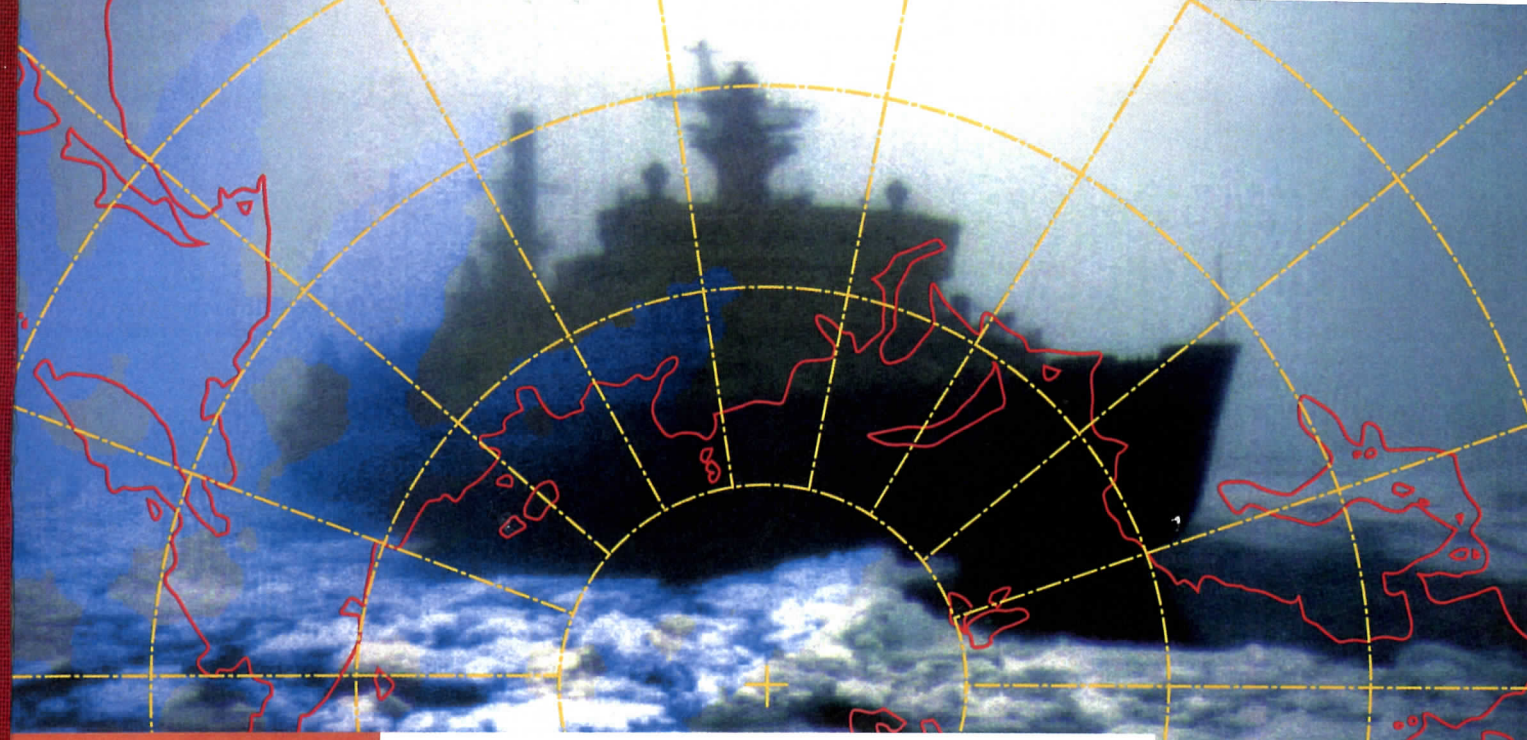

INSROP WORKING PAPER
NO. 89 - 1997, III.07.3

Marine Oil Transportation from Timan Pechora and Inland Russian Fields

By N. Isakov, A. Nikulin, N. Popovich and I. Sverdlov

INSROP International Northern Sea Route Programme

Central Marine Research & Design Institute, Russia

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Project III.07.3:	Marine Oil Transportation from Timan Pechora and Inland Russian Fields
Supervisor:	Yuri Ivanov
Title:	**Marine Oil Transportation from Timan Pechora and Inland Russian Fields**
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FOREWORD - INSROP WORKING PAPER

INSROP is a five-year multidisciplinary and multilateral research programme, the main phase of which commenced in June 1993. The three principal cooperating partners are **Central Marine Research & Design Institute (CNIIMF)**, St. Petersburg, Russia; **Ship and Ocean Foundation (SOF)**, Tokyo, Japan; and **Fridtjof Nansen Institute (FNI)**, Lysaker, Norway. The INSROP Secretariat is shared between CNIIMF and FNI and is located at FNI.

INSROP is split into four main projects: 1) Natural Conditions and Ice Navigation; 2) Environmental Factors; 3) Trade and Commercial Shipping Aspects of the NSR; and 4) Political, Legal and Strategic Factors. The aim of INSROP is to build up a knowledge base adequate to provide a foundation for long-term planning and decision-making by state agencies as well as private companies etc., for purposes of promoting rational decisionmaking concerning the use of the Northern Sea Route for transit and regional development.

INSROP is a direct result of the normalization of the international situation and the Murmansk initiatives of the former Soviet Union in 1987, when the readiness of the USSR to open the NSR for international shipping was officially declared. The Murmansk Initiatives enabled the continuation, expansion and intensification of traditional collaboration between the states in the Arctic, including safety and efficiency of shipping. Russia, being the *successor state* to the USSR, supports the Murmansk Initiatives. The initiatives stimulated contact and cooperation between CNIIMF and FNI in 1988 and resulted in a pilot study of the NSR in 1991. In 1992 SOF entered INSROP as a third partner on an equal basis with CNIIMF and FNI.

The complete series of publications may be obtained from the Fridtjof Nansen Institute.

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FOREWORD - INSROP WORKING PAPER

The present project "Marine oil transportation from Timan Pechora and inland Russian fields" seems to be a conclusive stage in the assessment of the development of trade and commercial shipping in the western sector of the Russian Arctic.

The preparation of the whole economic project of oil transportation from Timan Pechora and from the inland Russian fields in many respects exceeds the framework of this research in terms of tasks and scale. The present report includes the content of project II.1.3. taking into consideration Jorgen Ole Barenholdt's comments of 13 February 1996.

The authors of the project aimed to attract the attention of governmental circles and Russian and foreign investors to the idea of crude oil transportation from the shelf fields along the Northern Sea Route by sea vessels.

Sea transportation is not considered to be an alternative to pipelines. The use of sea transportation will enable us:

- to increase the reliability of fulfillment of contractual obligations to trade partners in Europe;
- to create more flexible systems for delivery of contractual volumes of oil to the world market by means of rational use of marine and ice-breaking vessels. At the same time, the economic feasibility of a sea transportation scheme is limited by the economic efficiency of new investments and by the necessity to solve the problems of Russian military enterprises converted to manufacture civilian production.

The project development is based on the materials open to publication, and in this respect, some special or economic information of commercial interest may be available to enterprises only in reduced and incomplete form.

The fact that many navigational and climatic conditions and ecological problems are shown in detail in some projects of other INSROP Sub-programs, is also taken into consideration.

The project's contents include:

- actuality of economic activity in the Russian Arctic;
- a list of certain technical decisions on the project's performance;
- limiting factors and possible risks in operation of the technological transportation system.

CONTENTS

INTRODUCTION

World energy problems. According to an official prognosis there is good reason to expect a certain growth of dependence of the majority of the developed countries on oil and gas imports in the next 15-20 years. For example, the demand for oil in the USA will increase two-fold by the year 2000 as against the present production level in the country. In accordance with data of the International Information Center on Gas (CEDIGAS, France), overall natural gas shortage in the countries of West Europe is estimated at 105 bln cu. m. by the year 2000 and up to 280 bln cu. m. by 2010.

There is a fast growth of natural gas consumption in the Far East, except Japan. An expected increase in natural gas shortage in Korea and Taiwan will come up to 35-40 bln cu. m. per year by 2000.

At present, about 3 mlrd t. of oil is annually extracted in the world. Approximately 58% of this quantity is shipped by sea which makes the tanker fleet one of the important and key elements in the world system of oil production and transportation. There are good prospects in Russia for the development of the tanker fleet and for its leading position in international trade.

Power resource potential of Russia. Positive known oil resources on Russia territory constitute 7-10% of total world resources.. Unexplored resources may reach 25% according to appraisal of western experts and 28-30% in accordance with the appraisal of the analytical service of "Germes".

According to information provided by Mr. U. Shafranik, the Minister of Fuel and Energy of the Russian Federation, Russia possesses 45% of the world gas and 23% of the world coal resources. In Siberia there is 85% of Russian gas, 75% of coal and 65% of oil.

Explored oil and gas resources which are presently available, are estimated at 2.5 mlrd. t. of oil and condensate and 50 trln. cu. m. of natural gas, being located in the Timano-Pechora and West-Siberian oil and gas provinces, and some areas of East-Siberia and the northern Far East.

Russian oil resources and industrial potential which make it possible to produce 400 mil. t. per year even in periods of crisis, guarantee that Russian transnational companies will become comparable to the leaders of international oil business in terms of sale volumes, capital and profit.

The main world trend of late XX - early XXI centuries is a shift of oil/gas extraction to the sea. Oil/gas production in the Arctic seas is thought to become the basis for development of the fuel-power complex of Russia.

Prospects of industrial developments for the next 20-25 years are also connected with these regions and with large-scale development of shelf fields of the Barents, Pechora and Kara Seas where more than 40 prospective fields with total resources of more than 1.25 mlrd. t. of oil and 13.7 mlrd. cu. m. of gas, have been explored.

An essential part of geological work and raw material sources for oil and gas industries is concentrated in the Nenets autonomous okrug (district) and the south-eastern part of the White Sea. Besides, the shelves of the Kara and Barents Seas are regions of industrial activity. The prospective oil and gas areas are 126,000 sq. km. that is one third of the Timano-Pechora province, where 2.5 mlrd t. of oil (60% of oil potential) and 1.17 trln. cu. m. of gas (45.1% of overall resources of European part of Russia) are concentrated.

The transition of oil and gas industries to market relations is difficult and characterized by transformation of the whole economic model. New approaches to management of industries with the assistance of state regulation of economic relations, require application of market organizational structures and integration of industrial development with due regard for the conditions of the North.

Transportation problems. Potential volumes of hydrocarbon transportation by sea from the Arctic regions are estimated at 55 mil. t. per year till 2010, including: up to 30 mil. t. of crude oil, 2 mil. t. of oil products and condensate, more than 20 mil. t. of LNG.

The first part of project III.1.3 (1994) is supplemented to this edition. Some aspects of development of oil fields along the NSR are here given in detail. Technical suggestions concerning tankers and roadstead transshipment terminals have been elaborated, and demands for technical means have been determined according to the versions of the main project.

In the present paper an attempt is made to present the results of studies on the marine transport of Russia and give quantitative assessment of the scale of the Arctic Marine Transportation System development for the solution of the problem of oil export from northern regions with due regard for oil potential production up to the year 2010.

1. CHARACTERISTICS OF RAW MATERIAL SOURCES OF THE NORTH-WESTERN RUSSIAN REGIONS

1.1. Timano-Pechora oil & gas province

The development of oil and gas industries of Russia to a large extent depends on settling clashes of interests brought about by the process of structural economic changes. The fact that oil and raw material production crisis automatically causes the reduction of specific consumption rates, need not be the case because the rationalization of consumption requires new technologies and consequently - considerable investments.

Essential oil, natural gas and condensate resources are concentrated in the northern regions of the European part, Western and Eastern Siberia of the Russia Federation, in the shelf regions of the Arctic and Far Eastern Seas. These regions give more than 85% of oil and natural gas and 70% of condensate currently being produced in Russia.

West Siberia will be the main region of oil production for the long-term outlook. Extracted oil resources in the northern regions of West Siberia are estimated at about 2 000 mil. t. of oil equivalent by 1995.

Industry development prospects for the next 20-25 years are also closely connected with these regions and with considerable extension of the development of shelf fields in the Barents, Pechora, Kara and other Arctic and Far East seas.

The state enterprise "Arkhangelskgeologia" has conducted systematic research into energy-fuel and mineral-raw material resources of the Arkhangelsk area and the Nenets autonomous okrug (district) since 1975. The results permit to conclude that the above region has a strategic position in terms of explored resources and known fields of hydrocarbon of the North of the Russian European region. Further development of prospecting, exploring and extracting oil and gas resources will enable the country to maintain the importance of the region as well as to keep a leading position in hydrocarbon material production in the European North and Russia as a whole.

The Arkhangelsk region has discovered 76 oil and gas fields, 45 of which have been exclusively explored by "Arkhangelskgeologia", which received the right to the whole complex of geological works from prospecting to processing natural resources; this right is reflected in the enterprise's constitution. "Arkhangelskgeologia" provided a great volume of work in surveying and prospecting the fields.

The raw material resources covered by this work are estimated at 1.3 bln. t. for oil and 1.17 trln. cu. m. for gas by the end of 1994.

The main front of geological prospecting and many sources of raw materials for oil and gas industries are concentrated in the Nenets autonomous okrug (district) and in the south-eastern part of the White Sea. A prospective oil and gas area embraces 126 000 sq. km. that is one third of the province with 60% of potential oil resources and 45.1% of gas in overall resources of the European region of Russia.

The scheme of sea basins of the Barents and Kara Seas with adjoining shores from the viewpoint of geological and geophysical investigations is shown in fig.1.1.

A general map of oil and gas fields of the Murmansk and Arkhangelsk areas is given in fig. 1.2.

1) Peschanoozerskoe, OGC
2) Juzhno-Hylchunsskoe, Go
3) Varandeyskoe, O
4) Inzyreyskoe, O
5) Toraveyskoe, O
6) Toboyskoe, O
7) South-Toraveyskoe, O
8) Oshskoe, O
9) Naulskoe, O
10) Zapadno-Komandishorskoe, O
11) Lobaganskoe, O
12) Voreyskoe, O
13) Trebsa, O
14) East-Panemdeyskoe, O
15) Titova, O
16) Murmanskoe, G
17) Visovskoe, O
18) Severo-Kildinskoe, G
19) Sediaginskoe, O
20) Shtokmanovskoe, GC
21) Ludlovskoe, GC
22) Prirazlomnoe, GC
23) Korovinskoe, OGC
24) Severo-Saremboiskoe, OGC
25) Niadeiusskoe, O
26) Kumdjinskoe, GC
27) Stepkovojskoe, O
28) Vasilkovskoe, GC
29) Khasyreyskoe, O
30) Vaneyvisskoe, GC
31) Chernausskoe, O
32) Laiavojskoe, OGC
33) Khosolbinskoe, O
34) Khylchunskoe, OGC
35) Hosedansskoe, O
36) Jareysskoe, OGC
37) Kolvinskoe, O
38) Severo-Guliaevskoe, OGC
39) Mejdurechenskoe, O
40) Pomorskoe, GC
41) Srednemakarinskoe, O

Where O - oil, G-gas, OG-oil and gas, GO-gas and oil, GC - gas and condensate, OGC-oil, gas and condensate.

Important prospective programs up to the year 2005 are the programs of development and production of hydrocarbon raw materials in the following basic regions:

- Oil production - Severo-Khoreyverskiy, Severo-Kolvinskiy, Central-Khoreyverskiy, Kolguevskiy, Denisovskiy;
- Gas production - Narian-Marskiy.

The extraction of oil in the Ardalinskiy and Peschanoozerskiy fields has started already. "Arkhangelskgeologia" under contracts with scientific design institutes, has prepared 8 projects on the complete development of oil fields and started to carry them out according to ad hoc programs:

1. Program on the western zone fields of the Severno-Khoreyverskiy region.
The program provides for development and extraction of oil from the basic explored fields of the zone (P. Trebs, A. Titov, Taraveyskoe, Varandeyskoe) up to the year 2000, exploration and exploitation of promising fields (Luzhno-toraveyskoe, Naulskoe, Lobaganskoe, Passedskoe, Sediaginskoe) up to 2025 and further on.

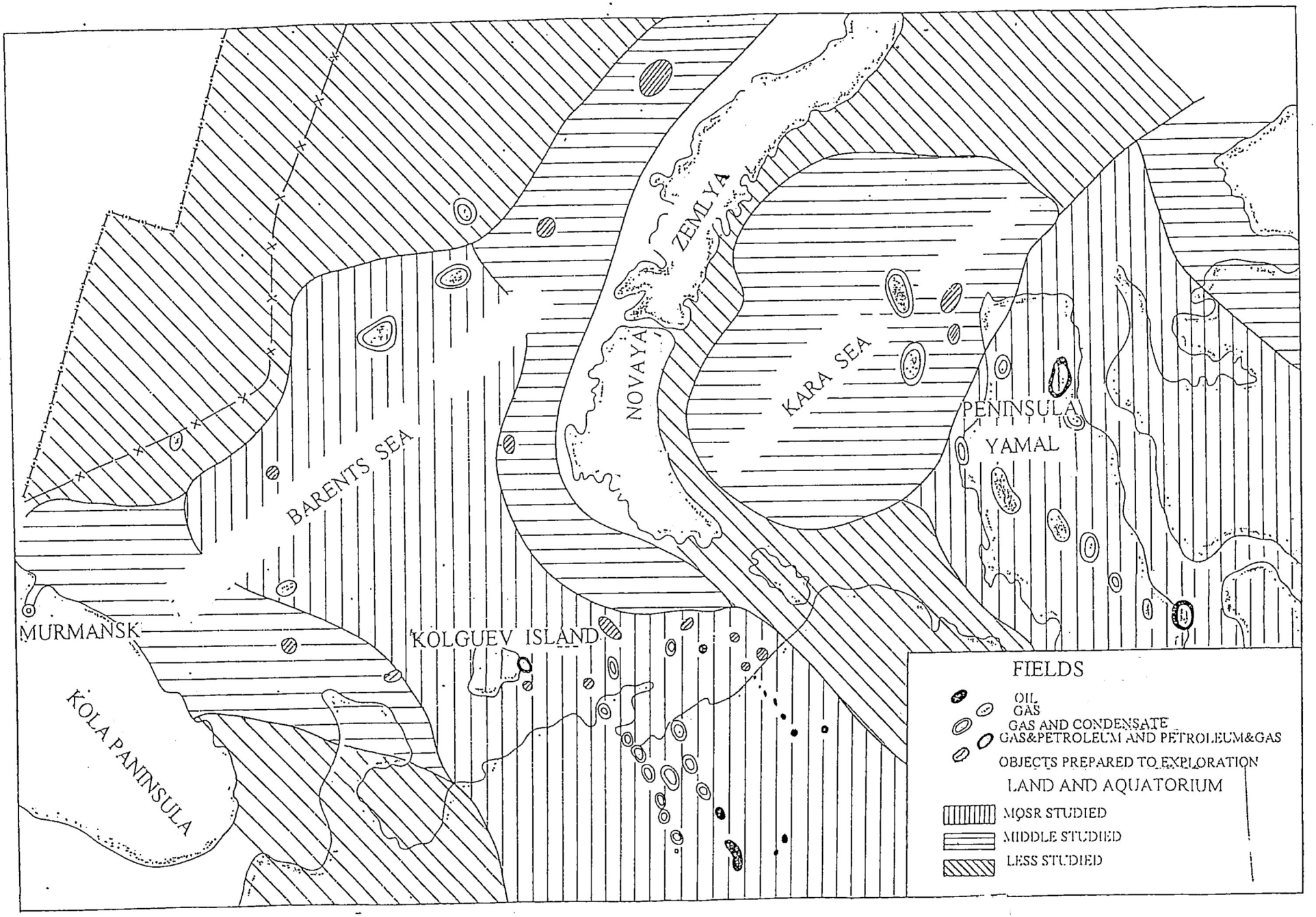

Fig.1.1. SCHEME OF GEOLOGICAL AND GEOPHYSICAL DEVELOPMENT

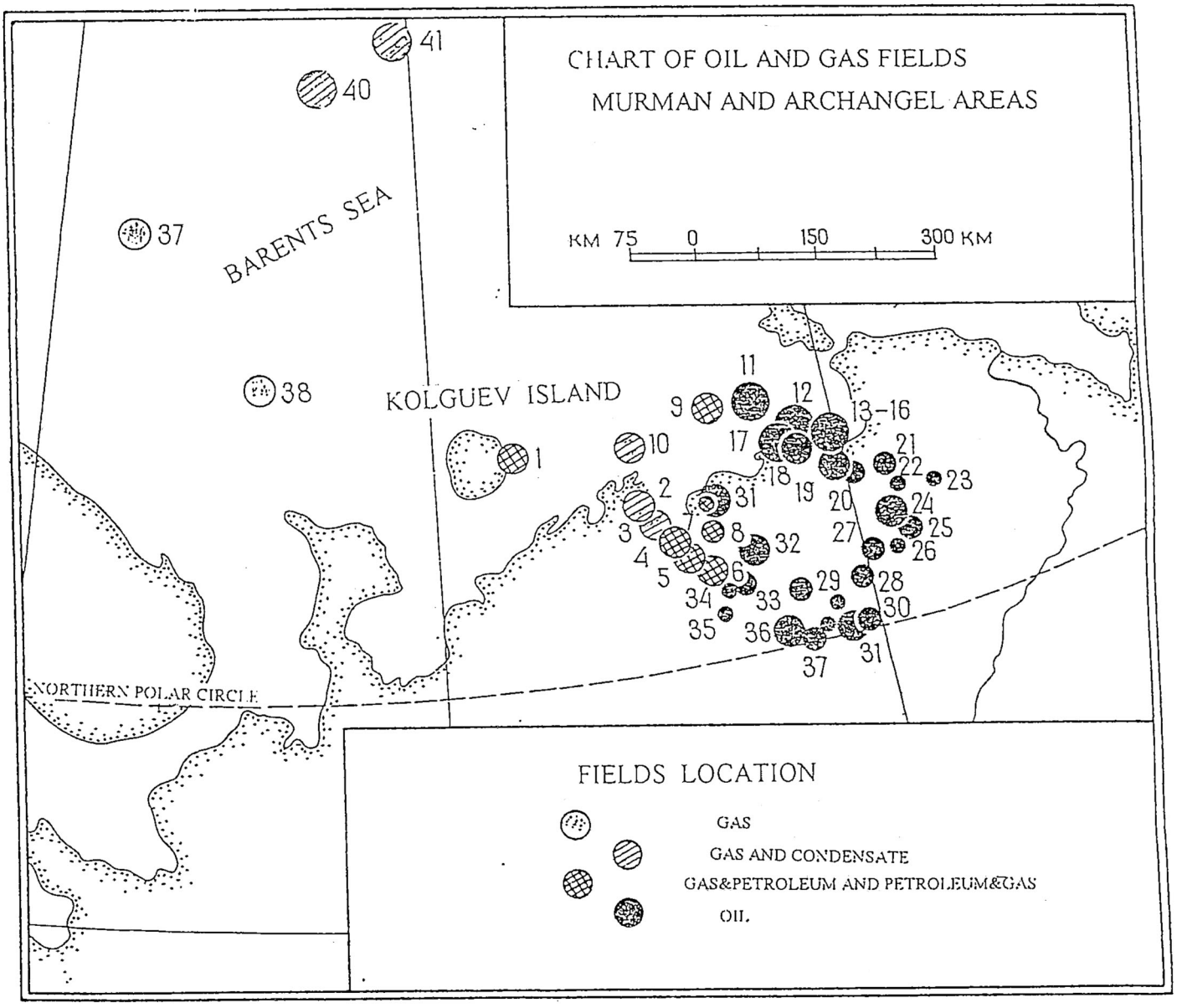
CHART OF OIL AND GAS FIELDS
MURMAN AND ARCHANGEL AREAS
KM 75 0 150 300 KM
BARENTS SEA
KOLGUEV ISLAND
NORTHERN POLAR CIRCLE
41
40
37
38
1
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35
36
37
FIELDS LOCATION
GAS
GAS AND CONDENSATE
GAS&PETROLEUM AND PETROLEUM&GAS
OIL

Fig.1.2

2. Program on the Varandey-Adzvinskaya zone of the Severno-Khoreyverskiy region.
This program provides for development of oil fields and extraction of oil from the basic explored fields (Lobaganskoe, Passedskoe, Sediaginskoe) before and after the year 2025.

3. Program on the fields of the Severo-Kolvinskiy oil region.
The program focuses on development of oil fields and extraction of oil from the basic fields of the Luzhno-Khylchuskoe region up to 2000, exploration and development of promising fields in the Jareynskoe, Khylchuskoe, Inzureyskoe, Saratajuskoe, Severo-Khariaginskoe regions up to 2025 and further on.

4. Program on the fields of the Ardalinskaya zone of the Central-Khoreyverskiy region (Joint Company "Polar Light")..
The program provides for development of fields and extraction of oil from the Ardalinskiy, Oshkotynskiy, Vostochno-Kolvinskiy, Djusushevskiy fields before and after 2000.

5. Program on the fields of the Tedinskaya zone of the Central-Khoreyverskiy oil region.
The Program provides for development of fields and extraction of oil from the Tedinskiy fields zone up to 2000 and further development of the field named after U. Rossihin before and after 2025.

