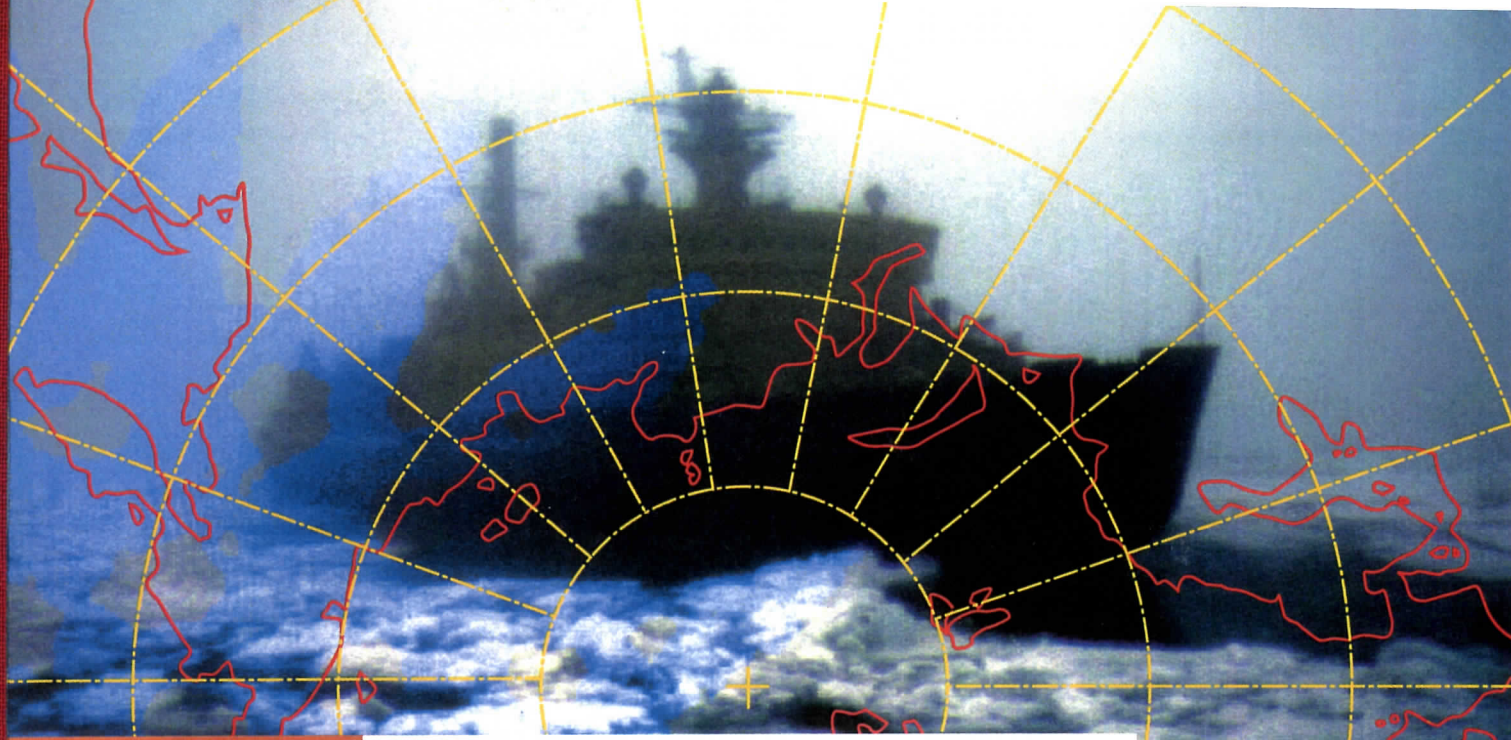

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The Cargo Generating Potential of the Angaro-Yenisei Region for the Northern Sea Route

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Project III.01.5: The Angara and Yenisei Region, Cargo Generating Area for the NSR

Supervisor: Alexander G. Granberg, SOPS, Moscow RUSSIA

Title: **The Cargo Generating Potential of the Angaro-Yenisei Region for the Northern Sea Route**

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What is an INSROP Working Paper and how to handle it:

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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ABSTRACT

The research is done within the framework of the "International Northern Sea Route Programme (INSROP) - Programme code III.01.5. The presented study allowed us to draw the following principal conclusions concerning the cargo generating potential of the "Yenisei - NSR" transport system in the perspective 2005 - 2015

1. AYR possesses the necessary conditions to provide cargo for the transport system.

2. The scale and direction of potential AYR development are conditional of the economic situation in the country.

3. Extended use of the Yenisei part of the NSR is of national significance for solving both immediate and future problems concerning resource supply.

