accidents of injury and mortality caused by unpredictable weather conditions (storms, floods, etc.), growing number of infectious, parasitic diseases and cancer, acute and chronic illnesses, reproductive dysfunction [3, 7].

Efficient and safe development of Arctic resources is also complicated by transport-related and technological problems. Oil and gas activity in the Arctic region inevitably involves the use of stationary drilling and production platforms, ice-class vessels designed for ice navigation, exploration, and rescue operations under harsh Arctic weather conditions. Highly-developed port infrastructure that would meet international navigating requirements is also of great importance. Due to projected increase in cargo flows on the Northern Sea Route, it is of great importance to find the ways to reduce the discussed transport-related and technological risks. Here Russia's Arctic strategies are of great value as the Northern Sea Route is the historically formed national single transport communication of the Russian Federation in the Arctic. To guarantee cargo flow security on the Northern Sea Route, it is necessary to use up-to-date engineering facilities and provide highly developed infrastructure in Russian Arctic. However, currently these conditions are not sufficiently fulfilled. In comparison with other polar countries, Russia is characterized by insufficient level of infrastructure development in the northern regions. Therefore, the problems related to the applied technologies and infrastructure should be considered in a wider arena including political background [8] and political risks [2] of the Arctic region. Today, there is no well-developed international Arctic law. The legal status of the Arctic seas is defined by the principles and norms of the international law, precisely by 1958 Geneva Conventions on the Law of the Sea and UN Convention on the Law of the Sea which do not capture many legal aspects of the Arctic issues. There is no unique approach to define the Arctic borders as a geographical region with strict division into political and administrative regions of the Arctic countries and clear mapping of areas of their responsibility.

The basic findings of the current research are as follows: relationships of the Arctic countries, as well as the Arctic region itself, are intensively transforming. Due to interacting forces of climate change, globalization, social and economic trends, there is an urgent need to modernize the already existing models of the Arctic region development. The Arctic sustainable development is directly dependent on natural, social, economic, and political uncertainties which contribute to new risks. Based on our estimates and specific geographical and climatic conditions of the Arctic, we assume that uncertainties can emerge within any activity related to the Arctic development. The analysis of ongoing transformations allows us to define four basic groups of Arctic risks which could cause negative effects on a world-wide scale: natural risks, social and environmental risks, political risks, industrial and transport risks. To predict the likely level of harm, each group of Arctic risks is divided into catastrophic, critical, and allowable.

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OFFSHORE ICE-RESISTANT FIXED PLATFORM PRIRAZLOMNAYA

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Prirazlomnaya is an ice-resistant oil platform, designed to develop the Prirazlomnoye field in the Pechora sea. Currently, the OIRFP Prirazlomnaya is the only platform, extracting oil production on the Russian Arctic Shelf. The first shipment of Polar oil ARCO was shipped in April 2014 and in September 2014; the millionth barrel of oil was produced on the OIRFP Prirazlomnaya.

The platform is located 55 km north of the village of Varandey in the Nenets Autonomous District and 320 km north-eastward of the town Naryan-Mar. The license for the Prirazlomnoye field belongs to LLC Gazprom Neft Shelf (a subsidiary of JSC Gazprom Neft).

The platform is designed specifically for field development and carries out all required process operations: well drilling, oil production and storage and offloading to tankers, heat and electricity generation [1]. The unique feature of Prirazlomnaya is in that, for the first time, hydrocarbon production on the Arctic Shelf is carried out from a stationary platform in the severe conditions of ice fields.

The platform is designed for operation in extreme climatic conditions, meets the most stringent safety requirements and can resist ice loads. Offshore ice-resistant fixed platform (OIRFP) Prirazlomnaya is designed specifically for the project. It provides the implementation of all technological processes: well drilling, oil production and storage, offloading to tankers, power generation.

Prirazlomnaya is designed ensure the top level safety and security of oil production. The environmental parameters are designed with a large margin (for example, wave height is 10 m, which according to statistics happens every 100 years). Specifically designed a lower part of the platform (caisson) is capable to resist the Arctic climate. Three-meter concrete walls of the caisson are covered with inch and a half plated steel layer, corrosion and wear out resistant. Degree of safety of a lower part of the platform vastly exceeds actual loads. The platform base can withstand a direct torpedo attack. The upper part of the OIRFP protected against ice and wave action with a special wave and ice deflectors installed around the platform perimeter. The ice deflector is a wall of 16.4 m high, the inclined upper part of which prevents flowing over the incident waves [4].

The caisson is both the extracted oil storage and the oil storage system at the platform providing a wet method of feedstock placing in reservoirs. Due to this, the feedstock flow coming into reservoirs displaces ballast water. Otherwise, when oil loading into the tanker, the oil displacement process by ballast water is observed. Thus, the oil storage is constantly filled with fluid: oil or water ballast and this prevents oxygen from entering into the tank and therefore, preventing accumulation of explosive gas.

The platform is equipped with direct offloading complexes, operated on the crane system and provides tanker loading from the oil storage platform. Offloading is carried out through one of the bow loading system in relation to environmental factors (rough water, ice drift, wind and etc.). Special attention is paid to safety issues: offloading can be started only in case of synchronous observance of the necessary conditions. Offloading line to transfer oil to the tanker is equipped with emergency shutdown system, with is seven second response time [2].

The automated control and safety system (ACSS) is applied at the OIRFP Prilazlomnaya. The ACSS controls remotely and in an automatic mode the oil production, storage and offloading, electric energy generation and distribution as well as fire protection control. When the occasion requires the emergency shutdown of the equipment and processes occurs. The process is entirely automated, sothat the human factor is reduced to zero.