6. Program on the fields of the Central zone of the Central-Khoreyverskiy region.
The aim of the Program is development of oil fields and extraction of oil from the Zapadno-Khosedajuskiy, Sihoreyskiy and furhno-Siurharatinskiy fields up to 2000, exploration and development of the promising fields of this zone (Visovoe, Severo-Hocedajuskoe, Sjurharatinskoe, Urernyrdskoe, Piusejskoe, severo-Sihorejskoe, Vostochno-Sihorejskoe, Severo-Oshkotynskoe, Vostochno-Janemdeyskoe, Verhnekolvinskoe) prior to and after 2025.

7. Program on the fields of the Kolguevskiy region.
This program provides for development of fields and extraction of oil from the Peschanoozerskiy fields of Kolguev island up to 2000 and further with prospects of development of the Tarkskiy fields up to 2025.

8. Development of and gas extraction from the Narian-Mar region fields.
This program provides for development and gas extraction from the Lajavorhskoe fields before and after 2000, exploration and exploitation of promising fields of the region (Vanejviskoe, Kumzhinskoe, Korovinskoe, Shapkinskoe) before and after the year 2025 .

Shtokmanovskoe gas and condensate fields .

Estimated resources are as follows: gas - 2.9 trln. cu. m., condensate - 21 mil. t.

A basic version of annual gas production of about 50 bln. cu. m. and condensate production of 700.000 t. has been elaborated in the feasibility study. The study's findings envisage that the construction of two sea ice protected stationary platforms (SISP) at depth of 300-320 m. and drilling of 120 wells will be carried out.

The pipe lines coming from the Shtokmanovskoe field will be connected to the united Russian system of the main pipe line Griazovec-Volkhov-St.-Petersburg.

Prirazlomnoe oil field.

The field is in the south-eastern part of the shelf zone of the Pechora sea, 320 km from the river port of Narian-Mar and 960 km from ice free sea port of Murmansk. This field is medium-sized field in terms of oil resources. Dimensions of the field are 13.8x3.5 and 7.6x2.6 km. Maximum annual level of oil production is 5.8 mil. t.

The Prirazlomnoe oil field is located in the tundra zone where pipeline network and infrastructure are absolutely undeveloped. The nearest pipeline belongs to the Transneft company formerly owned by the Ministry of Oil Industry.

The pipeline starts at Khartjaga and runs inside the mainland. The fact that the pipeline from sea shore to Khartjaga has not been laid, creates oil transportation problem to be solved.

The development of the Prirazlomnoe field is being carried out by the Rosshelf company , 40% shares of which belong to the Archangel region.

The oil of this field is characterized by high viscosity, tar content, low content of paraffin and, besides, it contains sulphur of lower gas factor. The petroleum gas contains hydro-sulphur.

At present, 140 oil fields have been defined in the Timano-Pechora Province, including 73 fields which are in a region of the Komi Republic; 39 gas fields have been defined in the Province , 28 of which are in the Republic.

Fields structure is characterized by the following indices:

Volume of annual extraction		Time of exploitation	
More than 1 mil. t.	- 3	Up to 5 years	- 8
From 100 till 1000 000	- 9	Till 15 years	- 3
Less than 100 000 t.	- 8	More than 15 years	- 9

Resources of the fields being exploited, predominate in the province (62.0 - oil, 78.0 - gas), resources prepared for industrial development are not available and share of field resources being explored is comparatively small.

Light oil is predominant in the province in terms of composition by fractions. Other products are mainly of high viscosity, hardly produced and two third of paraffin oil. Small and medium contents of sulphur (0.05 - 2.0%) may be considered as an obvious asset of the province oil.

Gas of the province is rich in valuable components. Up to 45% of resources are ethane containing gases. There are gases with higher contents of hydro-sulphur (0.0014%).

Helium belongs to valuable gas components. The share of helium containing gas among total resources comes to 13.5%.

The main part of exploited fields has low productive wells; the production of these fields are coming down now. Large fields (Usinskoe, Voseyskoe) provide about two third of oil

extracted in the Republic. The larger part of comparatively new fields (Kyrtaelskoe, Rosjuskoe, Beregovoe etc) are small fields.

Of a total amount of the oil produced, the share of high viscous, anomalous oil is increasing and its production is characterized by lower rate of oil pool yield. The technical aspects of deparaffinization of the northern oil have not yet been solved. Corrosion activity and water contents keep on growing (70%).

Further prospects for increasing of oil production in the Timano-Pechora oil and gas province (TP OGP) are closely connected with the development of adjoining territories of the Arkhangelsk area and the shelf.

Geological materials and resource assessments show that oil production in the Timano-Pechora Province could be increased up to 37 mil. t. per year by 2010.

An important task which determines, in the long run, the efficiency of the oil and gas complex of TP OGP including SC "KomiTEK", is diversification in the use of hydrocarbon products. The increase of diversification in the use of oil, strongly depends on the maximum output of final products taking into consideration the qualitative composition of oil. Therefore, the development strategy in oil processing should be provided for the following three directions:

- specialization of the Ukhta oil processing plant (O.P.) for handling light oil of high quality and unique Jareg oil;
- organization of a new northern O.P., specializing in processing high viscous oil under modern technology of the world standard;
- use of autonomous oil processing module installations for the fields with an output of 50-100 thous. t. per year each.

Calculations show that in case of the conversion of the Ukhta O.P. to the processing of light and heavy oil mixtures which is in progress now, the plant will lose up to USD10 per ton due to fall of oil quality.

In order to solve the problem of separate shipments of oil products of different quality, and establishment of a new northern O.P. for handling high viscous oil produced in the Komi Republic and Nenets autonomous okrug of the Arkhangelsk region, it is necessary to use modern technology of the world level; foreign investors could help us to solve this problem.

Orientation of Ukhta O.P. towards processing light oil and heavy Jareg oil would, to a great extent, solve ecological problems due to favorable location of the plant in Ukhta.

Gas industry

The Timano-Pechora province has practically no possibilities to increase gas production because there are no available large gas fields which have been prepared for the development. Therefore, all attention must be concentrated on geological works, exploration and development of oil fields. The development of gas industry in coming years will depend on the conditions of further exploitation of gas and condensate fields (Vuktylskoe, Zapadno-Soplesskoe, Pechorgorodskoe, Pechorokorhvinskoe as well as Narjan-Mar group of fields).

Exploration and the development of hydrosulphur gas fields of the Intin region will enable the country to provide an additional gas volume of up to 3.0 bln. cu. m. per year by 2005. It should be noted that the development of gas resources of the Intin region requires considerable expenses on maintenance of the plant designed to process gas with high content of hydrosulphur and on environmental protection; so these circumstances may considerably postpone starting date of the project realization.

Simultaneous use of petroleum gas of the Usinskiy area and natural gas of the Pechorogorodskiy and Pechorokorhvinskiy fields will require re-analysis of the existing system of gas supply for regional consumer. First of all, the scheme of gas supply for the Pechora power station must be changed and the possibility of utilization at this station of "dry" gas coming from the fields of the Nenets autonomous okrug (district) should be taken into consideration. Therefore, the coordination with a view to put into operation gas and gas & condensate fields of the Nenets autonomous okrug, and construction of CGC will be required. When projecting CGC, it is necessary to research in detail the problem of site choice (suggested area is at a distance of 10 or 25 km from Sosnogorskiy GPP) and take into consideration the area of the town of Vyktyla among others, where the problem of employment of the able-bodied population is aggravated by the reduction of gas and condensate output of the Vyktyla field.

The production of liquefied natural gas (methane) is expected to meet the requirements of railway transport with an output of 5.000 ton a year. Further development of the network of automobile gas compressing stations in the towns of Embe and Vyktyl capable to provide about 125 installations a day, is in progress now.

It is reasonable to inculcate new methods of increasing of oil production per unit of oil field area which will require the growth of volume of fuel gas used for steam generators and for other purposes by 2-2.6 bln. cu. m. per year. When estimating balance between the production and use of natural gas, especially in the northern areas of the Timano-Pechora province, it is necessary to provide for replacement of petroleum gas, which as was mentioned above will be pumped to the CGC for producing polyethylene, by natural gas coming by the pipe line "Jamal-West".

The construction and operation of pipe lines of the "Jamal-West" system will exert a great influence on the economy of the Komi Republic. Approximately 77 000 workers will be involved in its construction. Thus, there is a necessity to conduct a series of scientific research works and carry out expert examinations in order to determine a rational location of this system on the territory of the Republic taking into account its economic interests.

1.2. North-Western oil and gas province

For the last three decades the oil and gas complex of the north - western area has been the main source of Russian oil production. This area embraces fields of the Kara Sea shelf, Jamal Peninsula, Ural range, Tatarija, Bashkirija, Khanty-Mansijsk autonomous okrugs (districts).

The Kara Sea Shelf and Jamal Peninsula.

It embraces 27 fields of natural gas, oil and condensate, including:

Phersmanov Structure - 700 km north-east of Murmansk. "Arktikmorneftegasrasvedka" license;
Rusanov structure - 1300 km north-east of Murmansk. "Arktikmorneftegasrasvedka" license, prospective reserves;
Leningrad Structure - the Jamal peninsula, "Arktikmorneftegasrasvedka" license, prospective reserves;
Bovanenkovskoe - the Jamal peninsula;
Novoportovskoe (oil and gas);

Ural.

Krasnouphimskiy district (oil and gas) - North of the Sverdlovskaya area. "Uralneft" license;
Ivlelskiy district (oil and gas) - North of the Sverdlovskaya area. "Uralneft" license;
Kedrovskoe and Bukharovskoe (oil and gas) - North of the Sverdlovskaya area.
Ereminskaya Group (oil) - North-East of the Sverdlovskaya area.

Tatarija

Romashkinskoe (oil) - South-East of the Republic
Elkhovskoe (oil) - South-east of the Republic
Oubijskoe (oil) - oil reserves

Bashkirija (105 fields)

Shakshinskoe (oil) - Uphimskiy district, "Bashmineral" licence (JV Bashkirija, Hungary and Canada);
Phjodorovskoe (oil) - Blagoveschenskiy district;
Veselovskoe (oil) - Burajskiy district.

Khanty-Mansiyskiy autonomous district

Pajtykheyskoe and Vostochnoinginskoe (oil); Vostochnoperevalnoe (oil); Selijarovskoe (oil); Verkhnekondinskoe and Vostochnoturgovskoe (gas);
Zapadnovarjeganskoe (oil) - Tjumen area. Total extracted oil is 3.2 mln t;
Tagrinskoe (oil) - Tjumen area;Roslavlskoe (oil); Priobskoe (oil); Verkhnesalymskoe (oil); Salymskoe (oil); Zapadnosalymskoe (oil); Tailakovskoe (oil); Polukhnijahskoe (oil); Symorjahskoe (oil); Talnikovoe (oil); Valjuninskoe (oil); Barsukovskoe (oil).

Since 1995, in the basin of the Enisey river, "Eniseyneft" ltd. has started to develop the Vankorskoe oil field situated on the territory of the Turukhanskiy district of the Krasnojarskiy area about 125 km to the west of Igarka. It is supposed that crude oil will be delivered through

pipe lines to Igarka or Dudinka and then shipped by shuttle-tankers to the Russian border point (Pechenga).

There are prospects for the Vankorskoe field to function through the main pipeline to the Suzunskiy, Lodochny and Tagulskiy fields. This branch-line will be connected to the system of the Purp Transneft pipe lines and put into operation by 2000.

Kharasavey field.

Export pipe-line volume of natural gas from Russia to the countries of West Europe comes up to about 100 bln. cu. m per year. Under conditions when the developed material and technical base of LNG is existing in Europe, this fact appears be a decisive factor of formation of a long-term flexible technical policy of Russia in the international sale of the most important hydrocarbon raw materials .

Gas delivery is possible by means of two alternative transport modes: pipe-line and marine transport. Natural gas transportation by sea vessels is more ecologically safe due to the fact that the construction of gas pipe lines in the northern areas under conditions of continuous cold weather leads to the destruction of soil cover, for revival of which a few decades must pass. The destruction of upper layer of tundra zone leads to the development of unrecoverable processes caused by the upset of balance in nature.

1.3. Exports volume.

The development prospects for certain oil and gas fields in the northern areas and on the shelf of the Russian Arctic seas with participation of the marine transport on a share basis are analyzed in the following sub-projects prepared for realization:

1.Timano-Pechora province fields - calculated transportation volume grows from 4 mil. t. to 25 mil. t. per year. Transportation versions provide for transportation by sea tankers;

2. Priobskoe and Barsukovskoe fields - it is supposed to transship to marine transport up to 5 mil. t. of oil and approximately 1 mil. t. of oil products through new terminal in the Ob Bay (Kamenny Cape area);

3. Vankorskoe field - there is a possibility of transshipment of about 1 mil. t. of oil per year to the marine transport.

4. Kharasaveyskoe natural gas field - according to the developed project, it is recommended to export up to 46 mil. cu. m. of natural gas by gas - carriers (INSROP Project III.07.4).

These volumes should be assumed for analysis of the economic figures of tanker shipment for the future.

1.4. Commercial interests of foreign partners

Oil quality and volume of resources became an object of growing interest of foreign partners - potential investors in the development of fields and raw materials production. This interest was increasing while geological works and estimation of resources of the Timano-Pechora province were being carried out.

The interests of foreign investors, as foreign press writes, is that in which "...they can not overcome the temptation of giant non-owned reserves of the cheap raw material like oil. Russian assets are considered to be fantastically cheap".

Actual activities of foreign investors penetrating into the province, have taken a scandalous character when economic situation in Russia starts changing for the worse. In particular, due to the fact that JSC "Arkhangeskgeologia" has no experience of cooperation with foreign firms, the American company "Texaco", being an equal right partner, makes an attempt to be the only managing company authorized to control all oil fields of the province and proposes principally new cooperation: not establish a JV, but act on a "Production-Sharing" basis (that is a product share distribution with excluding the partner from its own profit share); and what is more, the fact that JSC " Arkhangelskgeologia" has made a great contribution to geological exploration work in the province, is not taken into consideration. Western oil and gas companies follow this principle in the third world countries.

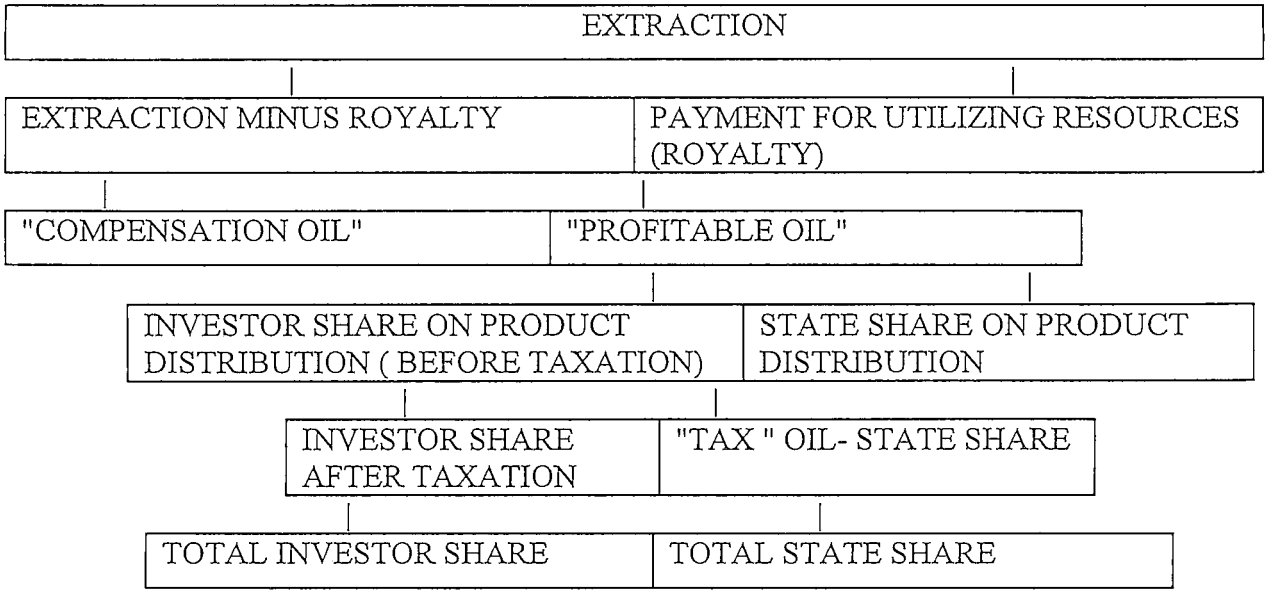
The situation around the province, is explained by the absence of national Law on resources, regulating the order and interrelation of authorities of all levels and enterprises, including foreign partners taking part in the product distribution.

In this respect, the discussion and adoption by the State Duma (Parliament), after the first hearings, on February 24, 1995 of the Law " Agreement on the Product Distribution" are a progressive step aimed at regulation of the utilization of natural resources. In case of its final adoption, the normative basis for attraction of large investments in the research, exploration and extraction of hydrocarbon and mineral raw materials, may be created in Russia.

According to the principle laid down in the draft Law, investors receive a part of the extracted material, for instance oil, as a compensation of their expenses. The proportion of further distribution (remaining) between the state and investors depends on the actual profitability of the capital investments. This distribution must provide profit and rent for the state, and returns on capital - for the investors.

The mechanism of the extracted oil distribution, in accordance with the Law, is shown in fig.1.3.

Fig.1.3. Mechanism of the extracted oil distribution in Russian model of the product distribution agreement*



* Journal "Commersant" N9, 14 March 1995

2. TECHNICAL DECISIONS ON THE FLEET

2.1. Conception of formation of Arctic sea transportation system for oil and gas exports

A great number of oil and gas fields is located on the shelf of the Arctic Ocean. In this respect the actual question is to make use of marine transport during development of this area.

Advantages of the development of a marine transportation system as compared to pipe lines, are as follows:

a. sufficient working flexibility for prospective consumers and desirable independence at the external market;

b. smaller specific capital investments owing to reduction in metal consumption and labor input, implementation of progressive module methods of high productivity and shortening of start-up periods;

c. reduction of the land utilized for the marine transportation system as compared to that needed for construction of pipelines and their maintenance etc. In order to formulate the conception, let us take into consideration the conditions of establishing an Arctic marine transportation system within three aspects: technical, organizing and economic.

Technical aspect defines two versions of the shipbuilding policy realization:

- construction of ice classified tankers of higher strength intended to be escorted by ice-breaker in ice conditions in spring, winter and late autumn ;
- use of ice-breaking tankers capable of sailing autonomously along the main routes in the Arctic.

In the first version, the sizes of cargo ships are adequate to operating potential of ice-breakers, ensuring escort of these ships in ice.

The main requirement to the second version is the ability to navigate without ice-breaker assistance along the main routes, and the use of such ice-breaker assistance in ice when maneuvering in narrow passages and in port water areas.

At the present time, the development of sea cargo fleet is mainly being carried out under the first version.

Organization aspect characterizes two versions of working organization of tanker fleet within the following structures:

- Main waterway-feeder transport-technological system (TTS) of oil and gas exports from the Arctic fields with the transshipment at an intermediate terminal in an ice free port of the Kola Peninsula (for example, the ports of Pechenga, Teriberka);
- Main waterway transport-technological system of oil and gas exports from the Arctic fields without the above transshipment;

Main waterway-feeder TTS of transportation of oil and gas ensures that carriages are performed by two transportation schemes:

- the first transportation scheme includes operations of Arctic going ships from the field to an ice-free port of the Kola Peninsula. A key transportation task according to this scheme is to finish the process of production of oil (gas) and to make it meet the requirements of the world standards in terms of quality of product itself and of its marketable appearance (type of a ship, quantity of goods in one shipment, time of delivery and others); In this connection more intensive application of expensive ice-breaker fleet in the Arctic Seas should be provided.
- the second transportation scheme - from an ice free port of the Kola Peninsula to a customer in one of the European ports - is similar to traditional world schemes of oil and gas transportation, both in selection of tanker sizes and in contractual terms of carriages.

Main waterway TTS of oil/gas transportation provides the direct carriages from the field area for export. The main requirements to the ships (ice class, architectural-constructive type, type of engine and power etc.) according to this version correspond to those accepted for Arctic going ships with a maximum cargo and carrying capacity. A deadweight of Arctic going tankers in some foreign projects varies from 120000 t. to 200000 t. .

In this version, a positive task of producing goods (oil, condensate and others) corresponding to the world standards under conditions of development of several fields could be problematical, and this fact naturally will be reflected in goods price.

A domestic experience of sales of oil and gas consists in transportation of hydrocarbon raw materials through pipelines to our borders (trade counter), where they are sold and transported further to consumers either via the foreign pipelines or by Russian or foreign ships.

This policy is realized to the full by means of organization of the main waterway-feeder TTS of oil/gas exports from the Arctic fields through an ice free port of the Kola Peninsula.

Organization of operation of transport and ice-breaker fleets is a traditional kind of regular cargo carriages in the Russian Arctic. The shipping companies of Russia have collected a rich semi-centennial experience in shipping planning and management in the Arctic both in summer period of Arctic navigation and in winter when some ships are engaged in experimental commercial voyages on the Dudinka route.

An economic aspect characterizes the integrated value assessment of the versions of oil/gas transportation from Arctic fields for export, including compensation expenses on the environmental protection.

Economic efficiency assessment for organization of the main feeder TTS enables us to consider the feeder transportation of hydrocarbon raw materials from the Arctic fields to an intermediate ice free Kola port as an industrial transport which continues the oil/gas production process.

Economic efficiency assessment for organization of the main TTS for the direct export transportation of hydrocarbons from the Arctic fields is restricted by the feasibility to obtain only 50% income (under standard conditions of agreement with foreign firms).

Simultaneously, the losses resulted from the part or complete chartering of foreign vessels should be evaluated to ensure the transportation of own commodities provided that domestic fleet is lacking.

An adverse tendency for foreign shipping companies is a certain growth of capital expenses due to acquisition of more expensive Arctic going tankers and an increase in transport current expenses caused by rather high payment for work with Arctic bonus, ice-breaker escorts, other dues (transportation insurance, port charges, cargo handling operations , etc.) as well as by risks of disturbing regularity of transport process due to force-majeure circumstances.

When assessing economic priority of the main feeder TTS vs. the main TTS, one also needs to take into consideration both the priority of field development and priorities of Russia (strategic, political etc.) in the Arctic zone, and also the necessity of economic cooperation with the developed northern regions in processing raw materials up to the world standard.

Thus, the formation of the Arctic marine transportation system for the purpose of development of fields and transportation of hydrocarbons from the Arctic areas, should be performed on the basis of:

1. Construction of Arctic going vessels which meet both the requirements of navigational limits and technical capabilities of the ice-breaking fleet.
2. Organization of reliable feeder transportation system operating from the Arctic fields to an ice free Kola port.
3. Economic interests of indigenous peoples of the Extreme North, oil/gas production enterprises and Russian shipping companies.

Realization of the suggested conception for the formation of the Arctic marine transportation system may be successful when a number of political decisions of first priority are taken and complied with.

2.2. Scientific - technical and normative potential as a basis for the marine transportation system development for exports of oil and oil products

The modern stage of development of the Arctic Marine Transportation System is characterized by special conditions after the dissolution of the Soviet Union into a row of independent states; this process leaves Russia without important ports in the West and South which earlier received about 50% and more of the branch's investments for their development. Russia has suffered great losses of the specialized marine fleet: LASH carriers, RO-RO vessels, ferries, gas and chemical carriers, ice going tankers. As a result, the Arctic cargo fleet, first of all, tanker fleet is growing slowly as far as the expensive ice-breaker fleet is concerned.

The slow-down in the development of the marine transport restricts in its turn the development of the Arctic fields rich in hydrocarbon as well as the development of new fields using alternative kinds of transport - pipe or railway; besides, this slow-down may result in considerable ecological harm to vulnerable tundra zone.

Oil and gas transportation through pipelines crossing territories of CIS and the Baltic countries is often not effective due to stringent transit requirements applied by these countries. Thus, an increase in role of the Arctic Marine Transportation System and its social and economic significance for the foreseeable future leads to the change of geopolitical situation around Russia.

The development of natural resources of the North as well as the initiation of international shipping in the Arctic including transit transportation between ports of the Atlantic and Pacific Oceans along the NSR, are a new stage in the development of technical means of the Arctic marine fleet.

Vessels for oil transportation in the Arctic in operation and project

Ice-breakers and ice category ULA vessels have preferred until recently to utilize electric propeller installations which increase the twisting moment under growing pressure on the propeller in ice. However, the efficiency of these installations is rather low, the fact that is especially undesirable for tankers and bulk cargo vessels due to relatively low cost of cargo.

This circumstance explains the design and construction of ice-breakers and vessels carrying marine propulsion plant with a controllable- pitch propeller. A weak point of the latter is unsatisfactory adjustment for loading fluctuations. Increase of loading in ice conditions contributes to an increase in twisting moment and reduces the pitch of CPP propeller and power input, and consequently ice-going capacity and speed as well. This disadvantage may be weakened by inertial fly-wheels fixed on shaft and through automatic engine control.

Conditions of continuous maneuvering in ice also speak for controllable- pitch propeller. In order to safeguard the propeller against damage, ballast tanks must be used to ensure deeper draughts in ice than those required for conventional vessels in ice-free water, actually almost those like load line draughts.