4. Even the evolutionary scenario, being realized, makes it possible to regain the volume of operations achieved by the system in the late 1980s.

5. Realization of the radical scenario requires modernization of the system and a very intensive functioning already by 2005.

6. The plans according to maximal scenario freightage may be realized only if the NSR is transformed into the NEP with the highest level of logistics.

7. The main and most realistic scenario is considered to be the radical one with an optimistic situation.

The obtained results may be considered as conditional or preliminary ones in considerable confidential intervals. They correspond to a certain economic situation in Russia and to the hypothesis of AYR development. The authors aimed to find out the maximal amount of existing prognoses concerned with cargo generation for NSR. In the next stage the presumed cargo volume is to be refined. It will most probably decrease. It may also happen that some of the cargo generation conditions, as well as those of "Yenisei - NSR" transport system exploitation, will turn out to be less favorable.

CONTENTS

INTRODUCTION

Aim of the study. The research is done within the framework of the "International Northern Sea Route Programme - INSROP) - Programme code III.01.5 [17]. It is concerned with forecasting the cargo generating potential of the Angaro-Yenisei Region (AYR) in the service zone of the "Yenisei - NSR" transport system.

Focus of the study. During the research process the following questions have been considered.

1. Conditions for the creation of a "Yenisei - NSR" transport system in the process of NSR revival and transformation into an inter-ocean route: the North-East Passage (NEP) [31].

2. Determination of feasible service zone borders of the "Yenisei - NSR" transport system in Middle Siberia.

3. Prognosis for development of production in the Yenisei part of the "Yenisei - NSR" transport system.

4. Determination of main cargo generating units and areas together with routes connecting them to the seaports.

5. Determination of possible freight turnover in the Yenisei part of the "Yenisei - NSR" transport system in the perspective of 2000, 2005, 2010 and 2015 by different scenarios and variants.

6. Determination of main specialization and forecasting turnover of seaports of the "Yenisei - NSR" transport system.

Limitations of the study. The problems of cargo transportation by the Northern Sea Route to the Yenisei basin are not new. There have been many serious investigations. Unfortunately, most of them were done before the break-up of the Soviet Union. During the post-soviet period the situation has essentially changed, especially in forecasting transport relations and volumes of cargo processing.

Today there are no official prognostic studies and projects on production development and creation of transport systems in a perspective up to 2015. This concerns not only AYR, but also the whole country or certain spheres of economic activity (including the prognosis on external trade of the country). There is no project documentation on those units that may become users of the "Yenisei - NSR"

transport system. For example, according to the data of specialized institutes, the NSR freightage demand (without transit and transportation of hydrocarbons from deposits of the western section of the Arctic) may by 2005 - 2015 increase to 6 millions tons. Different sources give prognostic freightage volumes varying in a wide range. For example, for dry cargo the range is from 3 to 15 millions tons [14].

The northern regions of Krasnoyarsk Krai are not adequately provided with reliable prognostic materials, even though they are precisely those regions which form the main cargo generating zone of the "Yenisei - NSR" transport system. There are several prognoses and programs elaborated by scientific organizations for the development of Northern Russia and Siberia, the Taymyr and Evenk Autonomous Districts and the town of Igarka until 2000 or 2005 [11,25,28,29]. All of them have been done at different times, by different researchers and with different aims. The results are frequently contradictory and cannot be generalized. None of these documents have been officially confirmed at the governmental level. However, there is one exception. A Federal Target Programme for development of the Lower Angara Region (LAR) was confirmed in 1997 by the Government of Russia [12].