The platform operates in accordance with the "zero discharge" principle. Waste drill mud, drilling cuttings and other waste will be pumped into a special disposal well. Refined petroleum oil and oily water, polluted rainwater and snow are re-injected back into the reservoir [3].

Special meteorological Arctic conditions required fundamentally new and unique technologies for field development.

Table

The characteristics of the OIRFP Prirazlomnaya

Staff		200 people
weight	own	117 kt
	with regard to ballast	506 kt
dimensions	the total height	141 m
	the height of the caisson	24,3 m
	the caisson at the bottom	126 x 126 m
	the caisson in the upper part	102 x 102 m
Capacity of the caisson	tanks storage tank oil	12 pieces. (113 thousands m^3)
Performance	the plan on oil recovery on 2014	300 kt
	peak production (after 2020 y.)	5 mln tn per year
	period of shipment of oil (at maximum output)	6 days
Autonomy	change watches	30 days
	the replenishment of materials	60 days

For the project implementation, the offshore ice-resistant fixed platform Prirazlomnaya was established, which provides the all technological operations: drilling, production, storage, offloading, heat and electricity generation.

The platform length and width is 126 m, the weight is 117 thousand tons. Endurance for the food and fuel storage is 14 days, for technology and chemical stocks is 60 days, for drilling operation supplies is 40 day, accommodation building is designed for year-round accommodation and suitable for up to 200people.

The platform meets the most stringent safety requirements and can be adapted to work in harsh climatic conditions. It is designed to expect maximum ice loads the region. The OIRFP Prirazlomnaya is designed to ensure the top level safety and security of oil production [5, 6].

The sea depth in the field area in not than 20 meters, so the platform is installed on the seabed and is securely held due to its weight (500 kt) and protective stone and gravelberm.

Specifically designed substructure (caisson) is capable to resist the Arctic climate. For greater resistance to corrosion and wear out, its walls are made of inch and a half layer plated steel and three-meter space between them is filled with heavy duty concrete. The caisson part design is arranged so that it can withstand a direct torpedo attack. Safety

margin of a lower platform exceeds factual loads. All wells to be drilled at the field are located within the platform. The platform basement also serves as buffer between the well and the open sea.

Besides, the installed equipment is intended to prevent the uncontrolled oil and gas release.

Oil storage system at the platform provides a "wet" method of placing raw materials in reservoirs, which prevents oxygen passage and formation of explosive mixtures.

Mikhail Ulyanov and Kirill Lavrov, oil tankers of the strengthened ice class and deadweight (cargo weight) of 70 tons will provide year-round export of products. These vessels are specially designed to oil transport from Prirazlomnaya.

Offloading line to transfer oil to the tanker is equipped with emergency shutdown with a seven second response time.

Near the platform the Ice Breaking Emergency Evacuating Vessels are on permanent emergency duty, fitted with the latest oil recovery systems equipment for operation in winter conditions. In addition, at the banks of the Varandey settlement, the Oil Spill Response Equipment is located, which helps to protect the coastline.

According to the world's practices and the Russian legislation requirements, a detailed plan of prevention and response to possible oil spills was developed. Due to this, various scenarios of risk were considered, resources and manpower calculation for forming facility emergency organizations was made, professional units for prevention and management of Oil Product Spills and etc.

The design progress and construction of OIRFP can be divided into five stages:

1) Design and factory setting of the platform in the water area of the production association "Sevmash" in Severodvinsk;
2) The platform towing from Severodvinsk to Murmansk;
3) Further construction, completion and concrete ballasting of the platform in the water area of Kola Bay (Murmansk);
4) The platform towing from Murmansk to the field;
5) The platform installation in the field, back filling of protective berm, and start-up operations, drilling the first three wells.

In November 18, 2010 the initial construction phase of the platform was completed: the platform factory setting was accomplished in the production association Sevmash, the living quarter platform installation in OIRFP, preparatory works for the platform towing to Murmansk to the 35 shipyard.

During the period from 18 to 27 November 2010, the second phase was completed: the platform towing from Severodvinsk to the completion site of the substructure (caisson) - the 35 shipyard in Murmansk. For the platform transportation seven ships were used.

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MODERN TECHNOLOGIES OF OIL TRUNK PIPELINE SYSTEM CONSTRUCTION IN PERMAFROST ENVIRONMENT

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In the near future oil production levels will rise due to development of new fields, the majority of which are located in the regions of the Far North. Oil fields of the Yamal Peninsula, the North of Krasnoyarsk Krai and Yakutia are considered perspective areas; the potential of hydrocarbon extraction on the shelves of the Arctic seas is being currently discussed. Increasing volumes of production in this region demands the development of oil trunk pipeline system in extremely severe conditions.

The difficulty of pipeline construction in the region of the Far North is connected not only with features of climate, but also with special geocryologic conditions which occur due to permafrost. The term frozen soil refers to all types of soil having zero or negative temperature and containing the frozen water in the form of ice inclusions, which cement the soil. During the summer period thawing takes place in the top (active) layer of the permafrost soil, which, in its turn, causes and intensifies various physical-mechanical processes connected with soil movement. Soil rebound, cryogenic cracking, thermokarst can lead to pipeline displacement from the design position, change its stress-strain behaviour and cause emergency situations. Being transported through the pipeline, high viscosity oil is heated, which, in its turn, increases thermal impact on frozen soil and leads to significant increase in thickness of an active layer [2]. The