As to the development of heavy lift vessels for active transportation of crude oil and LNG, the description of basic technical and operational requirements to ice going vessels is illustrated with oil and methyl fuel tankers.

The most known and studied and therefore feasible system for the Arctic is the technological transportation system which includes self-propelled surface tankers. Last years, UL ice classified tankers of "Samotlor", "Ventspils" and "Partizansk" types of 16 500-2 500 dwt have been used to deliver oil products in the Arctic.

The most suitable vessels for the use in ice are European ice classified vessels of the English Register of Lloyd or Swedish-Finnish 1A Super as well as 1A Norwegian Veritas. Basic characteristics of Finnish tankers are presented in table 2.1, a number of particulars of ice-going foreign tankers is noted as below.

Table 2.1.

Basic technical and operational characteristics of ice going tankers of the Finnish building

Characteristics	"Vikla"	" Tebo Olympia"	"Kihu"
Year of construction	1981	1980	1984
Ice class	1A Super	1A	1A
Purpose	Oil products and chemicals	Oil products	Oil products and chemicals
Length, m			
overall	133.3	140.9	160.9
BP	124.3	132.8	149.4
Breadth, m	19.0	21.2	23.1
Depth molded, m	9.5	10.7	14.2
Draught, m	7.2	7.3	10.11
Deadweight, t.	8388	11500	19990
Displacement, t.	12545	15800	27070
Factor of whole thickness	0.720	0.750	0.757
Cargo capacity, cu. m	8890	13830	26110
Volume of isolated balance tanks, cu. m	3900	6190	6670
Engine type	MRE	MRE	MRE
Engine output, N kW	4410	5570	729
Open water speed at 0.9N, kn.	15.0	14.3	15.8
Rated ice going capacity, M	0.55	0.56	0.71

Deadweight of major ice going tankers does not exceed 20000 t. Bow and stern ice formations decrease the whole corpulence by 0.03 as compared to conventional tankers. Rectilinear fore has an inclination to water line of 30-35 degrees; for some vessels ("Kihu", "Igloo Finn") ramming bow is provided, as well as stern teeth to protect propeller when moving astern.

Every foreign ice-going tanker has a vertical side in the middle part except of tanker "Kiisla" with the inclined side. Although even international regulations did not require double bottom and skin structures which would prevent or decrease risks of emergency oil pollution, nevertheless double bottoms were provided for all ice-going vessels, and double sides (boards) - for 1A Super class vessels, as a rule. Some vessels of 1A class (for instance "Tebo Olympia") are also equipped with double skin.

Double structures of skin and bottom, in addition to protection against damages, decrease expenses on cargo heating and increase the volume of isolated ballast tanks.

Isolated ballast tank volume must provide an ice ballast draught more than that required for conventional tanker on even water surface. Ratio of isolated ballast tank volume to deadweight falls inside the limits of 0.34-0.54 cu. m. per ton. The harder ice conditions in operation area, the higher figures of this range which are reasonable for a new ice-going tanker.

One of distinctive features of an ice going tanker is an increased power-to-tonnage ratio. Class 1A Super vessels have this ratio within 0.35=0.5 kW per ton.

Higher output of the main engine, sharpness of stern and ice-breaking shape of the fore considerably reduce the utilization of tanker length of cargo tanks; the corresponding length of class 1A Super comes to 0.54-0.62 and of class 1A - about 0.75. The use of compact diesels of middle revolution number enables us to raise the coefficient of length's utilization.

Considerable increase in local strength, additional structures, larger dimensions due to less hull corpulence and increase in output may reduce the utilization of displacement of ice going tanker by 5-10%. The ratio of displacement utilization to deadweight comes to 0.64-0.74, meanwhile tankers without ice class have a ratio of 0.67-0.82 under similar deadweight.

Ice maneuvering ability influences the efficiency of use of the controllable pitch propeller. In order to decrease ice resistance, the systems of pneumatic hydraulic cleaning of the hull ("Kiisla", "Nestegas") are utilized.

Almost all foreign tankers are equipped with deep hydraulic pumps that increases both the cost of cargo system at least by 30-35% and the number of cargo handling operation devices. At the same time it is possible to abandon the idea of utilization of pumping room as well as the major part of cargo pipes with fittings. The effective separation of a large number of different cargoes is, to a large extent, reasonable under conditions of oil transportation of small shipments, with a deep-well pump system being available.

In Russia, vessels of three types are mostly used to deliver oil products to Arctic points and to export crude oil: "Samotlor" - 16 500 dwt, "Ventspils" - 6 500 dwt and "Partizansk" - 2 500 dwt.

The first series of 14 ice going tankers of "Samotlor" type were built in 1975-1978, and 6 doubled bottom tankers of "Ventspils" type were built in 1984-1985 .The type NO-20A was offered instead of "Samotlor" type.

"Samotlor" type vessels are of good ice going capacity: they are capable to move through flat compact ice of 0.55-0.58 m thick at a continuous speed of 2 knots when loaded and through 0.48-0.5 m ice when in ballast. However, the strength of hull restricts vessel's ice going capacity.

Series of 6 double bottom tankers of "Ventspils" type designed for Arctic operations, were built in 1984-1985. At a draught of 6.7 m vessel's ice strength corresponds to UL category and at 7.2 m (the maximum at which they could operate in the Baltic) - ice strength corresponds to L2 category of the Register of the Russian Federation.

NO-20A type tanker of ULA category taken close to the dimensions of "Norilsk" type was proposed to replace "Samotlor" type.

Basic technical and operation particulars of domestic ice going tankers are given in table 2.2.

Table 2.2.

Basis technical and operation characteristics of domestic ice going tankers.

Characteristics	"Samotlor"	" Ventspils"	"NO-2OA"
Year of construction	1975 -1978	1984-1985	1996-2000
Ice class	KM*UL[1]A2	KM*UL[1]A1	KM*ULA[2]A1
Purpose	liquid oil		
Length, m			
overall	160.0	113.0	177.0
BP	148.0	105.3	164.7
Breadth, m	23.0	18.3	24.4
Depth molded, m	12. 9	8.5	14.0
Draught, m *	8.5	6.7	9.0
	9.2	7.2	9.6
Deadweight, t*	15150	5493	18200
	17200	6297	19990
Displacement, t*	22520	8596	27800
	24570	9400	29590
Net cargo capacity, t*	-	4900	-
	15180	5704	19300
Cargo capacity, cu m	17937	5943	-
Volume of isolated ballast tanks, cu m	5850	2220	-
Engine type	LRE	LRE	LRE
Engine output, N kW	8538	4350	14560
Open water speed at 0.9N, kn	15.7	15.2	14.4
Rated ice going capacity, M	0.68	0.57	0.73
Crew, persons	37	27	23

note :* calculated figure/according to load mark

Conception of new vessels designed for large-scale Arctic carriages

A major feature of intensification of transportation process which takes advantage of prospective new designed vessels is the provision of succession and further improvement of the best technical and operational parameters of existing Arctic-going vessels, choice of reasonable solutions on deepening specialization and universalization of certain vessels, increase in cargo capacity, in particular for dry and bulk cargo vessels.

In recent years the Institute studied a number of general technical and operational problems on the creation of effective heavy tonnage specialized vessels for different purposes. The following aspects are involved herewith: technical improvement of certain elements and equipment of vessels and ice-breakers; the improvement produces a positive increase in ice going capacity, reduction of ice damages, the provision of the workability under Arctic conditions etc.; in addition, due attention should be paid to long experience of ice navigation,

results of modeling, studies of AARI and other organizations, theoretical estimations and so on.

For example, research on hull shapes, device of pneumatic hydraulic cleaning allow us to increase ice going capacity by 15%. Operation mathematical models of vessels moving in ice along the NSR in dependence of seasons were developed, improved and recommended for use in economic comparative calculations.

Scientific technical progress in shipbuilding, mechanical and instrumental engineering, especially in spheres of application of lower-temperature-resistant materials, decreasing fuel consumption and making steps forward in ecological improvements, designing special equipment, structures etc. for use in the Arctic (for example, pneumatic hydraulic, cleaning, new shapes of hull, high-latitude communication systems etc.) enables the scientists to offer new versions of vessels for Arctic transportation included in local and global technological transportation systems of different types which could be competitive to traditional transportation systems existing in the world.

High latitude routes beyond general NSR routes (including a known route beyond pack ice which is likely to be the shortest way between the Barents sea and the Bering strait) make it possible to pass along shallow waters and leave strict limits for vessel draughts permitting us to use vessels of higher cargo capacity. This circumstance has a positive effect on economics of oil, gas, containers etc. Prospective designing of new larger ice-breakers will contribute to further development of transport vessels.

Prospective creation of the heavier ice-breakers will assist to develop transport vessels in this direction. Thus, if the existing "Arktika" type ice-breaker with output of 55 MWT makes it possible to escort vessel of 30 m wide, then the designed 66.2 MWT ice-breaker - up to 35 m and projected ice-breaker - leader (110 MWT) - up to 40 m. The length of escorted vessels will also increase.

In the case when no strict limits are applied to vessel dimensions relating to traditional NSR routes, the idea suggests itself for the creation of new TTS with use of ice-breaking and transport vessels of autonomous navigation in ice conditions . The versions of the TTS with the use of autonomous ice-breaking vessels and carriers (with no ice-breaker assistance) should be compared with alternatives in terms of operations and economics, including other Arctic TTS, traditional or close to traditional.

The conception of creation of new Arctic going vessels is formed as a conception related to each vessel of this purpose: under ice-breaker escort or autonomous navigation. Common feature for all vessels of this section is the requirement that they must ensure cargo transportation within a contracted period in any season of the year.

Operational technological conception of new vessel takes into consideration not only Arctic navigating conditions but the particulars of berthing in the region and the conditions of cargo handling operations as well. The conditions of use of tankers and gas-carriers for oil and LNG exports are also under consideration hereafter.

Basic technical and operational requirements to Arctic going vessels

In recent years , the studies carried out by CNIIMF, with regard to technical and operation aspects of the creation of effective specialized and multi-purpose ice going vessels, focused on technical improvement of certain elements and equipment of vessels and ice-breakers, increase in ice going capacity, reduction of ice caused damages, provision of the workability under Arctic conditions etc. These studies are underlain by experience of ice navigation, results of modeling simulations, projects of specialized institutes, theoretical estimations.

Acceptable draught and dimensions of bulk cargo vessels actually identify their main parameter - deadweight or capacity. An increase in the latter positively influences the efficiency of transportation which is not limited by volume of the shipment of such cargoes as oil and gas.

Thus, taking into account of the experience of operating and projecting Arctic vessels as the most provable for Arctic year-round operations, two following versions of the technological transportation system may be considered : using ULA ice going vessels with escort and ice breaking autonomous vessels of the higher strength and force.

New Arctic going vessels must comply with the requirements of modern shipbuilding rules which may vary depending on the place and terms of operation, and whether they are escorted by ice-breakers or not. In accordance with the Russian Register, the vessels operating in the Arctic with ice-breaker assistance all the year round , are assigned to the ice category ULA, and the transport ice-breakers- are assigned to LL1.

Ice going capacity of the vessel is defined by main engine's output , deadweight, type of propellers, hull shape and shape of bow structure providing sufficient strength, in other words - mainly, by its ice class. The rules of the Russian Register specify minimum output of main engines for ULA category vessels, and the output of an LL1 ice-breaker is defined by ice going capacity of, at least, 2 m (in terms of ice thickness). Ice going level might be clarified taking into consideration operating and economic factors relevant to the region of operation.

As compared to existing vessels, new designed vessels for prospective Arctic technological transportation systems should be not only of higher cargo capacity, ice strength and power, but also meet the requirements and satisfy recommendations on improvements in loading particulars (specifically, constructive and architectural type and ship's loading facilities) in conformity with the purpose and specific navigating conditions.

At the same time all important achievements of scientific and technical progress , particularly in the spheres of energy supply, ergonomics, ecology and vessel's economy on the whole must be utilized. Some new effective findings have been used in construction of ice going vessels; these findings have been elaborated and tested successfully demonstrating considerably increase of ice-going capacity (for example, among these findings are new shapes of hull, pneumatic and hydraulic cleaning etc.).

Mechanical and other ship's equipment must meet the requirements of longer operation in the Arctic in terms of appropriate output, capacity, duplication and reserve. Lower air and water temperatures, polar night conditions as well as the necessity to use more drastic measures to

protect hardly restorable Arctic nature, should be expressed in detail when studying factors of vessel operations.

The Institute has shown that nuclear engine is the most effective power plant for heavy tonnage ice-going vessels (In spite of economic problems). However, nowadays there is no international coordination of marine nuclear vessel operations, i.e. call and service at foreign ports are impossible.

Deadweight of new larger tankers for the above TTS (with ice-breaker or without) may reach 80-200 thous. t. depending on acceptable draught and assumed working schemes.

The power plant of ice-going tanker is practically possible in two versions: diesel and diesel-electric plant. The nuclear plant version could be elaborated for ice-breaking tanker due to large output of the main engine that would make it possible to exclude the bunkering of large amount of fuel oil, which is difficult to provide under the extreme north conditions. However, nowadays, there is no international regulation of sea operations for commercial nuclear vessels, i.e. it is actually impossible to attend and service vessels in foreign ports. The prospects of such regulation are still unclear. This fact makes it impossible to include nuclear vessels in the analysis at the stage of practical elaboration.

The diesel -electric plant is more preferable to the diesel in terms of shaft twisting moments when operating in ice, and less expensive as compared to the nuclear plant. The diesel plant with direct transmission to the propeller requires less expenses due to less fuel consumption. It has been put to an evaluation test applied to domestic ice going vessels of "Norilsk" and "A.Kolecnichenko" types and to some foreign ice-breakers. However, some experts suppose that the reduction of speed under periodic increase in the twisting moment above average may lead to the fact that the ice efficiency of the diesel plant will be less than that of diesel-electric plant.

In making pre-project calculations for all tanker versions, it is reasonable to select similar power plants. For a diesel plant with the direct transmission to the propeller, lower- revolution engines may be accepted as the main engines. The modern model of LRE will ensure lower fuel consumption than the consumption being provided by a middle- revolution engine; the size of aft end permits us to find a rational location for the engine.

In accordance with new international requirements and special significance of ecological requirements to Arctic tankers, the latter must be provided with double bottom and bulkheads. Upper deck may also be doubled in tank part with places where longitudinal under-deck tanks of isolated ballast may be located. To facilitate tanks cleaning, the sections and longitudinal bulkheads may be reasonable to manufacture as vertically corrugated.

When a vessel is going in ice, the rules of the Russian Register do not permit one to use unattended mechanical equipment with the sign of automation being less than A2. Considering long distance of open water passages and higher operational expenses in the Arctic , the sign of automation must be in conformity with those provided for vessel of future and "Watch-1" class of Norwegian Veritas. Besides, a number of crew members may be decreased by 18-25 persons.

Ice going tankers for crude oil transportation from the Arctic fields and for transportation of oil products to the Arctic points present a series of prospective types and dimensions of 20-125 000 t. (table 2.3.).

In order to provide oil/product transportation from internal river basins, domestic shipbuilders have designed a series of river-sea vessels of different types and dimensions. The main technical and operational characteristics of prospective vessels and those being constructed as river-sea going vessels, are presented in the appendix.

Table 2.3.

General technical and operating characteristics of calculated types of vessels for the Arctic

Characteristics	Calculated types of vessels		
	NO-20A	NO-85A	NO-125A
Dead weight, t.	19990	85400	130600
Carrying capacity, t.	19300	81060	128500
Maximum length, m	175	262	338
Width, m	24,4	40,0	48,0
Load line Draught, m	9,6	15,0	16,0
Characteristics of main engine	MOD	MOD	MOD
Number and operating power, kW	1x8200	1x26500	2x18200
Velocity, knots	14,4	14,5	14,5
Category of ice-strengthening of the hull according to the Register of the RF	ULA	ULA	ULA

3. FORMATION OF TRANSPORTATION SCHEMES FOR OIL AND OIL PRODUCT EXPORTS

The NSR is the major national transportation way of the Russian North and may be considered as an element of structural changes in the system of public production of the North where the marine transport plays important role in the decision making on the involvement of natural resources in economic turnover and social security of nations of the Extreme North.

In accordance with the concept framed by the Institute on the development of specialized fleet, it is recommended to export not less than 50% of the oil produced when exploiting fields of the Arctic shelf area.

The basis of CNIIMF's studies on transportation supply of Arctic regions including the importation of oil products and equipment, and the export of oil and gas, is a strategy of creation by domestic shipbuilding industry of the foundation of the Arctic specialized fleet acting with assistance of Russian cargo- owners.

3.1. Conception of the formation of transportation scheme

Regular sea oil/gas transportation from the Russian Arctic region is possible during the whole year when Arctic going vessels with power plants of higher output as compared to conventional vessels of similar purposes and comparable dimensions, are in operation. Ice-breaker support will be additionally required both in the case of escorting vessels through ice routes and while berthing at a transshipment terminal of the oil/gas field. These additional requirements will result in increase of oil/gas transportation expenses.

Main consumers of oil and gas are located in the countries of West Europe and America. Length of ice passage in these directions would come to 10-30% of overall transportation distance. It is necessary to note that the limiting ice conditions are subject to seasons and last for 6-8 months a year.

The factor of reliability of operations depends on the compatibility of the main operational parameters (main dimensions and output of power plant) of vessels and ice-breakers.

In this respect, economic and operational calculations of CNIIMF must count the following two versions of fleet operations:

- the use of only heavy tonnage Arctic going vessels providing year-round oil/gas transportation directly from the fields to the ports of the consuming countries;
- on the basis of combination of heavy tonnage vessels in ice free regions and Arctic going vessels of smaller size operating in the Arctic seas directly from the fields to an intermediate ice free, as a rule, port of the Kola peninsula.

Additional expenses on fleet and intermediate port will be incurred in the second version. Simultaneously one can expect the reduction of capital and current expenses resulting from decreasing of the capacity of oil/gas storage in the fields caused by an increase in transportation system's reliability and improvement of ice-breaker support, etc.

Proposed schemes of oil transportation are typical for the mainland feeder system, for organization of which Arctic going tankers provide oil delivery from the fields to the nearest port, therefore it is possible to export oil by heavy tonnage tankers. Oil export from ice free Kola port makes it possible to create equal commercial conditions for Russian and foreign shipping companies.

3.2. Characteristics of schemes of transportation from the Timan-Pechora fields

The development of the Prirazlomnoe field is substantiated in the papers of Russian and foreign studies.

At the first stage it seems possible to produce oil using the mobile drilling platform "Molikpak".

Basic operational characteristics of the mobile platform "Molikpak"	
Volume of oil store of "Molikpak" type platform, tons	- up to 30 000
Extraction output, tons per day	- 3 000
Time of filling up the storage, days	- 10.0
Capacity of cargo pumps, tons per hour	- 3.8
Oil annual extraction volume, tons	- 1 000 000.0

Proposals on oil transportation organization.

Organization of oil transportation from the Prirazlomnoe field will require to create a productive transportation system (PTS) including:

- productive extraction complex MP "Molikpak" with a drilling device and oil storage tanks of up to 30 000 t;
- port-point (the Varandey settlement area) where the port fleet and other auxiliary transportation means and the repair base to provide the MP productive process, are located.
- basic port (in estimations and calculations, Murmansk and Arkhangelsk are assumed as basic ports), through which oil is delivered to internal Russian regions or abroad;
- Arctic going vessels (see table, 2.2, 2.3) carrying oil from MP "Molikpak" to a basic port or abroad;
- ice-breakers.

Organization of oil transportation is aiming at the year-round observance of schedule of the MP productive process. Schedule's role is to keep such an interval of tanker approaches, at which the volume of extracted oil, at a given capacity of MP, would be in correspondence with a shipment volume.

In order to evaluate transportation cost of oil exports from the Prirazlomnoe field to the ports of Murmansk and Archangelsk, calculations have been made to determine operational characteristics of the vessels. The calculations of operational characteristics have been executed on the basis of the following standards:

- Gross operational speed in open water is defined proceeding from the technical speed corrected by a coefficient of 0.85. Escorting speed in ice is assumed according to long term

observations and estimated at 6-8 knots for "Partizansk" and "Ventspils" types and 8-10 knots for vessels of "Samotlor" and "NO-20A" types;
- Cargo handling time in Archangelsk and Murmansk is calculated, with allowance for vessel's cargo pump capacity and estimated at 5 hours for oil discharge from MV "Partizansk" and 10 hours - for MV "Ventspils" and "Samotlor" and "NO-20A". The total port time incorporates additional expenses on auxiliary operations.

The analysis of operational characteristics points to the following:
- A transportation distance to Archangelsk is 50 miles longer than that to Murmansk;
- The need for vessels to cover the assumed volume of 1 mil. t., includes 8 items of "Partizansk" type, 4 items of "Ventspils" type and 1-2 items of "Samotlor" type;
- "Partizansk" type vessels require more close correspondence between the time of vessel's arrival and the time needed to collect goods intended for a shipment, with "Molikpak" operation being taken into account. When increasing vessel's size, the above correspondence is broken and this fact leads to an additional demurrage.

In order to determine expenses on oil transportation, planned figures of daily expenses for the vessels of the assumed type owned by the Primorsk Shipping Company and engaged in coastal voyages as of 01.01.1993, have been taken into consideration. After that these figures should be increased by a coefficient of 1.5 to calculate the profit rate and climate allowance added to the crew wages. Ice-breaker escort expenses are evaluated according to the recommendations and norms of the Murmansk Shipping Company for leasing ice breaking vessels of "Vaygach" and "Captain Sorokin" types as of 01.01.1993. The organization of ice-breakers' operation in winter makes provision for the use of one ice-breaker of "Vaygach" type on the route of "Prirazlomnoe-Murmansk" . One more ice - breaker of "Captain Sorokin" type will be required on the route of "Prirazlomnoe-Archangelsk".

Total expenses for oil transportation according to the above versions are presented in table 3.1.

The analysis of table 3.1 permits us to give preference for chartering "Samotlor" type vessel. Such a choice is reasonable if a great shortage of Arctic going vessels in Russia is taken into account.

The advantage of selection of the port of Murmansk or another port (new) of the Kola Peninsula is based on both lower transportation expenses and, as a matter of equal significance, geopolitical tasks of Russia which are believed to reside in preservation of the economic Arctic zone for the Russians.

When rising the volume of oil production, the foreseeable transportation volume will increase to 25.0 mil. t. per year. In this case, the following three versions used to control the flow of cargoes are taken into consideration:
- the first one is oil export by Arctic going tankers of 20 000 dwt;
- the second is oil export by Arctic going 85 000 dwt tankers;
- the third is oil export by Arctic going 125 000 dwt tankers;

It is assumed that oil year-round export by the marine transport goes from the Prirazlomnoe field (Via Varandey) and from other deposits of the Timano-Pechora region (Via Indiga) to

the basic port of Rotterdam. Characteristics of transportation schemes and assumed types of vessels are given in table 3.2.

Table 3.1.

Total expenses on oil transportation from the "Prirazlomnoe" field according to the assumed versions

Vessels types, factors	Prirazlomnoe - Archangel	Prirazlomnoe - Murmansk
MV "Partizansk"		
Vessel-days , pcs	2584.0	2066.4
Operational expenses, thous. rubles	2482.0	1968.0
Ice-breaker expenses, thous. rubles	631.3	347.0
Total expenses, thous. rubles	3113.3	2315.0
MV "Ventspils"		
Vessel-days , pcs	1102.4	867.2
Operational expenses, thous. rubles	1100.9	852.5
Ice-breaker expenses, thous. rubles	631.3	347.0
Total expenses, thous. rubles	1732.2	1199.5
MV "Samotlor"		
Vessel-days, pcs	400.2	376.6
Operational expenses, thous. rubles	683.3	607.8
Ice-breaker expenses, thous. rubles	631.3	347.0
Total expenses, thous. rubles	1314.6	954.8

Table 3.2.

General characteristics of transport schemes of oil export and assumed types of vessels

Transport schemes	Length, miles		Assumed types of vessels
	Total	in ice in winter	
Prirazlomnoye(Varandey) - Murmansk	600	350	NO-20A
Prirazlomnoye(Varandey) - Rotterdam	1950	350	NO-125A
Indiga - Murmansk	400	150	NO-85A
Indiga - Rotterdam	1800	150	NO-125A
Murmansk - Rotterdam	1500	-	NO - 200

Requirements for berths

Analysis of requirements for berths is made according to the method and standards reported in the working document 31.01.01-93 "Handbook on technological planning of sea ports" which specifies special conditions of planning structure of operations. The results of this analysis are presented in table 3.3.

Table 3.3.