In this study the prognosis for creation of AER cargo generating potential for the NSR in the beginning of the 21st century is based on the normative documents, the scientific prognoses of Siberian production development [10,11,12,22,25,29 et al.], as well as on the INSROP Working Papers [2,3, 15,16, 18, 24,26, et al.] The material on the Federal Target Programme for LAR development has been the most widely used, since the questions concerning the "Yenisei - NSR" transport system are studied in one of the research projects of the Programme [5, 7,8,23]

Methodology of study. A programme-objective approach together with economic-mathematical models are adopted as the methodological basis of the study. AYR is considered a large economic complex - part of the single economic space of Russia. Its internal structure is viewed as a system of territorial-production complexes and separate industrial units. Territorial-production optimization models are used for forecasting the productive and spatial structure of the region, simulation models are applied for determining freight turnover of seaports under different variants of cargo generating development and of external communication schemes. Moreover, an attempt is made to present experimental results of applying a

behavioral model (Petri Nets) [6] for analyzing the influence of external (relatively to AYR) conditions and accidental circumstances on the feasibility of the forecast cargo generation for NSR. We believe that this investigation should proceed within the framework of the INSROP project III.01.5.

Assessment of the results. The obtained results may be considered conditional or preliminary ones in considerable confidential intervals. They correlate to a certain economic situation in Russia and to the hypothesis of AYR development. We believe that at this stage of the study it is crucial to determine the reality of creating a direct "exit" for Middle Siberia (more precisely Middle Russia) to the world market and the role of the "Yenisei - NSR" system in the formation of a main inter-ocean route - the North-East Passage, rather than to calculate the possible freight turnover. In our opinion this applies both to Russia and to the community of Polar countries. The authors aimed to find the maximum amount of existing prognoses concerned with cargo generation for the NSR. At the next stage the presumed cargo volume is to be refined. It will most probably decrease. Some of the cargo generation conditions and the conditions for use of the "Yenisei -NSR" transport system may turn out to be less favorable.

The study is done in the Sector on Territorial-Production Complexes (TPC) Formation of the Institute of Economics and Industrial Engineering (IEIE) of the Siberian Division of Russian Academy of Sciences (SD RAS).

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I. THE ANGARO-YENISEI REGION AND THE NORTHERN SEA ROUTE

1. AYR AND A SERVICE ZONE OF THE «YENISEI - NSR» TRANSPORT SYSTEM IN MIDDLE SIBERIA

1.1.Angaro-Yenisei region

AYR covers the territory of the River Yenisei basin, and partially that of the River Ob tributaries (Chulym and Ket) basins, as well as those of rivers flowing directly into the Kara Sea (r.Piasina) and into the Laptev Sea (Khatanga) of the Arctic Ocean. The rivers Nizhnyaya Tunguska, Podkamennaya Tunguska, and, especially, Angara are the most economically significant. The territories around Yenisei and Angara have the same preconditions and problems of economic development. This has determined their specialization and close interrelations of economic complex units, as well as the expediency of considering them as a single economic region, referred to as AYR.

AYR is situated in the middle of Russia approximately equidistant from its east and west borders (Fig.1.A). The territory of the region stretches more than 2000 km from the Arctic Ocean to the north down to the Sayan mountain system at the southern border with Mongolia, and for 500–700 km from west to east between the watersheds of the rivers Ob and Lena. AYR consolidates 7 administrative subjects of the Federation, with a total area of more than 3.3 million km^2, and a total population of more than 6.7 million persons. (Table I.1.1)

Table I.1.1

The Angaro–Yenisei Region

Subjects of Federation	Area 1000 Sq. Km	Population 1000 pers.
Krasnoyarsk Krai	710.0	2932.4
Irkutsk Oblast	745.5	2621.0
Republic of Khakass	61.9	588.1
Republic of Tyva	170.5	306.9
Taymyr Autonomous District (A.D)	862.1	86.2
Evenk Autonomous District (A.D.)	767.6	23.0
Ust–Ordynsk Autonomous District (A.D.)	22.4	143.4
Total	3340.0	6701.0

