pipelines;
- Onshore system for support of subsea field arrangement and gas transportation;
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- LNG offshore transportation.

Liquefied natural gas production complex is planned for construction in the area of settlement of Vidyaevo (Murmansk region). LNG production will consist of the following principal units:

- Sour gas removal unit;
- Feed gas dehydration unit;
- Mercury removal unit;
- Gas liquefaction unit;
- Nitrogen extraction unit.

LNG storage is planned in the isothermal tanks. The storage system includes two tanks with capacity of 160 000 cubic meters each, operating under pressure of 30-45 bar (overpressure) and temperature minus 162° C.

There are vertical pumps installed in the tanks to feed LNG to the offloading system with capacity of 1250 cubic meters per hour.

Design capacity of the LNG offloading system is 20 000 cubic meters per hour.

It is planned to have not less than three hoses for offloading liquid product and one hose for returning gas vapors.

Loading of the LNG-carrier in normal mode with capacity of approximate 215 000 cubic meters lasts about 16 hours.

The project may have both big macroeconomic and geopolitical importance and significant potential with regard to the economic region and to the state in whole. The facilities of the designed system will be built on the territory of Russia:
On the continental shelf – production complex, offshore pipelines;

On the territory of Murmansk region – LNG production complex.

Implementation of the project allows to start gasification of the Murmansk region which is an important aspect of its development.

Investments in the facilities of gas industry will allow to intensify the activities of the adjoining industries, will promote the construction of new enterprises and modernization of the existing ones, will increase business activity in the region, will maintain the existing places of employment and provide for new ones.