Calculation results showing demand for berths at island roadstead terminal

Characteristics	Variant 1		Variant 2		Variant 3	
	summer	winter	summer	winter	summer	winter
Deadweight of assumed vessel, thous. t.	125		85		20	
Load of assumed vessel, thous. t.	112.5		81.05		17.0	
Calculated intensity of oil pumping to a berth thous. .t./ hour	15	15	10	10	5	5
Average pumping intensity thous. t./hour	13.5	12.8	9.0	8.5	4.5	4.3
Handling time, hours	8.3	8.8	9.0	9.5	3.8	4.0
Productive berthing time, hours	12.0	14.5	9.0	12.0	6.5	9.0
Index of the probable use of a berthing time depending on hydrometeorological conditions	0.85	0.65	0.85	0.65	0.85	0.65
Normative index of using berth for handling	0.45	0.45	0.45	0.45	0.45	0.45
Index of monthly approach variation (unevenness)	1.25	1.3	1.25	1.3	1.25	1.3
Monthly capacity of one berth mil. t./month	1.45	0.92	1.27	0.81	0.50	0.39
Duration of navigational period, months	3	9	3	9	3	9
Overall capacity of one berth in navigational period, mil. t.	3.48	6.38	3.05	5.60	1.20	2.70
Number of required berths	2.53		2.89		6.4	
Number of accepted berths	3		3		7	

The demand for berths is defined on the basis of the necessity to provide loading of tankers at a rate of 25,0 mil. t. of crude oil per year (including 3 months - summer time and 9 months - winter period).

Calculations are carried out for the following three versions of freight traffic:

- version 1 - conveyance of oil in summer period by tankers with calculated load (Dc) of 125 thous. t. per vessel, with a calculated rate of oil supply taken to be 15,0 thous. t. per hour;
- version 2 - all- year- round conveyance of oil by tankers with rated load (Dc) of 85 thous. t. per vessel, with a calculated rate of oil supply taken to be10,0 thous. t. per hour;
- version 3 - all-year-round conveyance of oil by tankers with rated load (Dc) of 20 thous. t. per vessel, with a rate of oil supply taken to be 5,0 thous. t. per hour.

Monthly traffic capacity of a berth (P_{mon}) is determined by the following formula:

$$P_{mon} = \frac{24\ DC}{Te + Td} \times 30 \times Km \times Ke, \text{ thous. t. per month,}$$

where:

Te time interval within which the berth is used for vessel's cargo handling operations, hours;

Td time interval within which the vessel is berthed and the berth is not used for vessel's cargo handling operations, hours;

Km coefficient of possible use of working time of the berth due to hydrometeorological conditions in the month of maximum employment in summer and winter;

Ke normative coefficient of employment of the berth in vessel's cargo handling operations for a month's period.

The traffic capacity of a berth in summer and winter is determined by multiplication of a monthly traffic capacity (calculated by the above formula) by a number of working months in the given season, and then by division of this product by the coefficient of monthly variation (unevenness) of vessel approaches in the season under consideration.

The annual traffic capacity of a berth consists of the sum of traffic capacities of the berth in summer and winter.

A number of required berths is determined by division of total calculated carrying capacity (25 mil. t. per year) by annual traffic capacity of one berth.

The time interval of employment of a berth with cargo handling operations is determined by division of rated load of a vessel (Dc) by accepted rate of oil supply according to the given version, with reduction of the rate by 10-15% being made, and thus, taking into consideration the slower technological process at the beginning and end of the loading.

The time interval of employment of a berth without cargo handling operation consists of time intervals which are spent for mooring, official registration of the arrival, inspection and acceptance of tanks before loading, hosing, measurement, sample selection, tallying cargoes and paper formalities after loading, unhosing, official registration of departure and unberthing.

Under calculations, this time interval is accepted according to the Standards of technological planning of sea ports for vessels of the corresponding deadweight and for the corresponding season.

The coefficients of possible use of working time for a berth in dependence of hydrometeorological conditions in the aquatorium, where the construction of a planned road terminal is envisaged, are presently accepted according to expert estimations of Lenmorniiproject, and are equal to:

- 0.85 - in summer
- 0.65 - in winter.

These coefficients must be made more precise in the future after obtaining data on hydrological conditions in the area.

The normative coefficient of employment of a berth with cargo handling operations taken for a month's period can be determined according to the Standards of technological planning of sea ports for specialized berths intended for raw petroleum and oil products, and is equal to 0.45-05.

The coefficients of monthly variation (unevenness of vessel approaches are determined by Lenmorniiproject according to the analogy with the already elaborated projects of other building sites, and are equal to:

- 1.25 - in summer
- 1.30 - in winter

The results of calculations show that in order to provide 25 mil. t. of raw petroleum planned to ship through the island terminal of the Timan-Pechora province and the aquatorium of the Pechora sea , it is necessary to build:

- three berths - according to version 1,
- three berths - according to version 2,
- seven berths - according to version 3.

Each berth must be provided with storage capacity. The reason for it is the necessity of providing for the guaranteed oil supply for vessels staying at berths under conditions of even supply from a shore and uneven approach of vessels to berths.

Experience of planning shows that storage capacity must be equal 1.5-2.0 volumes of a maximum assumed vessel's capacity for each berth.

Considering rather difficult working conditions for the terminal in Varandey, each berth must have the operating storage capacity which equals:

- 187.5 thous. t. or expressing as a whole number - 235 thous. m^3 - according to version 1;
- 170.0 thous. t. or expressing as a whole number - 200 thous. m^3 - according to version 2;
- 60.0 thous. t. or expressing as a rounded number - 80.0 thous. m^3 - according to version 3.

For other building sites of the roadstead terminal, where its berths are situated not far from the shore (4-5 km from the shore), storage capacities might be placed on shore.

Location of roadstead island berths

The following points and regions are assumed for shipment of 25 mil. t. of oil per year through the roadstead terminal:
- variant 1 - the region of Varandey settlement (south-east past of the Barents Sea);
- variant 2 - the region of the north-eastern coast of Kolguev island ;
- variant 3 - the region of Indigskaya bay;
- variant 4 - the region of the high seas in north - western direction from Kolguev island;
- variant 5 - the region of the Timanskiy shore.

According to variant 4, it is necessary to build a submerged oil terminal unlike all other variants, where island terminals are supposed to be constructed. Two points for location of the submerged terminal are accepted according to variant 4;
a) north - western direction from Kolguev island at a distance of 150 km and at a depth of 75-80 m (variant 4a).
b) north - western direction from Kolguev island at a distance of 60 km and at a depth of 50 m (variant 4a).

Principle location of roadstead terminals of all variants is presented on scheme-plan (pict.3.1-3.5.).

The transshipment of the prescribed volume of oil, taking into consideration the fairly high rate of loading (10-15 thous. t. per hour) into tankers of 85 and 125 thous. t. of carrying capacities, will demand availability of three stationary island berths of 20-23 m in depth.

A recommended structure of the berth is a ferro-concrete massive giant structure installed on stone bed. This structure is stretched in the shape (like a shape of vessel hull). It is divided into closed ferro-concrete boxes - compartments. If the berth is rather far from shore, these compartments serve as store capacities for oil, and almost each compartment is filled up with ballast to ensure stability.

If the berth is near to shore (when it is possible to use shore-based reservoir), all the ferro-concrete compartments shall be filled up with ballast. In this case the ferro-concrete structure, as a whole, is less wide.

The island berth (massive giant structure) is 40-60 m wide and up to 350 m long depending on function and location. The location of such berth will be determined depending on prevailing direction of ice drift, current and wind and wave regimes.

To provide appropriate equipment for development of oil deposits and to improve conditions of building and functioning of the terminal (three berths, submerged piping etc.), a port-scoop for depths of 5(6) m is planned to be built.

Allocation of roadstead terminals according to variants

Variant 1 - the region of Varandey (pict.3.2).

According to this variant the location of the roadstead terminal is planned to be at sea between Pakhancheskaya Bay and Dolgiy island at natural depths of 20 m or 23 m and at a distance of 38-40 km and 54-56 km respectively from the continent.

Additional variant 1-a is considered for this region. Location of island berths is suggested to be near Dolgiy island where depths of 20 m and 23 m come nearer to shore up to 23-24 km and 30-32 km.

However, in this case, it would be necessary to lay an oil pipeline across Matveev island in order to lead it to the coast of Dolgiy island. Moreover, submerged oil pipeline running through two straits between these islands will be required. It will demand 4 additional connections of submerged and surface oil pipelines.

In both variants, a base with a port scoop is supposed be placed at Varandey island which is situated at a distance of 40-65 km from roadstead berths according to variant 1, and at a distance of 70-80 km according to variant 1-a.

Variant 2 - region of the north-eastern coast of Kolguev island (pict.3.3).

According to this variant, there are two places for location of the roadstead terminal.

Variant 2a - region of the southern coast.
Kolguev island lays north of the Indigskaya bay at a distance of 87-90 km from Cape Svyatoy Nos (Saint Nose) (Timanskiy). Kolguev island extends for 83 km along longitude and 58 km along latitude. It is a flat-convex upland.

Changes of depths near island shore are rather smooth. Depths of 20 m and 23 m are at distances of 10-14 km from shore in the north-eastern part of the island.

The construction of the base and port- scoop is feasible only in the southern part of Kolguev island, in Remenka bay (Bugrino). The distance between the base and the roadstead terminal in the north - eastern part of the island will be about 120 km by water.

Remenka bay is protected against western and north-western winds, and it is also the best place at the island to anchor. So, variant 2-a suggests itself. According to this variant, the island oil berths are planned to locate near this bay. Depths of 20 m and 23 m are at distances of 16 km and 22 km.

Variant 2 requires laying an underwater 90 km long oil pipeline from the continent to Kolguev island. According to variant 2-a the length of such oil pipeline may be 16 km or 22 km less.

Variant 3 - the region of Cape Barmin , Indigskaya bay (pict.3.4).

According to variant 3, the sea area near Cape Barmin is under consideration. It lies at a distance of 32 km westward from the mouth of the Indiga river. In this region, proper depths of 20 m and 23 m required for roadstead berth are at a distance of 5.0-5.5 km off shore.

Variant 3a.
According to this variant it is supposed to run oil pipeline to Cape Svyatoy Nos (Saint Nose) (Timanskiy) which lies northward from the mouth of the Indiga river.

Depths of 20-23 m are rather near to shore, at a distance of 4-6 km (in this case the oil pipeline does not cross the Indiga river).

For both variants, it is possible to locate the building base with the port scoop in the month of the Indiga river where there is an approaching fairway to the settlement of Indiga with proper depths for vessels with 3.7 m. draught in the period of flood tide.

Variant 4. The region of the high seas in the north - western direction from Kolguev island (fig.3.5).

According to this variant unlike other variants the oil roadstead terminal is supposed to locate in a zone of open waters where ice-free navigation is carried out all the year round.

Places for terminal location are situated at a distance of about 150 km north - westward from Kolguev island at a depth of 75-80 m and also at a distance of 60 km north-westward from the island at a depth of 50 m.

Owing to inexpediency of building stationary berths at such depth, it is suggested to build submerged oil storage with capacity of 300-500 thous. t. at the same place where the oil terminal is situated.

Oil will be supplied through the submerged oil pipeline run from the continent to Kolguev island, further through the island to its north-west part, and then again through the submerged way to the store.

In this case, it is supposed to load oil into tankers through the flexible pipeline which can be taken up by a special float.

The base with the port scoop is situated on the same place as in variant 2, i.e. in the southern side of the island. In this case the water distance to the terminal is at least 220 km.

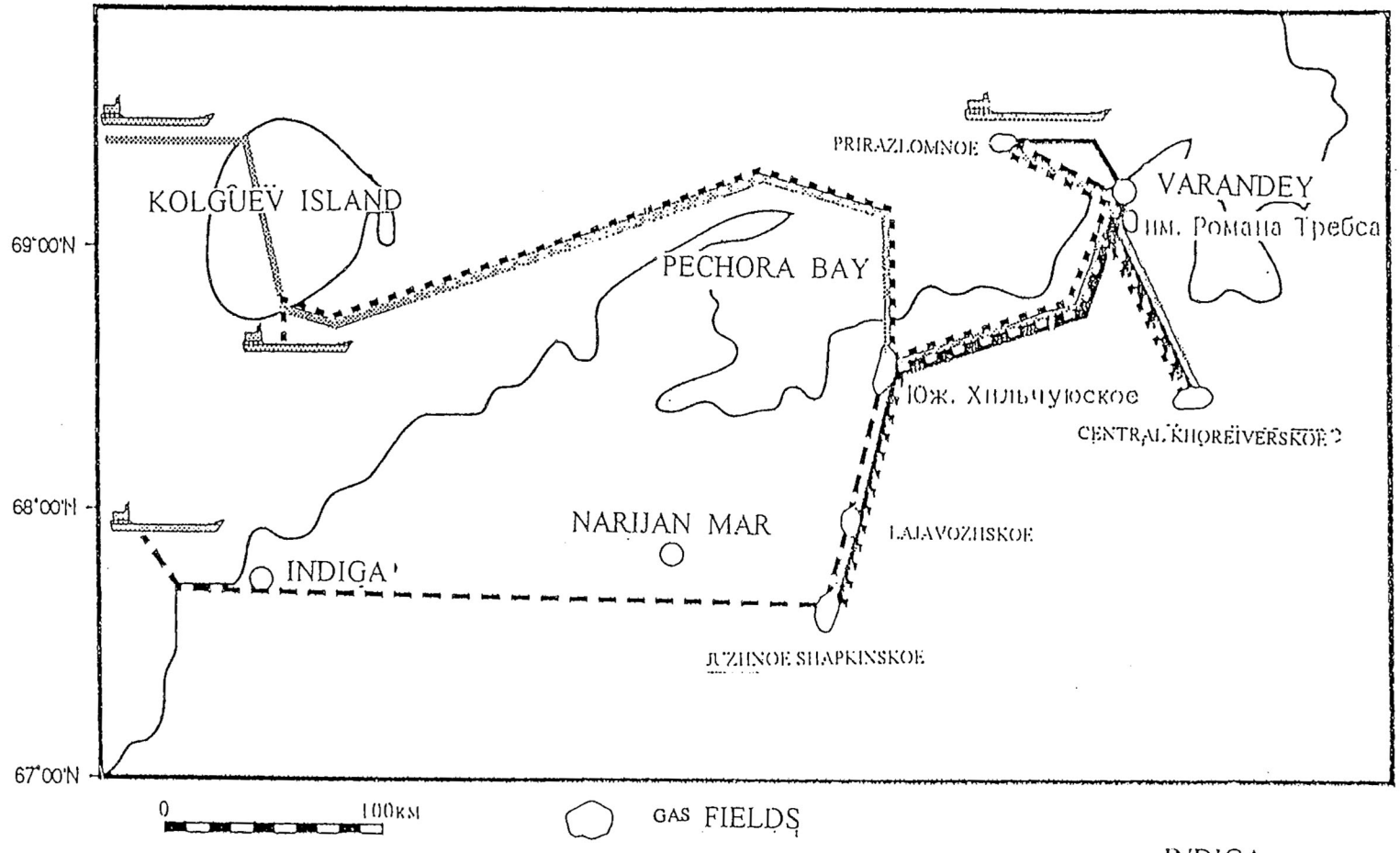
LENMORNIIPROJECT has additionally prepared the following variants:

Variant 5 - the region of the Timanskiy coast.

According to this variant, roadstead berths are situated between Kolokolkova bay and Pechorskiy bay.

Терминал "Северные Ворота"

Terminal "Northern Gate"



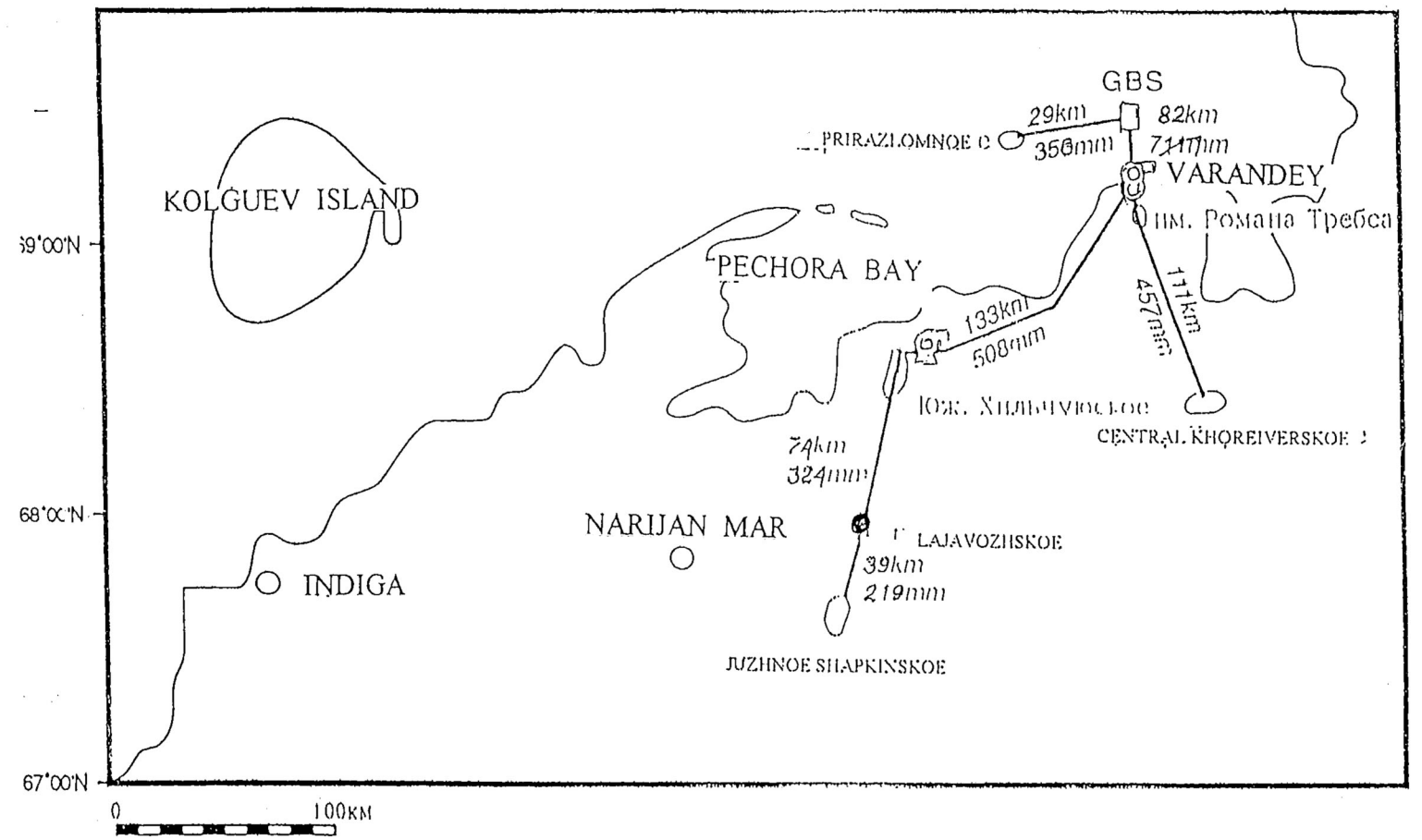
SUS 20.05.94 1a shR TVii
U&P/F&T-Tegneavdeling

Fig. 3.1

Рис. 2

Терминал "Северные Ворота" - Вариант "Варандей"

Terminal "Northern Gate" Variant Varandey



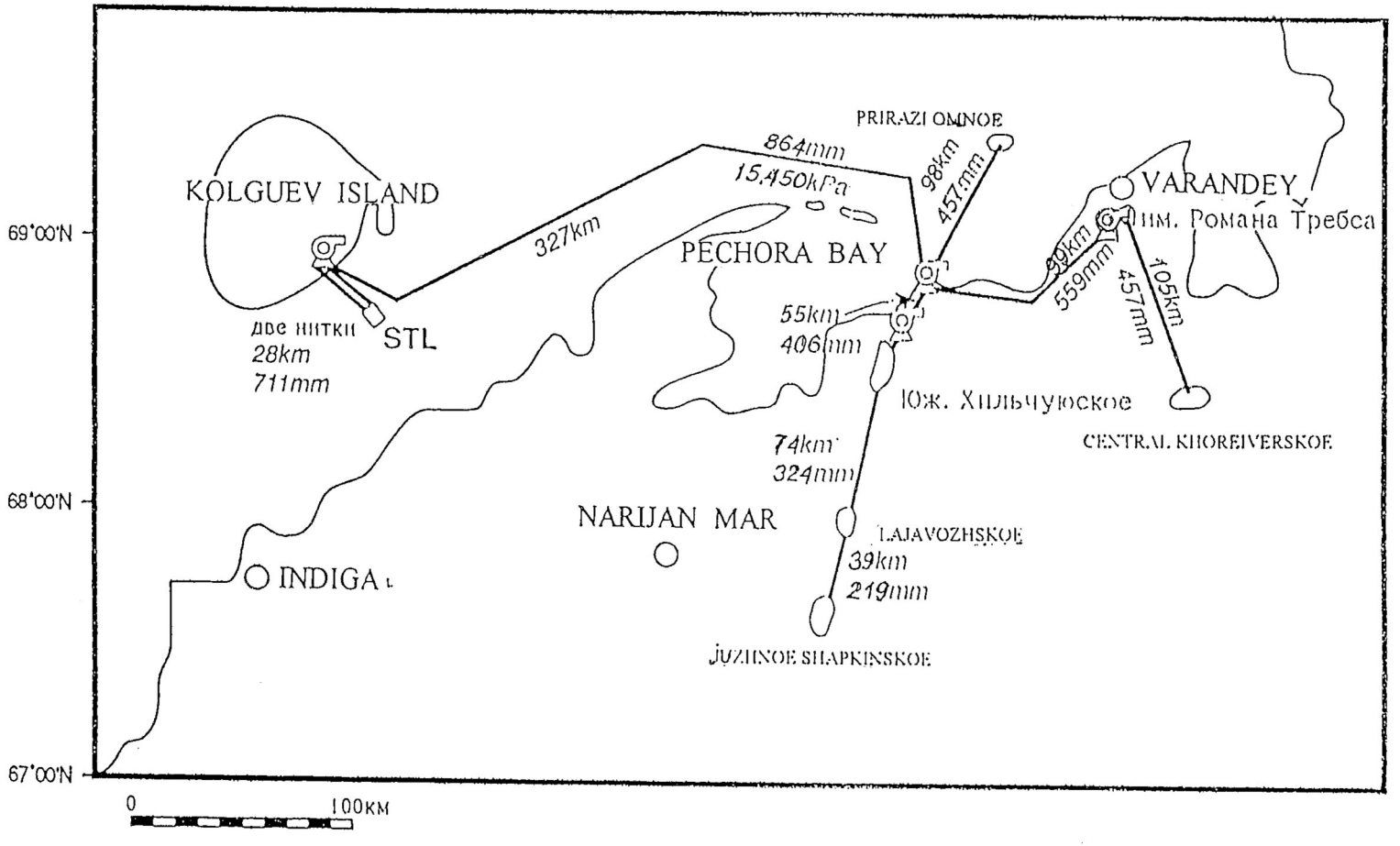
SUS 06.06.94 4a shR TVi E
U&P/F&T-Tegneavdeling

Fig. 3.2

Рис. 6

Терминал "Северные Ворота" - Вариант "Колгуев"

Terminal "Northern Gate" Variant "Kolguev"



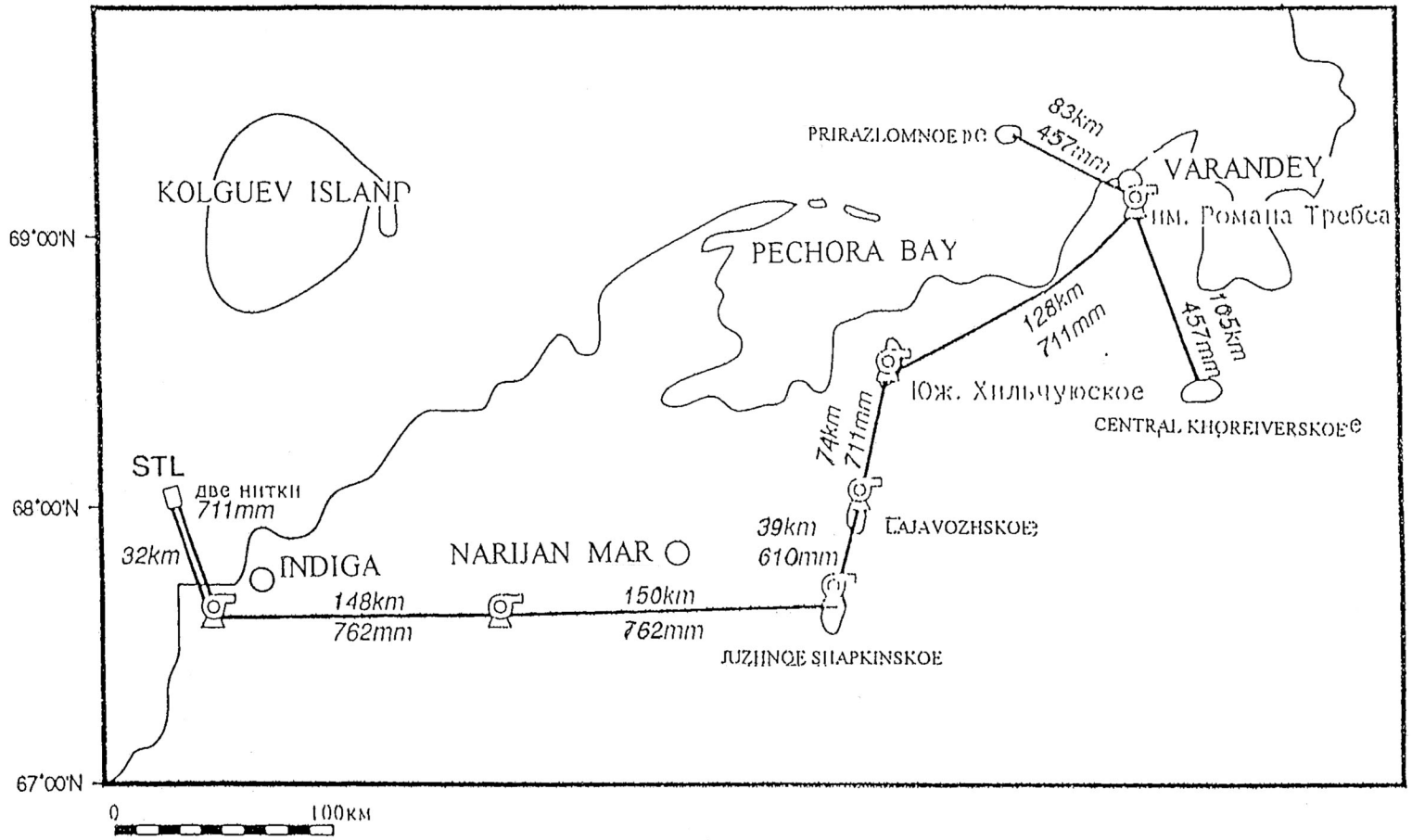
SUS 06.06.94 2a shR TVi E
U&P/F&T-Tegneavdeling

Fig. 3.3.