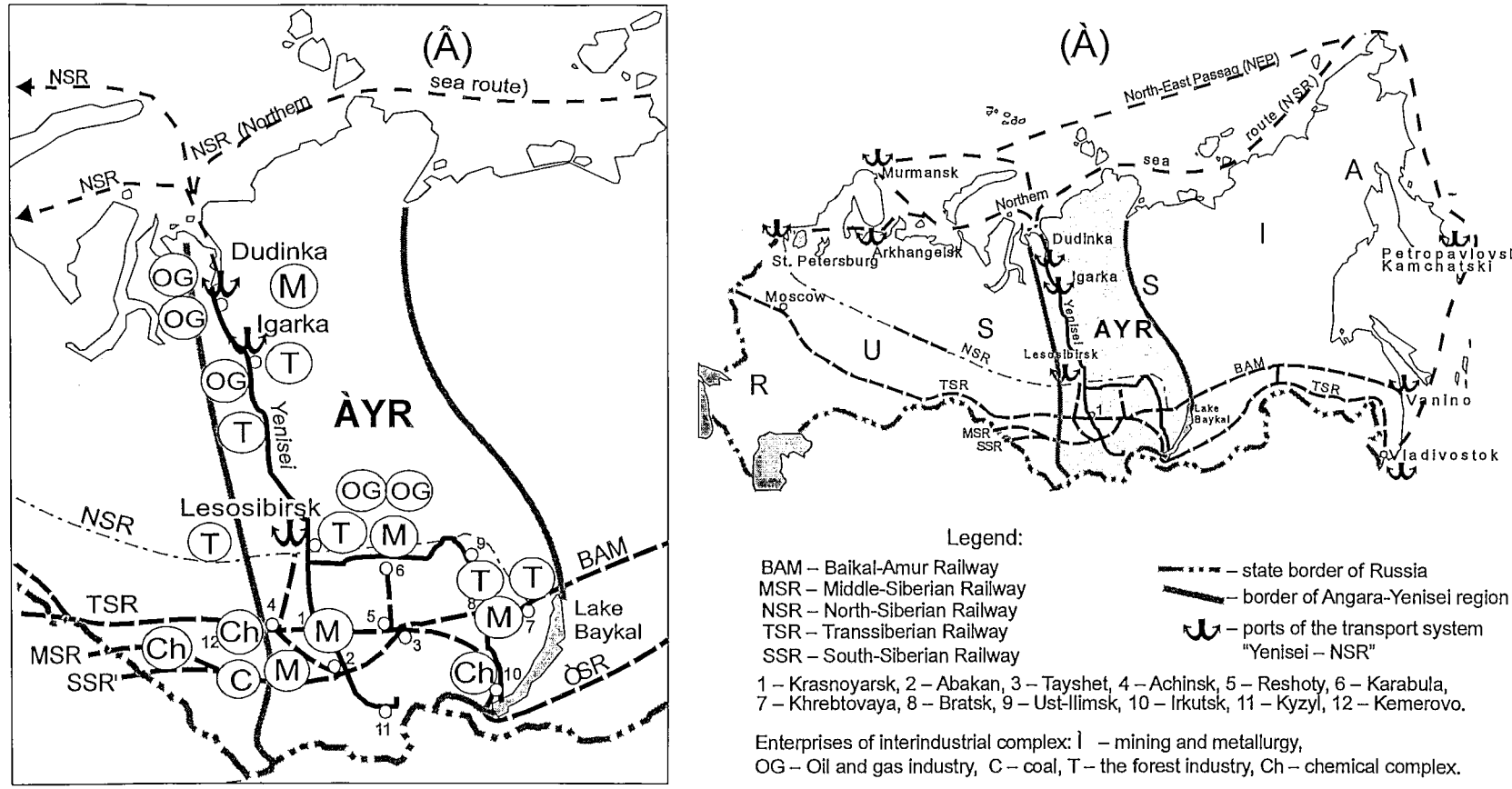


Fig. 1 Transport system "Yenisei – NSR": geographical situation of Angara-Yenisei Region (A) and location of the most important cargo-formating units (B).

AYR is a region with a high concentration of different resources (hydroelectricity, coal, large deposits of non-ferrous and ferrous metals, magnesite, salt and other minerals). The main national reserves of softwood are in the AYR territory. Electropower stations, power-consuming industries and wood processing of the region are of federal significance. Within a rather short period of time large industrial enterprises have been established here. The common rated capacity of electric power stations in AYR reached 30 million kW, producing about 150 billion kWh. of electric energy. In recent years more than 80 million tons of coal have been mined, about 2 million tons of aluminum, 1 million tons of alumina, 1.5 million tons of pulp have been produced, about 30 million tons of oil have been processed and 60 million m^3 have been logged. Today AYR is a region of huge reserves of the cheapest electrical energy in Russia.