Рис. 4

Терминал "Северные Ворота" - Вариант "Индига"

Terminal "Northern Gate" Variant "Indiga"



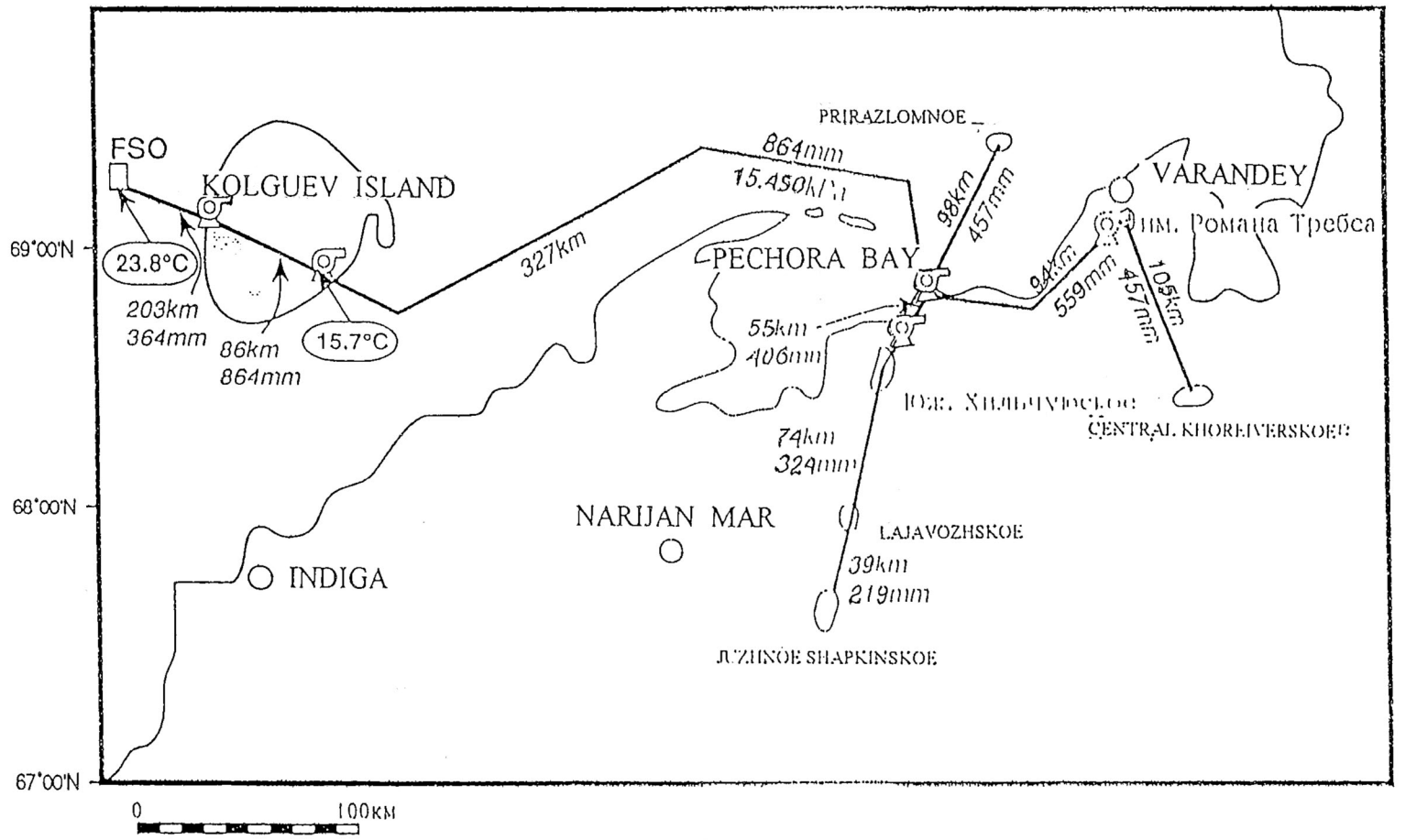
SUS 06.06.94 1a shR TVI E
U&P/F&T-Tognoavdeling

Fig. 3.4

Рис. 3

Терминал "Северные Ворота" - Вариант "Открытая Вода"

Terminal "Northern Gate"
Variant "The high seas"



SUS 06.06.94 3a shR TVi E
U&P/F&T-Tegneavdeling

Fig. 3.5

Рис. 5

The location of roadstead berths is suggested to be in the region of Peschanka settlement where depths of 20 m and 23 m are at distances of 4 km and 6 km from the shore.

Coast structures of the base and port fleet may be located in Kolokolkova bay near Topseda settlement or in the region of Peschany settlement . Depths at the coast are 2.0-3.0 m and in the region of Topseda - 5.0 - 10.0 m. In this case the distance from the roadstead terminal to the base is about 45 km.

Variant 5a.
The roadstead terminal is considered to locate in the region of the peninsula of Russian Zavorot. Depths of 20 m and 23 m are at distances of 8 km and 10 km from the shore. This variant requires laying supplementary submerged oil pipeline of 60 km in length. The basis for variant 5 a is the same as for variant 5.

Variants compared

The assessment and comparison of the variants of roadstead terminal locations should be performed with respect to a number of the main factors, including distance from the shore and to the bases. Such data is presented in table 3.4.

Version of the island pier location in the region of Varandey is worse than of Indiga due to natural and other reasons. However, it gives the most nearest pier location relative to the locations of main oil fields of the Timan-Pechora region.

Versions of Kolguev island are less preferable (as compared to Indiga and Varandey) because of more difficult seas and navigational conditions on the whole, longer submerged pipeline(to Kolguev).

At the next stage, it is wise to focus attention on the version of the construction of one or two piers in Varandey, one pier in Indiga, or vice versa.

General assessment and selection of a version of the oil terminal construction must be carried out by the customer on the basis of gross expenses on the piers, oil pipes, shore structure and on development of infrastructure.

Table 3.4.

Distances from roadstead terminals : to the shore and shore bases with port-scoop

NN of version	NN	Location of road terminal	Distance from the shore		Distance from the shore with port-scoop	
			to isobath 20,0m	23,0m	Location of the base	Distance on water, km.
1	1	Region north from Varandey village	38-40	54-56	Varandey region(creek)	40-45 (60-65)
1-a		The same but in region of northern edge of Dolgiy island including from islands (Golets, Matveev)	23-25 5	30-32 3	- \ -	70-75 (75-80)
2	2	North-eastern coast of Kolguev island	10-12	12-14	Bugrino village Remanka bay	120 (120)
2-a		Southern coast of Kolguev island	6-18	18-20	-\ -	18-20 (20-27)
3	3	Cape Barmin	5	5.5	Mouth of the Indiga River	32-33 (33-34)
3-a		Cape Svjatoy Nose (Timanskiy)	4	4.5	-\ -	28-30 (30-32)
4	4	North-western coast of Kolguev island to isobath 75-80m	150	150	-	-
4-a		The same to isobath 50m	60-65	60-65	-	-
5	5	Peschanka village	4	6	Peschanka village	45 (45)
5-a		Russkiy Zavorot Peninsula	68	70	-\ -	90-95 (90-95)

Note :

1. Distances of Kolguev island points are given from the island shore.
2. Additional laying submerged oil pipe of 80 km long from the main land shore (to the island) will be required for oil delivery to Kolguev island.
3. Distances to the roadstead piers at a depth of 23.0 m deep are shown in brackets.

3.3.Characteristics of transportation schemes from the Priob basin

At the first stage, it is recommended to export crude oil through the existing Jamburg port. Therefore, construction of the transshipment oil storage with a total tank volume of 100-150 thous. t. for crude oil is necessary in the port.

In the assumed port of departure located in Ob Bay (in area of the Jamburg, Kamenny and Krugly Capes), oil and oil products of the Priobskoe and Barsukovskoe fields may be

transported by railway, river transports and pipe lines. However, the first two kinds of transport, in our view, are inferior to pipe lines mostly due to seasonal influences.

Loading of marine tankers laying on the roadstead, is carried out by small tankers of river-sea "Lenaneft" and "Volgoneft" type as well as by marine tankers of "Partizansk" type of 2.3 thous. t. of carrying capacity.

Marine transportation schemes are mainly formed, with due regard for ice conditions' development in winter between Cape Kamenny in Ob Bay and Murmansk on the Kola Peninsula according to three alternative routes:

a) Kamenny Cape (Krugly Cape) - Kara Gate straits - Murmansk. Distance of round trip in summer - 2530 miles;
b) Kamenny Cape (Krugly Cape) - Ugorskiy Shar Straits - Murmansk. Distance of round trip in summer - 2600 miles;
c) Kamenny Cape (Krugly Cape) - Zhelanija Cape - Murmansk. Distance of round trip in summer - 2700 miles

Basic particulars of oil and oil product transportation schemes and calculated types of vessels are given in table 3.5.

Table 3.5.

Baisic characteristics of oil and oil product transportation schemes and calculated types of vessels

Transport schemes	Length, miles		Calculated types of vessels
	Total	in ice	
Jamburg-Kara Gate Kara Gate-Murmansk	780 550	740 180	NO-20A
Jamburg-Jugorskiy Shar Jugorskiy Shar-Murmansk	710 600	690 180	NO-20A
Jamburg-Zhelanija Zhelanija-Murmansk	620 780	600 200	NO-20A
Murmansk-Rotterdam	1525	-	NO - 200

As for the transportation scheme Jamburg-Murmansk, it is recommended to carry oil products by tankers of "Samotlor" type or by tankers of new project HO - 20A of carrying capacity up to 19300 t. These Arctic going tankers have well strengthened hulls and principal dimensions which meet, to a great extent, operational standards of the existing ice-breakers and vessels under construction.

Basic technical and operational characteristics of recommended vessels are given in table 2.3.

Ice-breaker support at sea is made by a nuclear ice-breaker of "Arktika" type, and in Ob bay - by nuclear ice-breakers of "Taymyr" type, or the diesel ice-breakers "Captain Sorokin" or "Captain Chechkin".

As for the export scheme Murmansk-Hamburg, it is recommended to carry crude oil by tankers of the world standard with carrying capacity from 125 to 200 thous. t. at equal commercial terms with companies - oil buyers. Round trip distance is 3050 miles.

Total length of ice passages

Length of ice passages (miles), depending on winter-spring navigation, and the development of one or another polynya in south-eastern part of the Barents sea and south-eastern part of the Kara sea on different routes, is given in table 3.6.

Table 3.6.

Characteristics of ice route distances in transportation schemes Ob Bay - Murmansk (miles)

NN	Variant of the route	Character of ice conditions		
		Light	Middle	Hard
1.	Ob Bay - Kara Gate strait	710	740	780
	Kara Gate strait - Kolguev Island	180	180	300
2.	Ob Bay - Jugorskiy Shar strait	690	690	710
	Jugorskiy Shar strait - Kolguev Island	180	180	300
3.	Ob Bay - Zhelanija Cape - Murmansk	800	800	1050

Technical solutions for shore problem

One of rational directions for the development and functioning of the Arctic marine transportation system is based on establishing both a powerful production plant, in the region of the Kola peninsula, for processing hydrocarbons, and a traffic junction for making cargo handling operations within the framework of the Arctic Marine Transportation System that will require realization of the following technical solutions:

1. Port of Jamburg.

Modernization of the pier front with additional two oil berths prepared for servicing the m/v "Volgoneft": deepening the aquatorium of the port; acquisition of additional vessels for the port fleet;

Relocation of oil transshipment terminal 70 km northward from the port of Jamburg, and construction of the port-point "Jasja" with a new oil terminal and oil pier and with an approaching ice strengthened platform of length 1.5 km and 11-12 m. in depth.
It is necessary to design and construct oil pipelines of length about 70 km to connect the port of Jamburg to the port-point Jasja.

2.Port of Murmansk.

It is planned to discharge vessels at existing piers of oil terminals of Murmansk and other points of the Kola Peninsula(ports of Pechenga, Teriberka, etc).

One of the rational directions for the development and functioning the Artcic Marine Transportation System is based on the creation in the Kola region of a powerful production plant - for processing hydrocarbons and of large transportation center - for receiving and shipping oil and gas, development of export carriages with participation of foreign companies on equal terms.

3.4. Characteristics of schemes of transportation from the basin of the Enisey river

The Vankorskoe field is located on the territory of the Turuhanskiy region of the Krasnojarskiy district, approximately 125 km west of Igarka and adjoins the Bolshaya Kheta banks.

Brief description of the Vankorskoe field:

1. Calculated explorable resources are more than 142 mil. t.
2. Low contents of sulphur and paraffin, 42 ANT.
3. Existing wells - 9
4. Estimated period (report to the State Committee) - 3 years maximum
5. Supposed beginning of exploitation in the winter of 1995/1996.
6. Export starts (long-term trial extraction) - in the summer of 1996.
7. Extraction top - 1999.
8. Calculated extraction maximum is 250 thous. barrels a day.

Crude oil is planned to move through oil pipe lines to Igarka or Dudinka, and then - by shuttle tankers to Russian border-point of sale (Pechenga). The port of Dudinka is preferable as a loading place. However, it seems more reasonable to construct a terminal on the western bank of the Enisey river in front of Dudinka that enables us to avoid the problems of laying pipe across the river.

Pechenga is considered to be a favorable sale place due to the possibility of reimbursing all transportation expenses at the expense of duties.

The use of Igarka will considerably reduce the distance run by the oil pipe leg to the terminal as well as the transportation time along the river to Lesosibirsk in summer, and then along the railway to the oil processing plant in Achinsk. Besides, a small oil processing plant of 2000 barrels a day will be built in Dudinka (Igarka) to meet local demands. The total oil volume internally transported, is estimated at 600 thous. t. a year.

4. TECHNICAL AND ECONOMIC CALCULATIONS OF OIL AND OIL PRODUCT EXPORTS BY THE MARINE TRANSPORT

In this section, a general conclusion has been drawn from the results obtained by the Institute's studies on the technical and economic evaluation of the marine transport system's work in prospective directions of oil product transportation.

Items of studying technological transportation system

When preparing technical and economic feasibility study (TEFS) of new technological transportation systems (TTS) of transportation along the NSR, experts faced two groups of interconnected questions:

The first group is a creation of perfect, from a technical standpoint, transport means - Arctic going vessels- suitable for this purpose in terms of the ice going capacity and dimensions taking into consideration updated ecological and ergonomic requirements to the vessels. This group of TEFS's problems has a rather clear and unequivocal solution. CNIIMF has collected large and unique experience in designing Arctic going vessels.

The second one, being more complicated due to it's multi-planning nature, included in TEFS, is operational and economic evaluation of efficiency of technical and technological solutions of the TTS in question.

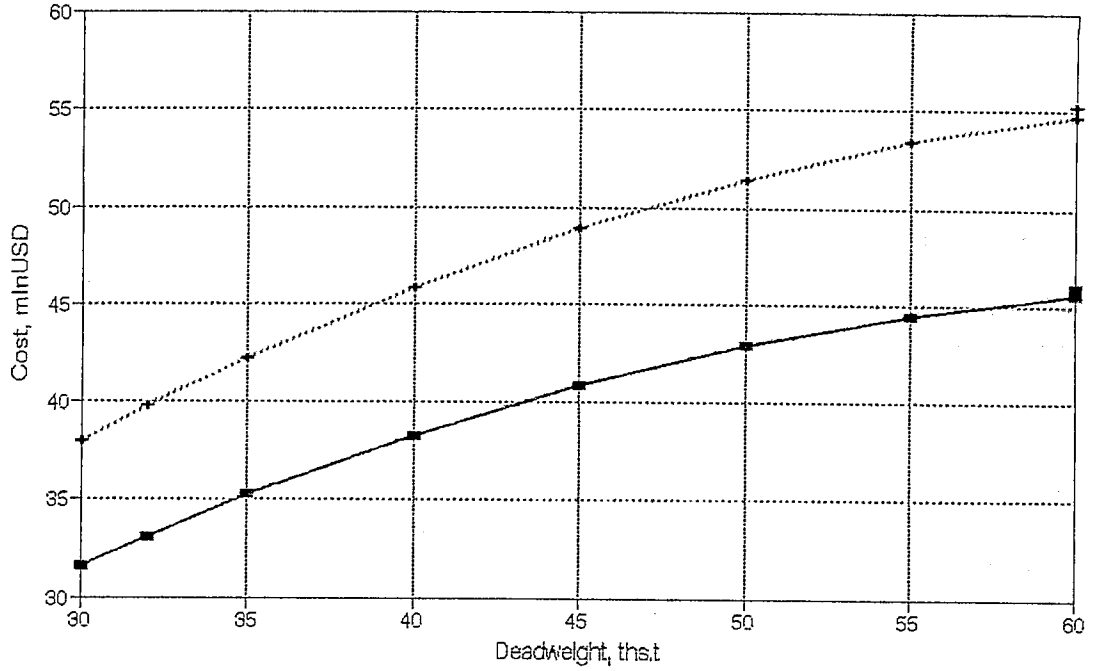
At first, these are issues related to quite correct definition of the limiting level of capital investments into technical means, and true assessment of the development prospects in the chosen segment of the transport service market, and calculation of running expenses on vessel operations.

In order to evaluate construction cost of Arctic going vessels, the approximating curves for double bottom tankers are presented on fig. 4.1. and 4.2., in dependence of tonnage groups of 20-80 and 80-250 thous. t., and calculated on the basis of statistics of "Lloyd's Shipping Economist" related to orders for non-ice going vessels placed with the world shipyards, and 20% cost increase - for the vessels registered by the Russian Register as ULA class.

The problem of economic and operational aspect of TEFS consists in the fact that at the present stage of domestic economic mechanism development, the traditional methods of economic efficiency evaluation based on the normative method of comparison with domestic basic versions identified for all consolidated groups of domestic vessels or with the world level by the criterion of specific expenses, make no sense.

At the stage of technical economic feasibility study, in addition to the elaboration of oil transportation schedule, the list of organizational technical measures, the realization of which would ensure, if necessary, the scheduled work of productive transportation system under extreme conditions, should be substantiated.

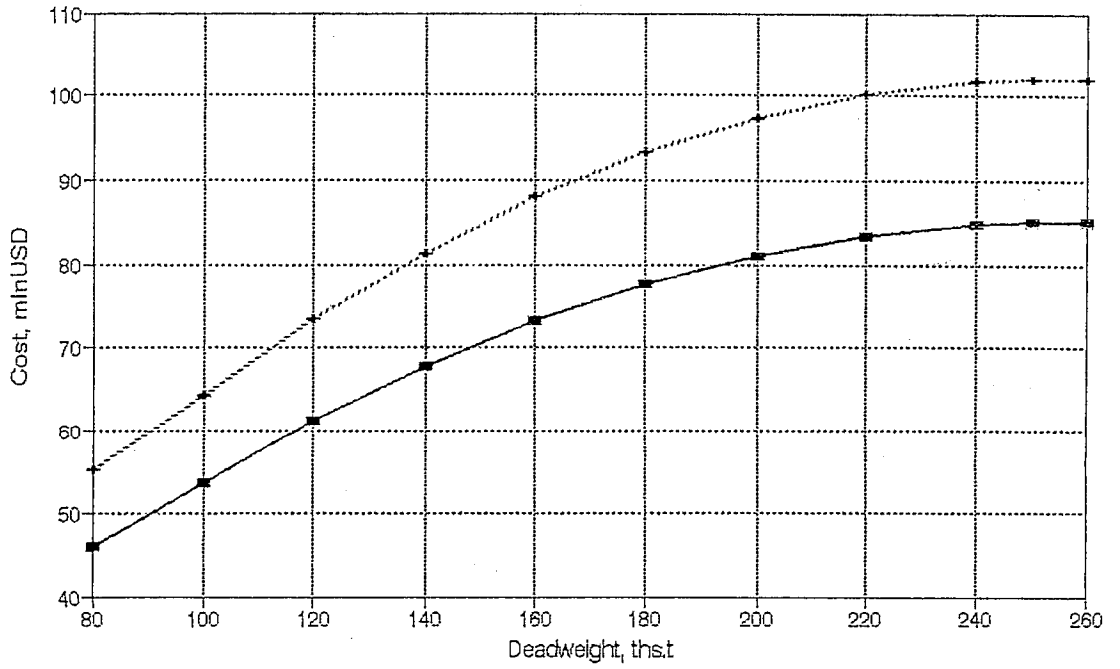
Figure 4.1 TANKER CONSTRUCTION COST.



Approximation — Base ···+··· +20%

Source: Lloyd's Shipping Economist 01-03.1997

Figure 4.2 TANKER CONSTRUCTION COST.



Approximation — Base ···+··· +20%

Source: Lloyd's Shipping Economist 01-03.1997

In this respect, the technological progress in developing the marine transport is to solve the questions of operational economic assessment of complex organization of transportation services, where the variables are composition of technical means, ways of their acquisition, priority of different functional sub-divisions, technology of cargo transportation, transshipment and storage.

The above complex of possible tasks enforces the specialists working on technical economic substantiation, to solve tasks with functional goal to "minimax", broadly varying parameters.

The shipping TTS should be considered in connection with the needs of a productive transportation system which includes real production utilized as a cargo for the selected market segment of marine transportation services.

Cargo base management , at the same time, exceeds the limits of competence of transport management. Therefore, when projecting TTS, the following aspects are of special actuality:

- problems of correct assessment of areas of acceptable and most probable figures of initial base parameters,
- substantiation of operational and technical characteristics and factors corresponding to the limiting factors.

Description of time-charter equivalent concept is hereinafter presented as an instrument of transport management assessment.

The term itself "time-charter equivalent"(TCE) is not a new term in the world practice of marine transport operations. It is utilized more often in the English terminology as a factor of economic efficiency level of vessel operations, and for making various types of carriage agreement comparable for certain vessel or average tonnage group.

So, the report of "Polar Shipping Consultants" [1] suggests to calculate it by subtraction of overall freight sum per voyage from direct voyage cost divided by a number of days per voyage.

This approach is suitable for practice of solving tactical tasks of transport fleet management, and to the same degree it is poorly applicable for strategic planning and substantiating new vessel types.

In works of a leading Russian specialist , Doctor of Economy A.N.Rakhovetskiy , the idea of using of the TCE as a factor of freight market prices, has been framed; this approach differs in principle from the above use of the TCE as a criterion of assessment of chartering vessel.

In particular, an empirical link at "the local freight market" between the TCE and rate of a leasing and time-charter, is treated in terms of statistics analysis:

$$TCE = 1.05 \times Ap = 1.13 \times Ab,$$

[1] "The Potential of the Northern Sea Route for a Regular Cargo Service", INSROP Working Paper No 15-1995, III.07.2.

where: Ap - rate of a leasing/time-charter per a voyage,
Ab - rate of a leasing/time-charter on a year basis.

On the basis of analysis of "marine transport product qualities" as well as factors influencing the freight rate level, a conclusion is made that freight rates characterize the marine transport product price rather than the freight market product price i.e. the TCE and leasing rate.

However, the author of this section does not know of wide use of such approach both in practice of fleet operation management and in practice of technical economic substantiation of the transport fleet being designed.

Now let's consider a transport vessel as an element of strategic planning productive system in the light of concept of determining "breakeven conditions" of UNIDO methods[2].

In fig.4.3 horizontal axis is a time range from the moment "0", when the ship-owner paid the first pre-operational expenses - through "A" - the moment of gaining first income(due to vessel operations) - up to the moment "T" limiting operational age of the vessel.

Vertical axis shows actual money figures of income and expenses summarized, before taxation and charges.

By adding all actual sums of income and expenses, one can obtain the same picture for technological transportation system as a whole.

Physical sense of economic efficiency criterion and practicability of introduction of productive system, for instance vessel, in practice, can be clearly seen in demonstration analytical graph.

Line {AE} - constant expenses, i.e. capital investments and a part showing the interest of investor (ship-owner) who invested cash and/or credit at the level of the capital reproduction rate under "passive" use.

Capital investments could be installed in different time. To set it in the regime of real time, the discounting process is utilized.

In practice, the substantiation of a real discount rate is a rather sophisticated financial and economic task.

Therefore, if necessary to show actual dynamics of reproduction of capital return, for example in practice of pre-project studies or operative works, it is reasonable to calculate the discounted money flows by means of the direct counting.

Direct calculations of flows of money in the regime of real time help us to avoid considerable mistakes, occurred when using integral formulas in calculations related to the description of "physics of the process" of functioning productive transportation system , influenced by a great number of factors not interconnected by strict mathematical dependence.

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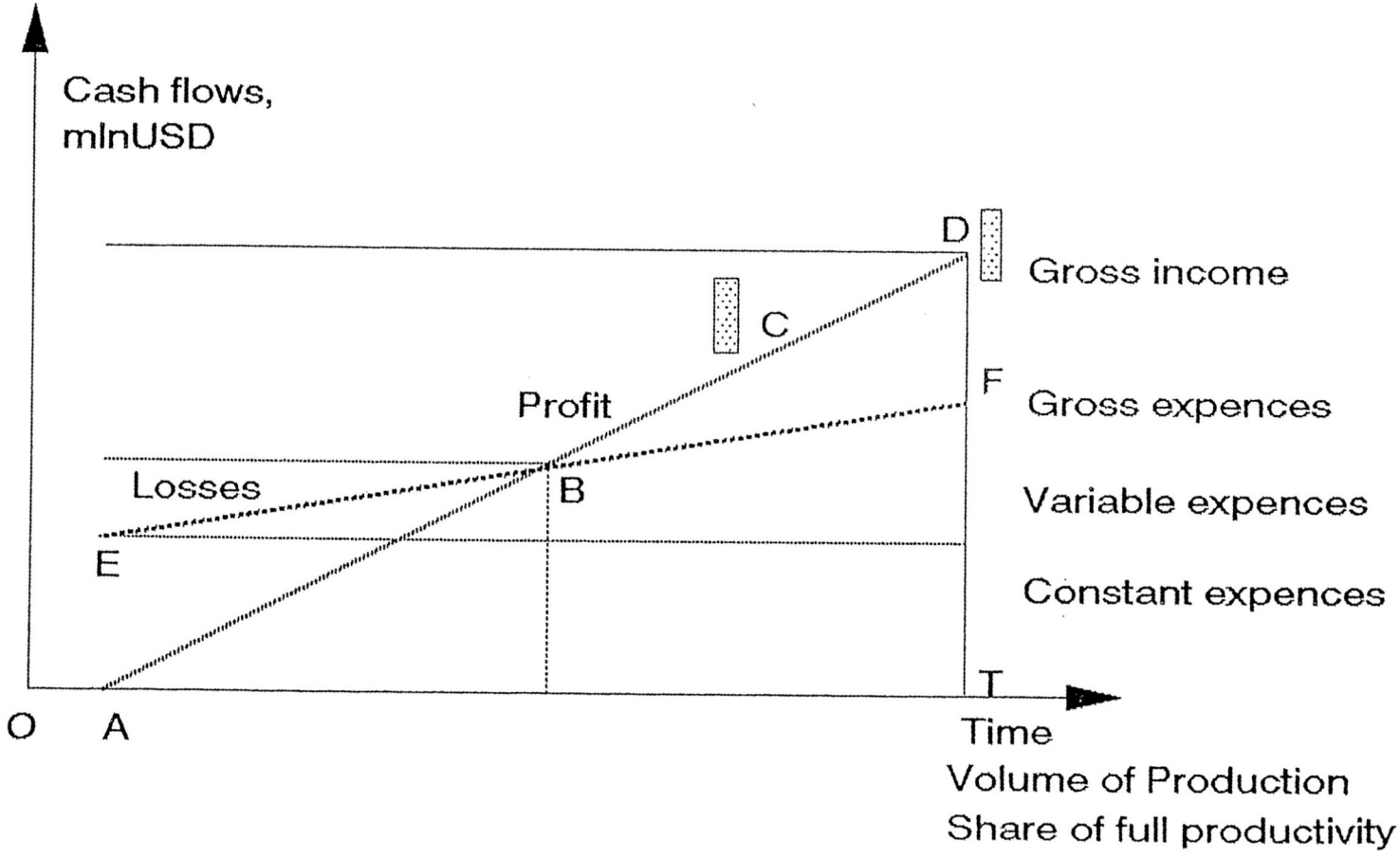
[2] W.Behrens, P.M.Hawranek "Manual for the Preparation of Industrial Feasibility Studies". UNIDO 1991.

Figure 4.3 Determination of "breakeven conditions" as the criterion of operational - economic efficiency of trade.



Line {EF} - current expenses for vessel operations. Generally, these are assumed variables.

Line {AD} - current income from vessel operations. Point "B" - so called "breakeven point", where an overall income covers overall expenses relating to the whole previous period of vessel's operation.

Point "C" shows some additional income which could be gained if selling workable vessel before its service life is expired.

Point "D" - possible expenses or income related to post-operational liquidation of a vessel (or income gained if selling a vessel for scrap or use it as a floating store, or expenses on its utilization).

Consequently, for certain purposes, it is acceptable to consider a vessel as the main (determining) element of making transport product sold at the market of transport services, an analysis of vessel group operations might be automatically carried out by means of integral assessment of the TTS.

Quantitative features of this transport product are as follows: vessel's carrying capacity, cargo units/vessels-days, transport output of the system, as a whole (cargo-flow covered), cargo units per operational period.

Economic characteristics of transport system are the following: gross income and profitability of fleet operations per day, and also other characteristics making sense as a feature of specific cost of transport product.

In this case, within the framework of the indicated methodical approach, the term "Time-Charter Equivalent" (TCE) should be defined as a minimum acceptable level of profitability of discounted capital investments per vessel, which enables the ship-owner to ensure his interest at a level not lower than total capital expenses, reduced to a common period of time, might provide when depositing money in bank on general terms.

This approach enables us to vary, quite correct, the constants and variables of initial data and comparison bases, carrying out objective and multilateral analysis of potential opportunities of a certain vessel or the surveyed TTS .

Parts of transport product price, in this approach, are divided into four groups which, by their composition, correspond to standard approach applicable in the world practice, for instance in analytical studies of "Drewry Shipping Consultants":

- parts of the first group are defined by value and character of capital investments per vessel, and do not depend upon either voyage terms or real operational characteristics of transport schemes. It is conventionally called the capital expenses.

This part characterizes initial commercial reasonability of the acquisition of vessel, and has to be covered by ship-owner under any kind of the contract of carriage.

- parts of the second group depend upon technical operational characteristics of vessel, and are called the operating expenses;
- parts of the third group depend upon characteristics of transport scheme, and are called varying operating expenses;

- parts of fourth group depend upon conditions, which are not defined by vessel's type or transportation distance, and called the additional expenses.

Parts of the last three groups might be included, under conditions of the contract of carriage or leasing vessel, into the rate of freight/charter fully or partly as an average figure, and might be factually paid by ship-owner or be charged to charterer' account.

Therefore, the main result of this operational economic study is the determination of possible and acceptable limits of changing of those factors which are the functions of technical characteristics of vessel and fleet as an independent transport system.

4.1. Timano-Pechora region

The demand for tankers according to the rated transport schemes has been provisionally estimated for transportation levels of 5 and 10 mil. t. a year. Such an approach may be considered correct for the first stage of the development of fields as well as for separate project of seaborne oil export.

The trade turnovers of trips are separately determined for summer and winter periods of navigation. The demand for ice-breakers is determined proceeding from the distance of ice-breaker's escort and accepted for transportation from Varandey as consisting of 2 units - the nuclear ice-breakers "Arctica" and "Taimyr". For oil transportation through the terminal in the region of Indiga one nuclear ice-breaker "Taimyr" is required.

The assessment of the regularity and safety of navigation in the region of the Prirazlomnoe field is given in the Appendix.

The calculations of the demand for tankers made in accordance with transportation schemes and working versions are presented in Table 4.1.

Series of comparative evaluations might be performed on the basis of Table 4.1. Thus, when delivering crude oil directly from the Prirazlomnoe field or through the terminal of Varandey settlement, the demand for vessels and capital investments into fleet will increase by 15-21% vs. the Indiga terminal version. The increase in feeder vessel deadweight from 20 up to 85 thous. t. results in the reduction of capital fleet investments for "Kolguev" by 48% and "Indiga" - by 41%.

It is recommended to use the mainland feeder transportation scheme via an ice free Kola port (Murmansk assumed) as a transport technological system of oil export. Arctic going vessels of 20.000 t. for the first stage of the project and up to 85.000 t. of carrying capacity for the future are utilized as feeder tankers.

Table 4.1

Vessel types	Cargo amount, t	Round voyage time, days		A number of voyages a year under transportation volume, thous. t		Calculated number of vessels to cover transportation volume, thous. t.		Capital investments into vessel construction, USD mln	
		winter	summer	*5000*	*10000*	*5000*	*10000*	*5000*	*10000*
I. Prirazlomnoe (Varandey) - Murmansk - Rotterdam									
NO- 20À	17000	7.0	9.5	294	588	7.17	14.35	165.6	331.5
NO - 200	180000	12.0	12.0	28	56	1.0	2.0	77.2	154.4
Total				**322**	**644**	**8.17**	**16.35**	**242.8**	**485.9**
NO- 65	55250	7.0	10.0	90	180	2.26	4.52	111.9	223.7
NO - 200	180000	12.0	12.0	28	56	1.0	2.0	77.2	154.4
Total				**118**	**236**	**3.26**	**5.52**	**189.1**	**378.1**
NO - 85À	81050	7.3	10.3	62	124	1.62	3.25	85.4	173.6
NO - 200	180000	12.0	12.0	28	56	1.0	2.0	77.2	154.4
Total				**90**	**180**	**2.62**	**5.25**	**162.6**	**328.0**
Prirazlomnoe (Varandey) - Rotterdam									
NO - 125À	112500	15.0	18.2	44	88	2.22	4.44	177.4	354.8
II. Indiga - Murmansk - Rotterdam									
NO - 20À	17000	5.6	6.6	294	588	5.35	10.7	123.6	247.2
NO - 200	180000	12.0	12.0	28	56	1.0	2.0	77.2	154.4
Total				**322**	**644**	**6.35**	**12.7**	**200.8**	**401.6**
NO - 65	55250	5.8	7.1	90	180	1.74	3.48	86.1	172.3
NO - 200	180000	12.0	12.0	28	56	1.0	2.0	77.2	154.4
Total				**118**	**236**	**2.74**	**5.48**	**163.3**	**326.7**
NO - 85À	81050	6.1	7.4	62	124	1.23	2.47	65.7	131.4
NO - 200	180000	12.0	12.0	28	56	1.0	2.0	77.2	154.4
Total				**90**	**180**	**2.23**	**4.47**	**142.9**	**285.8**
Indiga - Rotterdam									
NO - 125À	112500	14.0	15.4	44	88	1.93	3.86	154.2	308.4

Oil transportation from an ice free Kola port is performed by tankers of international standard with deadweight of up to 200 000 ton.

For each 10 mil. t. of crude oil per year to ship, a calculated demand for tankers will come up to: deadweight :

20 000	-	11-15	pieces
65 000	-	4-5	
85 000	-	3-4	
200 000	-	2	
125 000	-	4-5	

The arrangement of the feeder transportation through Murmansk or another Kola port will require additional expenses on cargo handling operation that will come to about USD 100 mil. per each 10 mil. t. of crude oil exported under this scheme.

4.2. Basin of the Ob river

Estimated transportation volume is 6 mil. t. a year including: crude oil - 5 mil. t. and oil products - 1 mil. t..

Proposals on transportation organization.

The proposals on transportation organization for loading marine tankers with crude oil and fuel oil are thought to be carried out from 2 points according to the following schemes:

1. In area of the Jamburg river port on the roadstead. Fuel and crude oil is delivered to the roadstead from the shore port oil storage by the vessels of "Volgoneft" (oil and fuel oil), "Lenaneft" (oil) as well as "Partizansk" (oil and fuel oil) types under relatively favorable conditions. Oil in tank wagons is delivered to oil storage from Korotchaevo and from oil processing plant in Purpa or oil producing area in Urengoy or Purpa. Transportation of oil and oil products is possible only in summer river navigation.

2. According to the second variant- if the pipe is laid on the eastern coast 70-80 km north of Jamburg to the Jarengsediaha (Jasja) river point where 11 m isobath is in the nearest proximity to the shore, there is a possibility to pump oil to vessel through the pipes installed on pier. This variant supposes the year round supply of fuel and crude oil providing their heating (fuel oil mostly) when loading and carrying by tankers to Murmansk.

The construction of a roadstead ice strengthened berth under the second variant makes it possible to provide transportation of estimated oil volume in all the year round regime. An alternative solution for berth is the construction of a new sea port "Jasja" of scoop type, the site of which is in the mouth of the Jarengsedejaha river. However, the construction of the port might be economically feasible only at cargo turnover of 5 mil. t. and more.

In the conducted research, the number of alternatives to fuel and crude oil transportation from the Priobskoe and Barsukovskoe fields through Ob Bay is considered. Some of the variants are observed in brief (for example, the river variant of fuel oil transportation along the Pur

river from Korotchaevo to the Jamburg port or the reasonability of fuel oil supply through the Kandalaksha port on the Kola peninsula due to lower output and higher technical and material expenses.

On the other hand it is suggested to set the sequence of stages when increasing traffic volume and to take into account the necessity to provide fuel oil transportation with a total of up to 500.000 t at the first stage.

Economic and operational calculations given in the present paper enable us to recommend the following versions of fuel and crude oil transportation by marine transport through Ob Bay.

Version I. Estimated transportation volume - up to 500 thous. t. of fuel oil a year.

Fuel oil transportation is recommended to execute from Ob Bay to Murmansk in a period from the first decade of July to the first decade of October by four Arctic going tankers with a cargo capacity of 15-20 thous. t. each: they may be tankers of existing fleet ("Samotlor" type or other chartered from the shipping companies) and of prospective construction (NO-20A) as well.

The organization of loading fuel oil in Ob Bay into marine tankers is performed under scheme "board to board" with the use of four tankers of "Volgoneft" type chartered from the river shipping companies.

Version II. Estimated transportation volume - up to 6000 thous. t. of oil products a year including: fuel oil - up to 1000 thous. t. and crude oil - up to 5000 thous. t. a year.

Twelve Arctic going tankers of up to 20 thous. t. of carrying capacity are recommended for fuel and crude oil transportation.

The final factors of total transportation expenses for the versions of carriages from Ob Bay to Murmansk by the marine transport are presented in table 4.2.

The normative coefficient of efficiency of capital investments into prospective new vessels is accepted as E= 0.15.

The normative coefficient of efficiency of capital investments in port structure is accepted as E=0.12.

The construction cost of vessels and daily expenses are accepted according to the standards of CNIIMF.

Economic factors speaks for the construction of a new oil port-point equipped with an ice strengthened platform of 1.5 km long where marine ice going tankers might berth and load.

Thus, specific expenses will decrease by 40% and transportation cost per ton of oil product will decrease by 20%.

Table 4.2.

Factors of total transportation expenses depending on versions of oil carriages from Ob Bay to Murmansk by the marine transport (USD mil.)

Factors	Variants	
	I	II
Basic data		
Rated transportation volume, thous. t.	500	6000
including: fuel oil	500	1000
crude oil	-	5000
Period of operations, days	96	365
Fleet leg		
Number of vessels	4	12
Capital investments	136.4	434.6
operational expenses	5.7	74.0
Port leg		
Capital investments	11.9	79.7
Including:		
1. Modernization of pier front of Jamburg port (2 oil berths)	5.7	
2. Deepening port aquatorium	2.0	
3. Oil pier in the Ob bay (approaching ice strengthened platform of 1.5 km long)	-	73.0
4. Port fleet	4.2	6.7
Operational port expenses	1.2	4.8
(% capital expenses)	(10)	(6)
Total		
Capital investments	148.3	514.3
Operational expenses	6.9	78.3
Specific expenses	28.8	153.6
Additional transportation cost		
Ice-breaker expenses	2.4	45.6
Stevedoring operations (including discharge in the port of destination)	12.5	72.0
Total transportation expenses		
Operational expenses	21.8	196.4
transportation cost, USD/t.	43.6	32.7

4.3.Basin of the Enisey river

In the judgment of "Eniseyneft" which has received the right to exploit the Vankorskoe field, the NSR is a part of whole transportation system needed for exploitation of this field because it enables us to obtain the product of great market demand and of independent transportation route.

Transportation schemes. The Vankorskoe oil is considered to be carried by marine Arctic going tankers from the port of Dudinka to a collecting Kola port (Pechenga assumed). Crude oil is shipped from Pechenga to Rotterdam by 150-200 thous. t. tankers.

Principal characteristics of oil transportation schemes and assumed types of vessels are given in table 4.3.

Table 4.3.

Transport schemes	Length, miles		Assumed types of vessels
	Total	in ice in winter	
Dudinka-Pechenga			NO-20A
- Kara Gate strait	1385	1035	-"-
- Ugorskiy Shar strait	1430	1050	-"-
- Around Zhelanija cape	1395	1095	-"-
- Pechenga-Rotterdam	1540	-	NO-200

The development of the Vankorskoe oil field enables us to keep tanker fleet fully occupied with transportation of oil products to certain port-points of the Arctic.

At the first stage, estimated transportation volume of 1 mil. t. moved from the Dudinka port area by Arctic going tankers of 15-20 thous. t. of carrying capacity, is taken into account.

Such a volume might be transported to oil processing plant being designed in the Arkhangelsk area or the Kola Peninsula as well as for export with transshipment in the Murmansk area (Pechenga) to heavy tonnage non-ice going tankers.

The demand for No-20A tankers capable to carry 1 mil. t. per year is estimated to be two items.

CONCLUSIONS

Studies and analysis of the prognosis on scale of the development of shelf and shore fields of the Barents and Kara seas show good promise for the marine transport development both for the development of the fields and for hydrocarbon transportation from Arctic seas to domestic market and for exports.

The evaluation of power resources of Russia in the main field groups of north-western region and western Siberia has been carried out. The level of readiness for the development of the regions in the long-term outlook (up to 2020) has been given in accordance with references issued in the Russian open publications.

The conception of the development of the Arctic Marine Transportation System for exports of oil, condensate and different oil products has been elaborated.

The analysis of composition of the tanker fleet which could be used for Arctic transportation (both domestic and foreign), has been conducted.

Technical and operational requirements to construction of Arctic going vessels of prospective building of 20-125.000 deadweight tons have been presented. The upper limit of tanker's size is restricted by draft limitations adopted for the major regions of the Arctic shelf fields.

The suggestions on technical solutions to the problem of development of transshipment terminals on the basis of shore and roadstead terminals have been given with due regard for the project capacity of certain fields and assessment of advantages of their location as well.

Transportation and technological systems and versions of their working organization in reference to navigational seasons have been made out.

The quantitative assessment of the demand for fleet on each project of the field development has been performed.

The following conclusions, recommendations and suggestions might be presented as a result of this work:

1. Potential volume of hydrocarbon exports from the Arctic regions by sea up to 2010 is estimated at least 55 mil. t. a year including:
- up to 30 mil. t. of crude oil;
- up to 2 mil. t. of oil products and condensate;
-more than 20 mil. t. of LNG.

These prospective volumes are thought to be realized with the next projects prepared for the development of:
1.1.Prirazlomnoe field - calculated transportation volume grows from 4 to 25 mil. t. a year. Transportation version - marine tankers;

1.2. Priobskoe and Barsukovskoe fields - it is supposed to carry by sea up to 5 mil. t. of oil and approximately 1 mil. t. of oil products via a new terminal in Ob Bay (Kamenny Cape area);
1.3. Kharasaveyskoe natural gas field - according to the project developed, it is recommended to export up to 46 mil. cu. m. of LNG by gas - carriers.

2. To provide transportation of the full volume of oil, up to 50 tankers must be constructed with overall deadweight of 3.2 mil. t. including 30 tankers with deadweight from 20 to 200 thous. t. each for crude/product transportation, and up to 20 LNG/LPG tankers of 40 - 65 thous. t. each.

In the state program of Russian fleet renovation, a priority must be given to the various forms of ownership to be involved in fleet development.

3. Technical possibility exists for all the year round navigation and operation of oil handling terminals in south-eastern part of the Barents Sea at natural depths of 20-23m with respect to the use of domestic technologies, constructing and floating means. In any case the activity provides crude oil pumping into the island terminal from shore oil storage through submerged pipelines (heating included).

4. Organization of loading crude oil and products into sea tankers in Ob Bay will be carried out with a deep water oil pier designed in a new point "Jasja", located 70 km north of the existing Jamburg port.

5. As a technological transportation system of oil export it is recommended to implement the main roadstead - feeder scheme of transportation through an ice-free port of the Kola Peninsula (Murmansk is assumed conventionally) using, as a feeder, Arctic going tanker with deadweight from 20000 tons at the first stage up to 85000 tons in the future. Crude oil transportation from an ice-free Kola port is carried out by international standard tankers of up to 200 000 dwt. each.

6. When carrying crude oil directly from the Prirazlomnoe field or through terminal near Varandey settlement, the capital investments into fleet will increase by 15-21% against transportation version through the Indiga terminal.

The increase in deadweight of feeder vessel from 20 up to 85 thous. t. results in reduction of capital expenses by 48% for Varandey and 41% for Indiga.

The organization of feeder transportation through Murmansk or another ice free port at the Kola peninsula will cause additional operational expenses for cargo handling operations that will come to about USD 100 mil. per each 10 mil. t. of crude oil exported according to this scheme.

An economic criterion of efficiency evaluation of transportation versions might be taken as the value of potential losses due to emergency oil pollution in the Arctic seas. Nowadays one case of emergency oil pollution has been registered (24.03.1989 Prince William Gulf, Alaska. Tanker "Exxon Valdez", USA) with evaluation of losses at USD 2.8 billion that considerably exceeds the reduction of capital expenses obtained from non reasonable increase in

deadweight of Arctic going vessels. This fact should be taken into consideration when accepting commercial decisions.

The use of an ice free port of the Kola peninsula for oil, oil products and LNG exports gives good opportunity for foreign shipping companies both in formation of their technical policy and in reduction of fleet operating expenses.

7. On the basis of analyzed factors and conditions, version N 2 (Indiga bay region) is the most preferable for the purposes of the construction and ice operation of the marine hydro-technical structures; then - version N 1 - Varandey, then as less acceptable is version N 2 - north-eastern part of Kolguev island.

According to recommended version N 3 (Indiga) an island terminal may be located near to shore because 20 m isobate passes in this region as far as 4-5 km from the cape which restricts Indiga Bay.

8. It seems reasonable to build a feeder, i.e. transshipment oil port (for example, Pechenga), in an ice free port of the Kola Peninsula. In this case crude oil will be transported by ULA class tankers of 20 - 85000 dwt each which considerably diminishes the risk of environmental pollution.

Construction of 6 berths (3 piers of trestle type)will be needed .

9. As for the further project and solution of problems of crude oil export by the Marine transport, it is necessary to carry out the complex of constructional and engineering investigations aiming at more substantial and comprehensive selection of floating oil terminal site taking into consideration the present preliminary conclusions and materials.

10. At the first stage the realization of the projects of the development of the Timan-Pechora region fields must be performed with participation of the Marine Transport that enables us to receive necessary investments in short period with further development of pipelines and construction of oil refinery plants in the Arkhangelsk and Murmansk areas.

11.The Federal Law "Agreement of product distribution" adopted on 06.12.95 by the Government offers good prospects for using results within the framework of some projects.

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APPENDIX 1

The factor of safety of navigation in the region of the oil field "Prirazlomnoye"

In the region of the field, transportation is carried out by vessels of Murmansk, Northern and Lithuanian sea shipping companies. At the same time, vessels of other shipping companies sometimes navigate in the region. Besides, in this region one can see trawlers of Murmansk and Arkhangelsk fishing companies ("Sevrybfleet", "Arkhrybfleet", collective fisheries, fishery unions and others), different kinds of scientific, geological prospecting ships and survey-vessels, warships and also foreign vessels which carry export/ import and transit commodities.

After the national Rules of navigating along the Northern Sea Route was put into force in 1991, French vessel "Astrolabe" bound for Japan was the first vessel to be conducted along the NSR in 1991.

Transit transportation along the NSR is regularly carried out by vessels of the Murmansk shipping company in both directions.

Statistical data analysis shows that the most intensive 1988-1993 transportation has been carried out by vessels of Northern and Murmansk sea shipping companies along the following routes:

Arkhangelsk - Dudinka	- 71 vessel-trip per year
Murmansk - Dudinka	- 145 vessel-trip per year
Arkhangelsk-roadstead points	- 30 vessel-trip per year
Murmansk - roadstead points	- 28 vessel-trip per year
Arkhangelsk - Arctic port	- 46 vessel-trip per year
Murmansk - Arctic port	- 4 vessel-trip per year
Igarka - port of West Europe	- 89 vessel-trip per year (export of timber)
Arkhangelsk - island Spitsbergen	- 56 vessel-trip per year

Total: 413 vessel-trips per year

So, the traffic density involving vessels flying various flags in the region of contemplated building of the transshipment complex, is 413 vessels per year. The number of tanker sailing along the routes in the region of the neck of the White Sea is 1119 vessels per year, in the region of Kola bay - 1116 vessels per year (according to the data of Northern and Murmansk sea shipping companies).