The results of implemented plans, programs and projects are the construction of a great deal of the largest electropower stations (Sayansk, Krasnoyarsk, Bratsk, Ust-Ilimsk, and under construction Boguchansk), the largest aluminum plants (Bratsk, Krasnoyarsk, Sayansk and Irkutsk), an alumina plant (Achinsk), wood-working complexes (Bratsk, Ust-Ilimsk, Lesosibirsk), enterprises of metallurgy, chemistry and mechanical engineering, including large units of Military Production complex (Krasnoyarsk, Norilsk, Angarsk, Irkutsk, Usolie Sibirskoye, Achinsk). The possibility to enter the world market which appeared with the new economic conditions, should give additional stimuli for AYR development, because it should increase the demand for the use of natural resources (Fig.1B).

At present most of the AYR production is exported to other regions of Russia and abroad. There are three export routes. Most of the cargo is transported westwards and eastwards along the Transsiberian Railway (TSR), and substantially less – to the north by the Yenisei and the NSR. The role of road transport remains insignificant. Such a distribution of communications is motivated by several reasons, most of them are based on the location of functioning economic units and transport conditions.

AYR may be characterized by the following features.

1. Extremely uneven development and distribution of production. Almost all industry and the absolute majority of the population in AYR are concentrated in the

territories surrounding the Transsiberian railway, the eastern part of the South-Siberian Railway (SSR) (Tayshet – Abakan – Novokuznetzk) and the western part of the Baikal-Amur Main Route (BAM) (Tayshet – Bratsk – Ust-Kut), which is the most favorable in terms of living conditions (Fig.1).

2. Concentration of raw material potential for future development in the northern parts of AYR, including areas bordering on the Yenisei. This is why the question of creating the "Yenisei – NSR" transport system is real both for involving Siberian resources in the economy, and for increasing freight turnover in the western sector of NSR.

3. A strong dependence on the formation of a polar belt of a Russian transport system. The question concerns the transformation of the NSR into a main international inter-ocean transport route, while the western sector of the Arctic should become a zone for year-round transport service with widespread use of the sea fleet in the exploitation of continental shelf oil deposits and transport of hydrocarbons. It is hardly probable that a latitudinal railway transit main route will be constructed in the first half of the 21st century in the polar zone of Siberia, to become a possible competitor for the NSR in the field of servicing economic communications of the Extreme North of Russia.

4. Active participation in the formation of the Single Economic Complex of Russia, and the existence of intensive relations with other parts of Russia. Traditionally AYR has had much more communications with the western and southern regions of the former USSR, being not nearly so closely related with the east and with quite poorly developed contacts with the northern areas bordering on the Arctic Ocean. The Norilsk Mining Metallurgical Combinate (NMMC) is an exception, it has production cooperation with similar enterprises of Murmansk Oblast.

The latitudinal routes (west – east) of export–import communications are covered by railway transport, and then via the ports of the Black, Azov, Baltic and Japan seas. Railways have always been significant in external relations and will remain so in future. In a sense this means of transport is a competitor to the «Yenisei - NSR» transport system in providing communications in the northern region of Krasnoyarsk Krai (Fig.1.B).