The data of the Northern branch of CNIIMF indicates that the traffic density in the next years will not be changed considerably and will be equal to:

- in the region of building of ice-resistant platform	- in summer - 2.1 (vessels a day) - in winter - 0.8 (vessels a day)
- in the region of the neck of White Sea	- in summer - 4,5 (vessels a day) - in winter - 1.4 (vessels a day)
- in the region of Kola bay	- in summer - 4.3 (vessels a day) - in winter - 2.6 (vessels a day)

Besides, the results of the analysis show that the site for building of the transshipment complex lies far away of the main navigating routes, which is a favorable factor for the safety of tankers' navigation. .The main routes in the direction to the Yugorskiy Ball straits (Yugorskiy Shar) expand to the north from the ice-protected platform at a distance of 10-15 miles, and the main routes in the Kara Gates straits - at a distance of 60-70 miles.

The great number of vessels go through the Kara Gates straits in summer and winter. So, the traffic density in the region near to the transshipment complex is less than the above , and equals 1.0 vessels a day in summer and 0.5 vessels a day in winter. However, there are possibilities of navigational mistakes or technical damages done to vessels. As a result , vessels going along the main routes may appear in close proximity to the ice-protected platform.

Fencing moles

Construction of fencing moles is contemplated in the future.

Analysis of vessels' accident rate in the aquatorium of the "Prirazlomnoye" oil field.

The main cause of accidents in the region of "Prirazlomnoye" is ice damages. Table 2 shows the data of the Northern Sea shipping company on distribution of accidents broken down into months and kinds of accidents during the period from 1985 to 1993.

Table 2

Distribution of accidents in 1985-1993

Month	Flood	Accidents	Ice accidents	Total	
				During 8 years	per year
January			1	1	0.125
February				-	-
March			4	4	0.5
April			4	4	0.5
May			3	3	0.375
June			2	2	0.25
July				-	-
August				-	-
September	1			1	0.125
October				-	-
November	2	1		3	0.375
December	2		1	3	0.375
Total	5	1	15	21	2.625

In those regions, where traffic density evidently depends on season, the maximum number of accidents is reported on March - April and on November - December, and in summer the accident rate falls sharply.

APPENDIX 2

Conception of measures taken to protect nature when developing oil fields

Updating intensive technology of oil and gas production in the Arctic seas is characterized by an increasing environmental impact.

Different problems are connected with the probability of accidents which could arise as a result of the following factors:

- uncontrolled motion of stratum fluids along oil wells;
- interstratum flows caused by hydro-background formation and other reasons.

Accidents with submerged pipelines are the most dangerous during the development and functioning of fields.

International statistics shows that the emergency gushing probability equals:

- during drilling of oil wells $1.0\text{-}5.0 \times 10^{-3}$
- during repair of oil wells $1.0\text{-}2.5 \times 10^{-2}$

"... Threat of pollution with hydrocarbons during marine oil and gas production under Arctic conditions becomes more serious because of lack of approved technical means for localization and liquidation of oil floods in the ice including floods on unsolid ice cover and underwater floods. Under the conditions of pack drifting ice, oil hydrocarbons will affect plankton of that aquatorium where melting of the ice will happen. Lack of knowledge about behavior of pollution with hydrocarbons under Arctic conditions does not allow us to forecast for certain influence of accident floods on flora, fauna and also on interests of other branches of industry and navigation. So, it is necessary to carry out a complex of the following scientific-research and test-design works when developing fields of Arctic shelf:

- qualitative and quantitative estimation of interrelations between the marine constructions intended for oil and gas extraction and the environment. Estimation includes studying marine biota changes, changes of the bottom and shore strip, an influence of hydrometeorological and climatic conditions:
- elaboration and creation of effective technical and technological means for protection of the environment;
- elaboration of normative - technical documents to ensure ecological safety of technological procedures during the development of Arctic oil and gas fields."

Detailed description of ecological problems is presented in other INSROP projects : II.5.6. Environmental Impact Assessment, II.6.1. Control of Pollution from Ships, II.6.4. Ship Pollution Emergency Plan, II.6.5. Coastal Pollution Emergency Plan.

APPENDIX 3

Operational economic calculations on the prospective types and sizes of tanker fleet depending on the assumed directions

Appendix 3
TABLE 3.1
CAPITAL COSTS
INPUT DATA:

Type of vessel	NO-20A	
Construction cost	23.4	mlnUSD
Loan	80	%%
Period of loan	8.5	years
Interest	10	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	4.68	mlnUSD
Loan	18.72	mlnUSD
Payments for credit	8.424	mlnUSD
TOTAL	31.824	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	0.936	0.936	1.1012
2	0.8809	1.8169	2.2024
3	0.8259	2.6428	3.3035
4	0.7708	3.4136	4.4047
5	0.7158	4.1294	5.5059
6	0.6607	4.7901	6.6071
7	0.6056	5.3958	7.7082
8	0.5506	5.9464	8.8094
9	0.4955	6.4419	9.9106
10	0.4405	6.8824	11.012
11	0.3854	7.2678	12.113
12	0.3304	7.5981	13.214
13	0.2753	7.8734	14.315
14	0.2202	8.0936	15.416
15	0.1652	8.2588	16.518
16	0.1101	8.3689	17.619
17	0.0551	8.424	18.72

Appendix 3

TABLE 3.2

INPUT DATA:

vsl type	NO-20A	
cargo type	cr.oil	
quontity cargo	19.3	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	13.015	ths.USD/vsl-day
expences at berth	9.544	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	5.62	2.2	7.82	vsl-day
2	10.1	2.2	12.3	vsl-day
3	9.93	2.2	12.13	vsl-day

Capital costs:

constr. cost	23.4 mlnUSD
advance	4.68 mlnUSD
loan	18.72 mlnUSD
payments for credit	8.424 mlnUSD
TOTAL	31.824 mlnUSD

VARIANTS:

1 Varandey - Murmansk
2 Jamburg - Murmansk
3 Dudinka - Murmansk

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	2.46803	1.56911	1.5911	ths.t/vsl-day
Necessary number	5.95855	9.37214	9.24261	vsl
TCE, total	97.5936	153.504	151.382	thsUSD/voyage
expences on proceeding	73.1443	131.452	129.239	thsUSD/voyage
expences at berth	20.9968	20.9968	20.9968	thsUSD/voyage
TOTAL expl.expences	94.1411	152.448	150.236	thsUSD/voyage
RFR	9.93444	15.8525	15.6279	USD/t

Capital Cost	11.34545 thsUSD/vsl-day
TCE	12.48 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

Appendix 3
TABLE 3.3
CAPITAL COSTS
INPUT DATA:

Type of vessel	NO-20A	
Construction cost	23.4	mlnUSD
Loan	40	%%
Period of loan	8.5	years
Interest	10	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	14.04	mlnUSD
Loan	9.36	mlnUSD
Payments for credit	4.212	mlnUSD
TOTAL	27.612	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	0.468	0.468	0.5506
2	0.4405	0.9085	1.1012
3	0.4129	1.3214	1.6518
4	0.3854	1.7068	2.2024
5	0.3579	2.0647	2.7529
6	0.3304	2.3951	3.3035
7	0.3028	2.6979	3.8541
8	0.2753	2.9732	4.4047
9	0.2478	3.2209	4.9553
10	0.2202	3.4412	5.5059
11	0.1927	3.6339	6.0565
12	0.1652	3.7991	6.6071
13	0.1376	3.9367	7.1576
14	0.1101	4.0468	7.7082
15	0.0826	4.1294	8.2588
16	0.0551	4.1845	8.8094
17	0.0275	4.212	9.36

Appendix 3

TABLE 3.4

INPUT DATA:

vsl type	NO-20A	
cargo type	cr.oil	
quontity cargo	19.3	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	13.015	ths.USD/vsl-day
expences at berth	9.544	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	5.62	2.2	7.82	vsl-day
2	10.1	2.2	12.3	vsl-day
3	9.93	2.2	12.13	vsl-day

Capital costs:

constr. cost	23.4 mlnUSD
advance	14.04 mlnUSD
loan	9.36 mlnUSD
payments for credit	4.212 mlnUSD
TOTAL	27.612 mlnUSD

VARIANTS:

1 Varandey - Murmansk
2 Jamburg - Murmansk
3 Dudinka - Murmansk

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	2.46803	1.56911	1.5911	ths.t/vsl-day
Necessary number	5.95855	9.37214	9.24261	vsl
TCE, total	84.6768	133.187	131.346	thsUSD/voyage
expences on proceeding	73.1443	131.452	129.239	thsUSD/voyage
expences at berth	20.9968	20.9968	20.9968	thsUSD/voyage
TOTAL expl.expences	94.1411	152.448	150.236	thsUSD/voyage
RFR	9.26518	14.7998	14.5898	USD/t

Capital Cost	9.84385 thsUSD/vsl-day
TCE	10.82824 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

Appendix 3
TABLE 3.5
CAPITAL COSTS
INPUT DATA:

Type of vessel	NO-20A	
Construction cost	23.4	mlnUSD
Loan	80	%%
Period of loan	8.5	years
Interest	15	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	4.68	mlnUSD
Loan	18.72	mlnUSD
Payments for credit	12.636	mlnUSD
TOTAL	36.036	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	1.404	1.404	1.1012
2	1.3214	2.7254	2.2024
3	1.2388	3.9642	3.3035
4	1.1562	5.1205	4.4047
5	1.0736	6.1941	5.5059
6	0.9911	7.1852	6.6071
7	0.9085	8.0936	7.7082
8	0.8259	8.9195	8.8094
9	0.7433	9.6628	9.9106
10	0.6607	10.324	11.012
11	0.5781	10.902	12.113
12	0.4955	11.397	13.214
13	0.4129	11.81	14.315
14	0.3304	12.14	15.416
15	0.2478	12.388	16.518
16	0.1652	12.553	17.619
17	0.0826	12.636	18.72

Appendix 3

TABLE 3.6

INPUT DATA: vsl type NO-20A
cargo type cr.oil

quontity cargo	19.3	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	13.015	ths.USD/vsl-day
expences at berth	9.544	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	5.62	2.2	7.82	vsl-day
2	10.1	2.2	12.3	vsl-day
3	9.93	2.2	12.13	vsl-day

Capital costs:

constr. cost	23.4 mlnUSD
advance	4.68 mlnUSD
loan	18.72 mlnUSD
payments for credit	12.636 mlnUSD
TOTAL	36.036 mlnUSD

VARIANTS:

1 Varandey - Murmansk
2 Jamburg - Murmansk
3 Dudinka - Murmansk

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	2.46803	1.56911	1.5911	ths.t/vsl-day
Necessary number	5.95855	9.37214	9.24261	vsl
TCE, total	110.51	173.821	171.418	thsUSD/voyage
expences on proceeding	73.1443	131.452	129.239	thsUSD/voyage
expences at berth	20.9968	20.9968	20.9968	thsUSD/voyage
TOTAL expl.expences	94.1411	152.448	150.236	thsUSD/voyage
RFR	10.6037	16.9051	16.666	USD/t

Capital Cost	12.84706 thsUSD/vsl-day
TCE	14.13176 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

Appendix 3

TABLE 3.7

CAPITAL COSTS

INPUT DATA:

Type of vessel	NO-20A	
Construction cost	23.4	mlnUSD
Loan	40	%%
Period of loan	8.5	years
Interest	15	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	14.04	mlnUSD
Loan	9.36	mlnUSD
Payments for credit	6.318	mlnUSD
TOTAL	29.718	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	0.702	0.702	0.5506
2	0.6607	1.3627	1.1012
3	0.6194	1.9821	1.6518
4	0.5781	2.5602	2.2024
5	0.5368	3.0971	2.7529
6	0.4955	3.5926	3.3035
7	0.4542	4.0468	3.8541
8	0.4129	4.4598	4.4047
9	0.3716	4.8314	4.9553
10	0.3304	5.1618	5.5059
11	0.2891	5.4508	6.0565
12	0.2478	5.6986	6.6071
13	0.2065	5.9051	7.1576
14	0.1652	6.0702	7.7082
15	0.1239	6.1941	8.2588
16	0.0826	6.2767	8.8094
17	0.0413	6.318	9.36

Appendix 3

TABLE 3.8

INPUT DATA:

vsl type	NO-20A	
cargo type	cr.oil	
quontity cargo	19.3	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	13.015	ths.USD/vsl-day
expences at berth	9.544	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	5.62	2.2	7.82	vsl-day
2	10.1	2.2	12.3	vsl-day
3	9.93	2.2	12.13	vsl-day

Capital costs:

constr. cost	23.4 mlnUSD
advance	14.04 mlnUSD
loan	9.36 mlnUSD
payments for credit	6.318 mlnUSD
TOTAL	29.718 mlnUSD

VARIANTS:

1 Varandey - Murmansk
2 Jamburg - Murmansk
3 Dudinka - Murmansk

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	2.46803	1.56911	1.5911	ths.t/vsl-day
Necessary number	5.95855	9.37214	9.24261	vsl
TCE, total	91.1352	143.346	141.364	thsUSD/voyage
expences on proceeding	73.1443	131.452	129.239	thsUSD/voyage
expences at berth	20.9968	20.9968	20.9968	thsUSD/voyage
TOTAL expl.expences	94.1411	152.448	150.236	thsUSD/voyage
RFR	9.59981	15.3261	15.1088	USD/t

Capital Cost	10.59465 thsUSD/vsl-day
TCE	11.65412 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

Appendix 3
TABLE 3.9
CAPITAL COSTS
INPUT DATA:

Type of vessel	NO-85A	
Construction cost	43.4	mlnUSD
Loan	80	%%
Period of loan	8.5	years
Interest	10	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	8.68	mlnUSD
Loan	34.72	mlnUSD
Payments for credit	15.624	mlnUSD
TOTAL	59.024	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	1.736	1.736	2.0424
2	1.6339	3.3699	4.0847
3	1.5318	4.9016	6.1271
4	1.4296	6.3313	8.1694
5	1.3275	7.6588	10.212
6	1.2254	8.8842	12.254
7	1.1233	10.008	14.296
8	1.0212	11.029	16.339
9	0.9191	11.948	18.381
10	0.8169	12.765	20.424
11	0.7148	13.48	22.466
12	0.6127	14.092	24.508
13	0.5106	14.603	26.551
14	0.4085	15.011	28.593
15	0.3064	15.318	30.635
16	0.2042	15.522	32.678
17	0.1021	15.624	34.72

Appendix 3

TABLE /3.10/

INPUT DATA: vsl type NO-85A

cargo type cr.oil

quontity cargo	81.06	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	15.365	ths.USD/vsl-day
expences at berth	11.591	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	3.3	2.5	5.8	vsl-day
2	3.5	2.5	6	vsl-day
3	3.43	2.5	5.93	vsl-day

Capital costs:

constr. cost	43.4 mlnUSD
advance	8.68 mlnUSD
loan	34.72 mlnUSD
payments for credit	15.624 mlnUSD
TOTAL	59.024 mlnUSD

VARIANTS:

1 Varandey - Murmansk (summer)
2 Varandey - Murmansk (winter)
3 Varandey - Murmansk (average)

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	13.9759	13.51	13.6695	ths.t/vsl-day
Necessary number	1.05223	1.08852	1.07582	vsl
TCE, total	134.251	138.88	137.26	thsUSD/voyage
expences on proceeding	50.7045	53.7775	52.702	thsUSD/voyage
expences at berth	28.9775	28.9775	28.9775	thsUSD/voyage
TOTAL expl.expences	79.682	82.755	81.6795	thsUSD/voyage
RFR	2.63919	2.73421	2.70095	USD/t

Capital Cost	21.04242 thsUSD/vsl-day
TCE	23.14667 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

Appendix 3
TABLE 3.11
CAPITAL COSTS
INPUT DATA:

Type of vessel	NO-85A	
Construction cost	43.4	mlnUSD
Loan	40	%%
Period of loan	8.5	years
Interest	10	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	26.04	mlnUSD
Loan	17.36	mlnUSD
Payments for credit	7.812	mlnUSD
TOTAL	51.212	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	0.868	0.868	1.0212
2	0.8169	1.6849	2.0424
3	0.7659	2.4508	3.0635
4	0.7148	3.1656	4.0847
5	0.6638	3.8294	5.1059
6	0.6127	4.4421	6.1271
7	0.5616	5.0038	7.1482
8	0.5106	5.5144	8.1694
9	0.4595	5.9739	9.1906
10	0.4085	6.3824	10.212
11	0.3574	6.7398	11.233
12	0.3064	7.0461	12.254
13	0.2553	7.3014	13.275
14	0.2042	7.5056	14.296
15	0.1532	7.6588	15.318
16	0.1021	7.7609	16.339
17	0.0511	7.812	17.36

TABLE 3.12

INPUT DATA:

vsl type	NO-85A	
cargo type	cr.oil	
quontity cargo	81.06	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	15.365	ths.USD/vsl-day
expences at berth	11.591	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	3.3	2.5	5.8	vsl-day
2	3.5	2.5	6	vsl-day
3	3.43	2.5	5.93	vsl-day

Capital costs:

constr. cost	43.4 mlnUSD
advance	26.04 mlnUSD
loan	17.36 mlnUSD
payments for credit	7.812 mlnUSD
TOTAL	51.212 mlnUSD

VARIANTS:

1 Varandey - Murmansk (summer)
2 Varandey - Murmansk (winter)
3 Varandey - Murmansk (average)

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	13.9759	13.51	13.6695	ths.t/vsl-day
Necessary number	1.05223	1.08852	1.07582	vsl
TCE, total	116.482	120.499	119.093	thsUSD/voyage
expences on proceeding	50.7045	53.7775	52.702	thsUSD/voyage
expences at berth	28.9775	28.9775	28.9775	thsUSD/voyage
TOTAL expl.expences	79.682	82.755	81.6795	thsUSD/voyage
RFR	2.41999	2.50745	2.47684	USD/t

Capital Cost	18.2574 thsUSD/vsl-day
TCE	20.08314 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

Appendix 3
TABLE 3.13
CAPITAL COSTS
INPUT DATA:

Type of vessel	NO-85A	
Construction cost	43.4	mlnUSD
Loan	80	%%
Period of loan	8.5	years
Interest	15	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	8.68	mlnUSD
Loan	34.72	mlnUSD
Payments for credit	23.436	mlnUSD
TOTAL	66.836	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	2.604	2.604	2.0424
2	2.4508	5.0548	4.0847
3	2.2976	7.3525	6.1271
4	2.1445	9.4969	8.1694
5	1.9913	11.488	10.212
6	1.8381	13.326	12.254
7	1.6849	15.011	14.296
8	1.5318	16.543	16.339
9	1.3786	17.922	18.381
10	1.2254	19.147	20.424
11	1.0722	20.219	22.466
12	0.9191	21.138	24.508
13	0.7659	21.904	26.551
14	0.6127	22.517	28.593
15	0.4595	22.976	30.635
16	0.3064	23.283	32.678
17	0.1532	23.436	34.72

Appendix 3

TABLE 3.14

INPUT DATA:

vsl type	NO-85A	
cargo type	cr.oil	
quontity cargo	81.06	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	15.365	ths.USD/vsl-day
expences at berth	11.591	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	3.3	2.5	5.8	vsl-day
2	3.5	2.5	6	vsl-day
3	3.43	2.5	5.93	vsl-day

Capital costs:

constr. cost	43.4 mlnUSD
advance	8.68 mlnUSD
loan	34.72 mlnUSD
payments for credit	23.436 mlnUSD
TOTAL	66.836 mlnUSD

VARIANTS:

1 Varandey - Murmansk (summer)
2 Varandey - Murmansk (winter)
3 Varandey - Murmansk (average)

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	13.9759	13.51	13.6695	ths.t/vsl-day
Necessary number	1.05223	1.08852	1.07582	vsl
TCE, total	152.019	157.261	155.426	thsUSD/voyage
expences on proceeding	50.7045	53.7775	52.702	thsUSD/voyage
expences at berth	28.9775	28.9775	28.9775	thsUSD/voyage
TOTAL expl.expences	79.682	82.755	81.6795	thsUSD/voyage
RFR	2.85839	2.96097	2.92507	USD/t

Capital Cost	23.82745 thsUSD/vsl-day
TCE	26.2102 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

Appendix 3
TABLE 3.15
CAPITAL COSTS
INPUT DATA:

Type of vessel	NO-85A	
Construction cost	43.4	mlnUSD
Loan	40	%%
Period of loan	8.5	years
Interest	15	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	26.04	mlnUSD
Loan	17.36	mlnUSD
Payments for credit	11.718	mlnUSD
TOTAL	55.118	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	1.302	1.302	1.0212
2	1.2254	2.5274	2.0424
3	1.1488	3.6762	3.0635
4	1.0722	4.7485	4.0847
5	0.9956	5.7441	5.1059
6	0.9191	6.6632	6.1271
7	0.8425	7.5056	7.1482
8	0.7659	8.2715	8.1694
9	0.6893	8.9608	9.1906
10	0.6127	9.5735	10.212
11	0.5361	10.11	11.233
12	0.4595	10.569	12.254
13	0.3829	10.952	13.275
14	0.3064	11.258	14.296
15	0.2298	11.488	15.318
16	0.1532	11.641	16.339
17	0.0766	11.718	17.36

Appendix 3

TABLE 3.16

INPUT DATA:

vsl type	NO-85A	
cargo type	cr.oil	
quontity cargo	81.06	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	15.365	ths.USD/vsl-day
expences at berth	11.591	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	3.3	2.5	5.8	vsl-day
2	3.5	2.5	6	vsl-day
3	3.43	2.5	5.93	vsl-day

Capital costs:

constr. cost	43.4 mlnUSD
advance	26.04 mlnUSD
loan	17.36 mlnUSD
payments for credit	11.718 mlnUSD
TOTAL	55.118 mlnUSD

VARIANTS:

1 Varandey - Murmansk (summer)
2 Varandey - Murmansk (winter)
3 Varandey - Murmansk (average)

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	13.9759	13.51	13.6695	ths.t/vsl-day
Necessary number	1.05223	1.08852	1.07582	vsl
TCE, total	125.366	129.689	128.176	thsUSD/voyage
expences on proceeding	50.7045	53.7775	52.702	thsUSD/voyage
expences at berth	28.9775	28.9775	28.9775	thsUSD/voyage
TOTAL expl.expences	79.682	82.755	81.6795	thsUSD/voyage
RFR	2.52959	2.62083	2.58889	USD/t

Capital Cost	19.64991 thsUSD/vsl-day
TCE	21.6149 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

Appendix 3
TABLE 3.17
CAPITAL COSTS
INPUT DATA:

Type of vessel	NO-125A	
Construction cost	77.2	mlnUSD
Loan	80	%%
Period of loan	8.5	years
Interest	10	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	15.44	mlnUSD
Loan	61.76	mlnUSD
Payments for credit	27.792	mlnUSD
TOTAL	104.992	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	3.088	3.088	3.6329
2	2.9064	5.9944	7.2659
3	2.7247	8.7191	10.899
4	2.5431	11.262	14.532
5	2.3614	13.624	18.165
6	2.1798	15.803	21.798
7	1.9981	17.801	25.431
8	1.8165	19.618	29.064
9	1.6348	21.253	32.696
10	1.4532	22.706	36.329
11	1.2715	23.977	39.962
12	1.0899	25.067	43.595
13	0.9082	25.976	47.228
14	0.7266	26.702	50.861
15	0.5449	27.247	54.494
16	0.3633	27.61	58.127
17	0.1816	27.792	61.76

Appendix 3

TABLE 3.18

INPUT DATA:

vsl type	NO-125A	
cargo type	cr.oil	
quontity cargo	128.5	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	19.516	ths.USD/vsl-day
expences at berth	14.722	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	13.2	1.8	15	vsl-day
2	14.3	2	16.3	vsl-day
3	13.65	1.9	15.55	vsl-day

Capital costs:

constr. cost	77.2 mlnUSD
advance	15.44 mlnUSD
loan	61.76 mlnUSD
payments for credit	27.792 mlnUSD
TOTAL	104.992 mlnUSD

VARIANTS:

1 Varandey - Hamburg (summer)
2 Varandey - Hamburg (winter)
3 Varandey - Hamburg (average)

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	8.56667	7.88344	8.26367	ths.t/vsl-day
Necessary number	1.71664	1.86542	1.77958	vsl
TCE, total	617.6	671.125	640.245	thsUSD/voyage
expences on proceeding	257.611	279.079	266.393	thsUSD/voyage
expences at berth	26.4996	29.444	27.9718	thsUSD/voyage
TOTAL expl.expences	284.111	308.523	294.365	thsUSD/voyage
RFR	7.0172	7.62372	7.27323	USD/t

Capital Cost	37.4303 thsUSD/vsl-day
TCE	41.17333 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

Appendix 3

TABLE 3.19

CAPITAL COSTS

INPUT DATA:

Type of vessel	NO-125A	
Construction cost	77.2	mlnUSD
Loan	40	%%
Period of loan	8.5	years
Interest	10	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	46.32	mlnUSD
Loan	30.88	mlnUSD
Payments for credit	13.896	mlnUSD
TOTAL	91.096	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	1.544	1.544	1.8165
2	1.4532	2.9972	3.6329
3	1.3624	4.3595	5.4494
4	1.2715	5.6311	7.2659
5	1.1807	6.8118	9.0824
6	1.0899	7.9016	10.899
7	0.9991	8.9007	12.715
8	0.9082	9.8089	14.532
9	0.8174	10.626	16.348
10	0.7266	11.353	18.165
11	0.6358	11.989	19.981
12	0.5449	12.534	21.798
13	0.4541	12.988	23.614
14	0.3633	13.351	25.431
15	0.2725	13.624	27.247
16	0.1816	13.805	29.064
17	0.0908	13.896	30.88

Appendix 3
TABLE /3.20/
INPUT DATA: vsl type NO-125A
cargo type cr.oil

quontity cargo	128.5	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	19.516	ths.USD/vsl-day
expences at berth	14.722	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	13.2	1.8	15	vsl-day
2	14.3	2	16.3	vsl-day
3	13.65	1.9	15.55	vsl-day

Capital costs:

constr. cost	77.2 mlnUSD
advance	46.32 mlnUSD
loan	30.88 mlnUSD
payments for credit	13.896 mlnUSD
TOTAL	91.096 mlnUSD

VARIANTS:
1 Varandey - Hamburg (summer)
2 Varandey - Hamburg (winter)
3 Varandey - Hamburg (average)

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	8.56667	7.88344	8.26367	ths.t/vsl-day
Necessary number	1.71664	1.86542	1.77958	vsl
TCE, total	535.859	582.3	555.507	thsUSD/voyage
expences on proceeding	257.611	279.079	266.393	thsUSD/voyage
expences at berth	26.4996	29.444	27.9718	thsUSD/voyage
TOTAL expl.expences	284.111	308.523	294.365	thsUSD/voyage
RFR	6.38109	6.93247	6.61379	USD/t

Capital Cost 32.47629 thsUSD/vsl-day
TCE 35.72392 thsUSD/vsl-day

****

Abbreviation:
TCE time-charter equivalent
RFR required freight rate

Appendix 3
TABLE 3.21
CAPITAL COSTS
INPUT DATA:

Type of vessel	NO-125A	
Construction cost	77.2	mlnUSD
Loan	80	%%
Period of loan	8.5	years
Interest	15	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	15.44	mlnUSD
Loan	61.76	mlnUSD
Payments for credit	41.688	mlnUSD
TOTAL	118.888	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	4.632	4.632	3.6329
2	4.3595	8.9915	7.2659
3	4.0871	13.079	10.899
4	3.8146	16.893	14.532
5	3.5421	20.435	18.165
6	3.2696	23.705	21.798
7	2.9972	26.702	25.431
8	2.7247	29.427	29.064
9	2.4522	31.879	32.696
10	2.1798	34.059	36.329
11	1.9073	35.966	39.962
12	1.6348	37.601	43.595
13	1.3624	38.963	47.228
14	1.0899	40.053	50.861
15	0.8174	40.871	54.494
16	0.5449	41.416	58.127
17	0.2725	41.688	61.76

Appendix 3
TABLE 3.22

INPUT DATA:

vsl type	NO-125A	
cargo type	cr.oil	
quontity cargo	128.5	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	19.516	ths.USD/vsl-day
expences at berth	14.722	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	13.2	1.8	15	vsl-day
2	14.3	2	16.3	vsl-day
3	13.65	1.9	15.55	vsl-day

Capital costs:

constr. cost	77.2 mlnUSD
advance	15.44 mlnUSD
loan	61.76 mlnUSD
payments for credit	41.688 mlnUSD
TOTAL	118.888 mlnUSD

VARIANTS:

1 Varandey - Hamburg (summer)
2 Varandey - Hamburg (winter)
3 Varandey - Hamburg (average)

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	8.56667	7.88344	8.26367	ths.t/vsl-day
Necessary number	1.71664	1.86542	1.77958	vsl
TCE, total	699.341	759.951	724.984	thsUSD/voyage
expences on proceeding	257.611	279.079	266.393	thsUSD/voyage
expences at berth	26.4996	29.444	27.9718	thsUSD/voyage
TOTAL expl.expences	284.111	308.523	294.365	thsUSD/voyage
RFR	7.65332	8.31497	7.93268	USD/t

Capital Cost	42.38431 thsUSD/vsl-day
TCE	46.62275 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

Appendix 3
TABLE 3.23
CAPITAL COSTS
INPUT DATA:

Type of vessel	NO-125A	
Construction cost	77.2	mlnUSD
Loan	40	%%
Period of loan	8.5	years
Interest	15	%% per year
Number of loan repayments	2	per year

****

RESULTS OF CALCULATION:

Total number of loan repayment	17	
Advance (deposit)	46.32	mlnUSD
Loan	30.88	mlnUSD
Payments for credit	20.844	mlnUSD
TOTAL	98.044	mlnUSD

CALCULATED CASH FLOW mlnUSD

Period	Current interest	Integrated data: interest	Integrated data: loan repayment
1	2.316	2.316	1.8165
2	2.1798	4.4958	3.6329
3	2.0435	6.5393	5.4494
4	1.9073	8.4466	7.2659
5	1.7711	10.218	9.0824
6	1.6348	11.852	10.899
7	1.4986	13.351	12.715
8	1.3624	14.713	14.532
9	1.2261	15.94	16.348
10	1.0899	17.029	18.165
11	0.9536	17.983	19.981
12	0.8174	18.8	21.798
13	0.6812	19.482	23.614
14	0.5449	20.027	25.431
15	0.4087	20.435	27.247
16	0.2725	20.708	29.064
17	0.1362	20.844	30.88

Appendix 3

TABLE 3.24

INPUT DATA:

vsl type	NO-125A	
cargo type	cr.oil	
quontity cargo	128.5	ths.t
operation period	330	days/year
year cargo volume	5000	ths.t
expences on proceeding	19.516	ths.USD/vsl-day
expences at berth	14.722	ths.USD/vsl-day

Budget of voyage time

Variant	proceed	berth	TOTAL	
1	13.2	1.8	15	vsl-day
2	14.3	2	16.3	vsl-day
3	13.65	1.9	15.55	vsl-day

Capital costs:

constr. cost	77.2 mlnUSD
advance	46.32 mlnUSD
loan	30.88 mlnUSD
payments for credit	20.844 mlnUSD
TOTAL	98.044 mlnUSD

VARIANTS:

1 Varandey - Hamburg (summer)
2 Varandey - Hamburg (winter)
3 Varandey - Hamburg (average)

****

RESULTS OF CALCULATION:

Variant	1	2	3	
Carrying capacity	8.56667	7.88344	8.26367	ths.t/vsl-day
Necessary number	1.71664	1.86542	1.77958	vsl
TCE, total	576.729	626.713	597.876	thsUSD/voyage
expences on proceeding	257.611	279.079	266.393	thsUSD/voyage
expences at berth	26.4996	29.444	27.9718	thsUSD/voyage
TOTAL expl.expences	284.111	308.523	294.365	thsUSD/voyage
RFR	6.69915	7.2781	6.94351	USD/t

Capital Cost	34.9533 thsUSD/vsl-day
TCE	38.44863 thsUSD/vsl-day

****

Abbreviation:

TCE	time-charter equivalent
RFR	required freight rate

REVIEWS

1. By Jørgen Ole Bærenholdt of INSROP report III.01.3 (of which Part1 has been integrated into this III.07.3 report)

2. By W.A. Patience of this III.07.3 report.

Jørgen Ole Bærenholdt 29 January 1996

Review of INSROP projekt III.01.3: 'Part 1: Development of Oil exports in Northern Russia, Part 2: Development of Gas/LNG Export in Northern Russia' by Y. Ivanov et al.

General comments - and suggestions for INSROP.

This report (part 1 and 2) is first of all a comprehensive technical and partly economical feasibility studies of alternativ possibilities to construct and operate vessels and port fascilities for transport of oil/gas from two specific deposits under exploitation to:

- in part 1: Prirazlomnoye oil deposit in Nenets Autonomous Okrug within Arkhangelsk Oblast (sea transport to Rotterdam)

- in part 2: Harasavey roadstead for gas deposits in Yamal Peninsula in Yamal Nenets Autonomous Okrug within Tyumen Oblast (sea transport to Wilhelmshaven)

As this is the case, and comparative analysis with other projects is not carried out, first of all **the title of the paper has to be changed** in accordance with its specific content. Otherwise, readers of the paper are very surprised and maybe disappointed, as the project is a part of the INSROP Subprogramme III: Trade and Commercial Shipping Aspects.

As a human geographer, I am not able to review the paper in respect to technical qualitities within construction of vessels and terminals/roadsteads. As technical considerations is the main content of the paper, a **review by a non-Russian ship constructor** or the like actually also ought to be carried out. I presume the paper has qualitities in this respect, which I do not have the qualifications to appreciate.

When that is said, in relation to oil and gas the subprogramme III would need to investigate several research questions, which is not studied in any detail in this paper (nor are there references to other INSROP projects on such questions:)

1. - the socio-econonomic preconditions for and consequences of oil and gas exports of Northern Russia - including analysis of market trends (also in Asia) and possible competitive suppliers. Exports of raw materials as hyrbocarbons is not necessary the most interestering prospect for Russia in the long-run (maybe for the North - maybe not because of reasons given in point 2 beneath).
   - Part 1 mentions an interesting prospect of development of a fuel-power complex in Arkhangelsk and Murmansk Regions, which ought to be studied in more detail.
   - Also possibilities to use domestic experiences (Severovinsk) for construction is considered in part 2 as a reason for specific choices of tech-

nologies - but not discussed in more detail. Maybe, it is already a political decision to do so.
- Evalueration of possible use of NSR for raw material export from other locations in the Russian Extreme North is mentioned in the conclusion of part 2 - but not included.

2. - the environmental sustainability of sea transport of hydrocarbons in Arctic Seas is considered in the paper - but it is not studied in any detail. As the environmental consequences and risks of Arctic Sea transport of hydrocarbons is very much discussed (i.e. in relation to the Davies Strait), this is a major limitation of a technical feasability paper. It seems that there is a major problem of lack of data within this issue. (Nor are there any references to other INSROP projects (subprogramme II) on these problems)

Such questions would be interesting to study within an **international research group** of both Russian and foreign researchers (of the same generation!). This is also true in relation to the type of technical questions analysed in the paper, where Russia lacks own experience - i.e. construction of LNG vessels (see detailed comments in relation to section 2.4.1).

It would also be interesting to know what kind of relation this project has to the Northern Gate project by several international oil compagnies, as the Northern Gate expression is only used in maps. And it would be interesting to know what is the relation between the LNGtransportproject and the pipelines already under construction from Yamal Peninsula (these questions are raised on the background of information from "INSROP Dscussion Paper 1995 III.02.3 Selected Issues in Regional Economic Developement along the NSR: Oil and gas in the north-western part of Russia" by Vigdis Nygaard, FINNUT).

Finally, the reader can not feel whether or not **field studies** in the two case regions has be carried out, as the paper has no statements of the research process and of the possible limitations in the approach chosen.

Comments on the way of presenting.

Maps in part 1 should have only English text. To draw more maps and detailed plans would make the paper much more easier to read and more trustworthy. This is especially the case for the current draft of part 2 - which in my copy only included one map (figure 2.1 using a (non-polar) map projection not favourable to the image of NSR).

Pagenumbers lack.

A section 2.4 "Basic technical and operational requirements to Arctic going vessels" is not mentioned in the list of contents, comes before section 2.3 and the other (true?) section 2.4

"Basic technical decisions for LNG loading terminal in Port Harasavey".

Although I'm not qualified, I feel English spelling and especially grammar ought to be checked.

Some critical detailed comments.
- with reference to section numbers due to lack of page numbers.

part 1:

1.1 ..."gradual motion of extrative industry forward to the North (...) are objective process..." - why???

1.2 Prirazlomnoye is **not** 360 km from Murmansk.

1.2 "- reduction of transport expenses necessary for fuel delivery from southern regions of the country" - what is the point? To which other fuel sources will Prirazlomnoye be competitive? Under what political and economic conditions?

1.6 Presumarily, the c) high sea variant location of oil terminal would be even less interesting, if raw oil was not to be exported - but refined in Arkhangelsk or Murmansk Region.

1.7 most of section "Ecological aspect of the problem" (less than one page) is a quote (" .. ") - from where???

part 2:

list of abbreviations does not include all abbreviations used - (and I think include several not used)

table 2.2 lacks unit (cm?)

2.4(first) the paper lacks a critical evaluation of prospects of large-scale ice-breakers and LNG carriers - suggested to be the most reasonable choice from a economic point of view. Calculations are founded in presumptions of scale-economics, which is not considering socio-economic and environmental aspects.

2.4(first) interesting and reasonable to point at "protection of interests of domestic producers, development of conversion process, interests of gas extraction branch, political aspects and protection of economic interests of Russia in the whole, must be considerend in detials in seperate research..." as reasons for chosing a "79 ths.cub.m LNG" ship - and not the larger type "125 ths.cub.m LNG". Further research should also investigate possible dif-

ferences in enviromental risks between large ("79") and very large ("125") LNG carriers.

2.4(true?) in-complete reference to "...second part of ths work "A Feasibility study of coastal cargo handling complex in the port Harasavey..." - is it the "LenmorNIIproject" (which is?) mentioned in the introduction of part 2?

2.4.1 (already mentioned in general comments:) A very good recognition a limiation of the paper: "This part of work presents general data on technological decisions concerning berths LNG on the base of avialable materials (translations, booklets etc.) and foreign experience, because Russia does not have normative basis and own experience in transshipment and transport by sea and river vessels"

2.4.1 handbook not mentioned in reference list (reference mentioned in text "RD 31.01.01-93" not understandable to the outsider)

2.4.2 "Network of local roads in that region mainly consits of..." rest of sentence is lacking (as well as a map of the road network - where/what is picture "N297950"?)

2.7 "Main requirements to preserving the environment" (3 pages) - only consists of requirements from Marpol 73/78 (which is?) and Russian laws

2.8 8 "Economic efficiency of all investments in LNG transportation by Marine Transport from Harasavey port is being carried out by VNIIgas" (Which is? - When are results ready?

2.8 9 mentioning the possibilities of development of Harasavey port as gas/oil center for other deposits than Yamal
- "(through subwater pipe over Ob bay)" makes the reader ask questions of the environment - compared to the critical discussions on pipe over Baydaraskaya Guba.

2.8 "...world market is evaluated as moderately optimistic, from one side there is a progressive increasing of needs in natural gas, from other side a price for this power bearer on a world market is hard tighened with a price of oil which in its turn has not a stable trend to increase for a while..." Of course these reasonable considerations are desicive to the outmost for the calculation following.

Part 2 does not include any considerations of the possible relations (contradictions or interconnections in questions of environment, economy or technology) between the Yamal gas

deposit exploitation and the future Stochmannaskaya gas project. Nor are future possibilities of Russian export of technology considered.

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Attention: Claes Lykke Ragner

Dear Mr Ragner

In response to your request for Brown & Root to provide a review critique of the INSROP Discussion Paper "Marine oil transport from Timano Pechora and inland Russian Fields", I must reluctantly decline to provide the comprehensive technical review that we would ordinarily like to respond to such a request with. The subject matter of the discussion paper, namely the technical and economic evaluation of tanker movement of oil in ice affected marine environments, is not an area where Brown & Root claims any unique insights, and I do not believe we could do a full technical evaluation justice.

However, in response to prompting from our partners, Arkhangelskgeologia, and our desire to assist the development of the energy resources of the Timan Pechora region, I can make the following more generalised comments on the report, which I hope will be of assistance to your work.

1. The report is substantial and has obviously been extensively and well researched. It contains a lot of technical material covering a range of specialised areas. This increases the importance of presenting the material, and the messages the authors intend to convey, in a logical and well structured way. The English translation of the document is however, generally weak, and makes reading and understanding difficult. In some places the translation is ambiguous and the meaning of the authors is not clear. A considerable effort is required in this area, to ensure the authors' intent is clearly reflected to the English speaker.

2. In my experience the report would benefit from leading with a well constructed "executive summary". This would be a high level summary of the key points from each section of the paper, ending with the principal conclusions of the paper. This device ensures that the reader is presented with the key messages from the report at his time of peak attention. This summary should be no more than three pages long, be illuminated with diagrams, be tailored for the intended audience and be easily understandable to readers who are not specialised in the specific fields of the paper.

3. The paper fails to confront what I would expect to be a central issue, i.e. how effective will the proposed marine tanker solution be, in competing against the "opposing" pipeline alternatives. Ultimately, if the tanker solution cannot be made economically attractive to potential customers, it will not be possible to obtain usage commitments, and therefore extremely difficult to finance the construction of the required fleet.

4. The paper, in my view, sits astride a position between a centrally planned economy solution (i.e. one which considers the merits of the scheme principally on the basis of the overall benefit to Russian society and the N.W. of Russia in particular), and a free market economy solution (i.e. one which simply considers the merits of the scheme on the basis of it's economic viability). Whilst, this position is quite possibly the correct view to adopt, in determining the best solution for the transportation of oil from Timan Pechora, it is not very clearly articulated in the paper. I would recommend that the authors, set out a position early in their paper, that they feel constitutes appropriate criteria for determining the preferred solution.

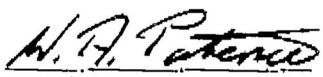
5. The economic evaluation of the tanker fleet proposal is weak, and would not be recognised or accepted as providing adequate information to even begin to consider the economic merits of utilising tankers by financial institutions. When considered alongside the volume and depth of the technical discussion in the paper, it creates a significant imbalance.

6. The paper seems to neglect what may possibly be a key advantage of a tanker based system over a pipeline system, and that is flexibility. By this I mean flexibility in investment requirements, flexibility in delivery locations, flexibility in responding to changing economic conditions (e.g. future internal consumption of oil instead of export), and flexibility in meeting fluctuating use demand.

7. Conversely the paper, rightly, raises the issue of the possibility and potential cost of a major oil spill and its resultant environmental consequences. It does not however go on to deal with the issue to any satisfactory resolution, but simply leaves the fear in the mind of the reader, that such a disaster is possibly inevitable and that the costs involved may exceed any economic benefit of the system for many years. The paper would, in my view, benefit from a well constructed risk analysis of the scheme and comparison with the risks associated with the opposing pipeline solutions.

I trust that you find these comments constructive, and they will help the authors refine their paper, so as to enhance its effectiveness and impact.

Yours Sincerely



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AUTHORS' ANSWER TO THE REVIEWS

We really appreciate the useful comments made by Mrs I.O.Baerhold and W.A. Patience in respect of our report on project III.01.3. The assessment of the report as " substantial, extensively and well researched" enables us to treat it on the whole as an INSROP working paper.

In general explanations concerning the reviews of separate editions (project III.01.3, part 1 and project III.07.3) the following consideration shall be taken in to account:

1. Titles of the projects were formulated and accepted by INSROP Joint Research Committee. The line of the research was briefly expressed in the project Catalogue.

The authors of the projects aimed to attract attention of government authorities, Russian and foreign investors to the idea of crude oil transportation by sea vessels along the Northern Sea Route.

As for social and economic and commercial aspects of seaborne transportation of oil and gas along the NSR mentioned in the review of Mr.Iorgen Ole Baerholdt (project III.01.3), the INSROP broad plan provides for its elaboration and execution. Particularly, the interest of Russia and the west countries in export of oil & gas is shown in project III.01.1; social and economic issues related to the influence of NSR on adjoining territories are presented in project IV.4.1.(Dr.A.Yakovlev, Dr.V.Pavlenko, Dr.Z.Sokolova).

2. Essential technology of hydrocarbon transportation from the Russian fields is based on the use of pipelines. The development of seaborne transportation of oil and gas in the Arctic as shown in the project , is not considered as an alternative to pipelines.

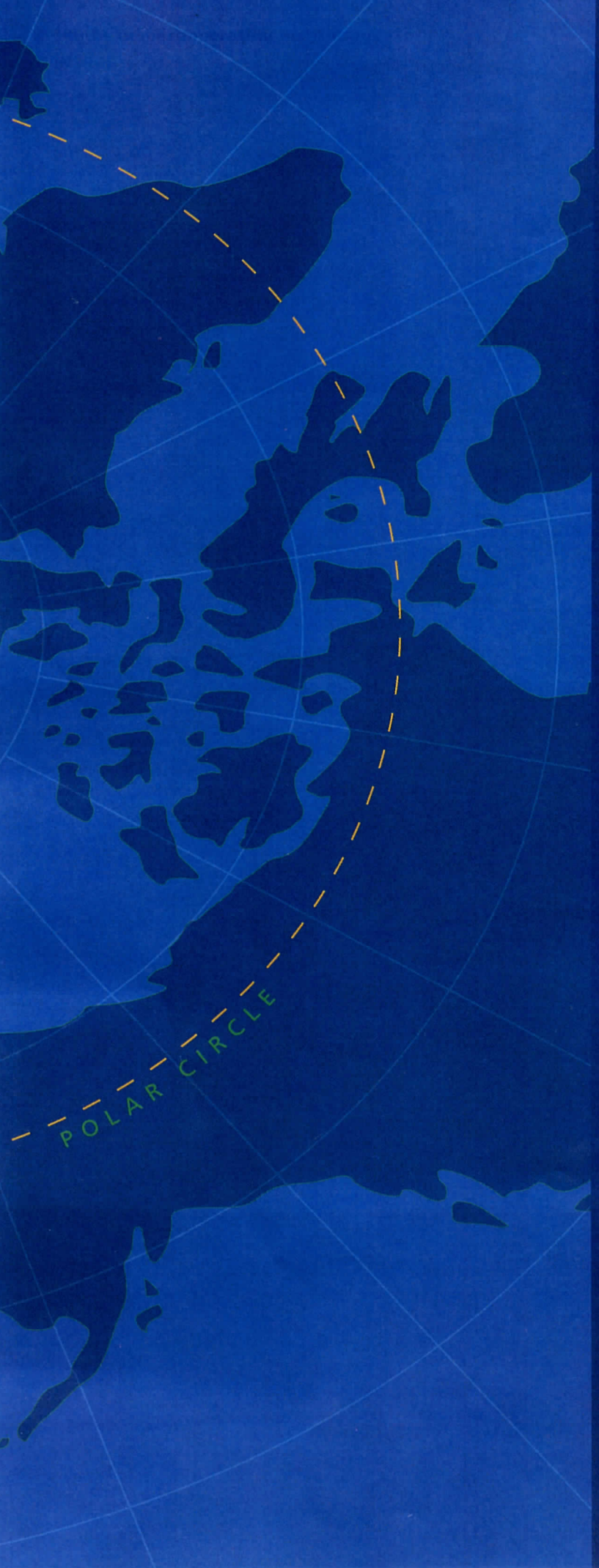
The use of sea transport will enable us :
- to increase the reliability of fulfillment of contractual obligations to trade European partners regarding oil delivery;
- to create more flexible system for delivering oil to foreign trade market by means of rational use of the marine transport and ice-breaker fleet. At the same time, economic feasibility of selection of the marine version is defined by both the criteria of economic efficiency level of new investments and the necessity to solve the problem of Russian military enterprises converted to manufacture civilian production.

3. Issues of ecology have been given in the project in brief in relation to the organization of seaborne oil and gas transportation in the Arctic seas (in particular, the main existing normative requirements to the environmental protection against tanker and LNG carrier operations). As for technical feasibility of ecologically safe means of oil and gas seaborne transportation, the experience shows that it is a quite solvable task under due control and correct operations.

4. The reasons for an additional study of demand for power materials in Archangelsk and Murmansk regions are indicated in the review (project III.01.3., part1). The domestic experience of special shipbuilding etc. has not been considered yet because it would extend

the stipulated framework of the project and overburden it with indirect information. Therefore, the above questions would require additional expenses and time.

5. Some omissions pointed out in the review of Mr.Jorgen Ole Baereholdt to the first edition (project III.01.3, part 1) (titles in figures, transportation distances), have been corrected in the final edition.



The three main cooperating institutions of INSROP

Ship & Ocean Foundation (SOF), Tokyo, Japan.

SOF was established in 1975 as a non-profit organization to advance modernization and rationalization of Japan's shipbuilding and related industries, and to give assistance to non-profit organizations associated with these industries. SOF is provided with operation funds by the Sasakawa Foundation, the world's largest foundation operated with revenue from motorboat racing. An integral part of SOF, the Tsukuba Institute, carries out experimental research into ocean environment protection and ocean development.

Central Marine Research & Design Institute (CNIIMF), St. Petersburg, Russia.

CNIIMF was founded in 1929. The institute's research focus is applied and technological with four main goals: the improvment of merchant fleet efficiency; shipping safety; technical development of the merchant fleet; and design support for future fleet development. CNIIMF was a Russian state institution up to 1993, when it was converted into a stock-holding company.

The Fridtjof Nansen Institute (FNI), Lysaker, Norway.

FNI was founded in 1958 and is based at Polhøgda, the home of Fridtjof Nansen, famous Norwegian polar explorer, scientist, humanist and statesman. The institute spesializes in applied social science research, with special focus on international resource and environmental management. In addition to INSROP, the research is organized in six integrated programmes. Typical of FNI research is a multi-disciplinary approach, entailing extensive cooperation with other research institutions both at home and abroad. The INSROP Secretariat is located at FNI.