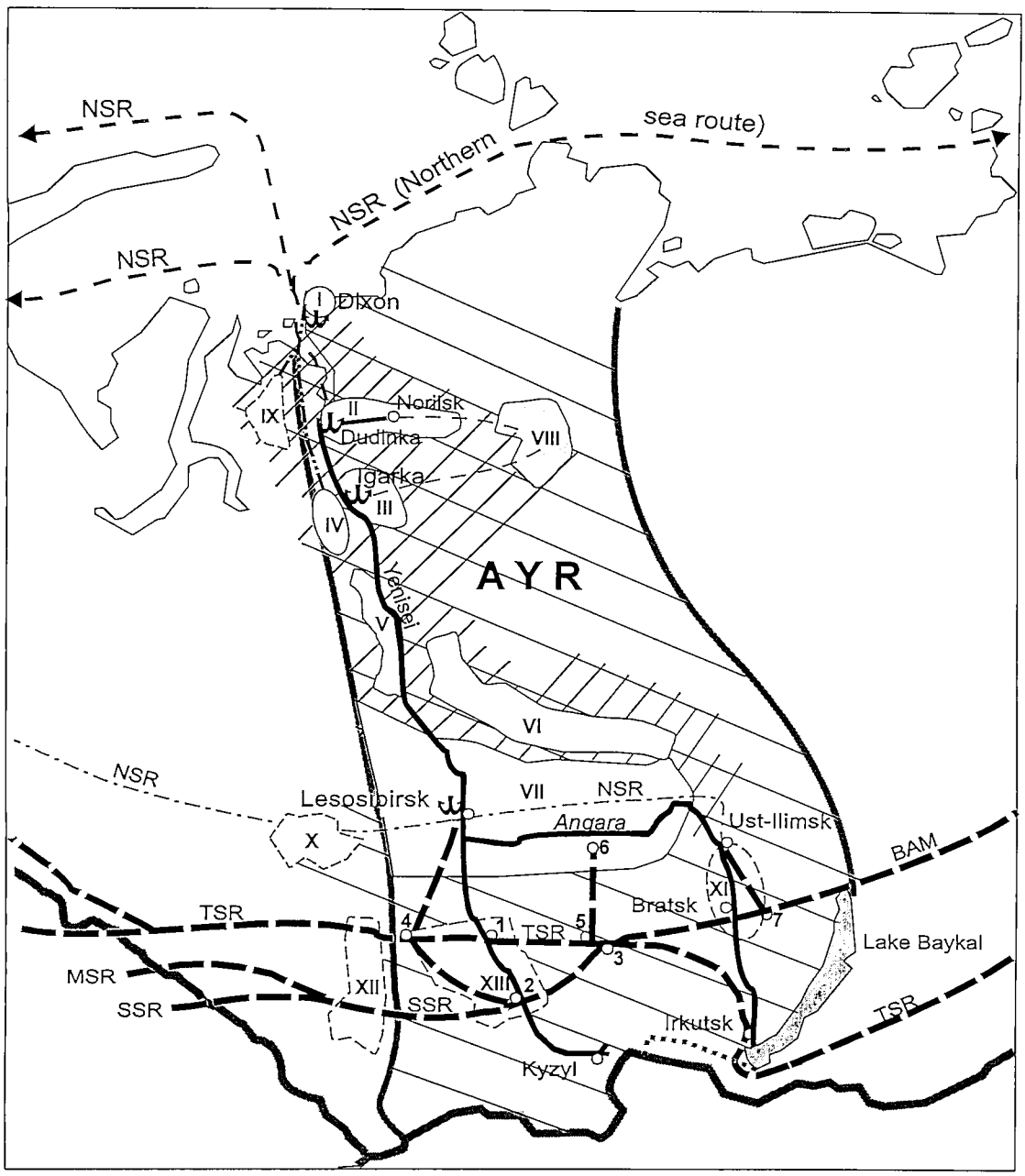
The longitudinal routes (South – North) of communication between the southern and the central parts of AYR are covered by railways Lesosibirsk – Achinsk, Abakan – Tayshet – Ust-kut, as well as Khrebtovaya – Ust-Ilimsk and Reshoty – Karabula. The largest part of northern AYR (far from the railway) is maintained only by seasonal river transport along the Yenisei and sea transport – along the NSR and in the lower part of the Yenisei (Fig.1.B)

1.2. Zones and areas under NSR service in AYR

The cargo generating potential of AYR is conditioned by the *zone of proximity* of the "Yenisei – NSR" transport system and by the level of its economy. The zone of proximity of the system comprises a large part of AYR and some contiguous areas of the west-Siberian economic region, whose cargo owners will have access to the "Yenisei – NSR" system. Within the boundaries of the zone of proximity a service zone is designated. This is a territory in which cargo owners will use the «Yenisei - NSR» transport system as a main facility for goods turnover (Fig.2).

In any case the *zone of service* of the future "Yenisei – NSR" transport system is considerably smaller than the territory of AYR. The zone is delimited by the Extreme and Near North of Krasnoyarsk Krai, i.e. Evenk and Taymyr Autonomous Districts, Turukhansk county and Lower Angara Region (Yeniseisk, Motyguinsk, Boguchansk, Kezhemsk and North-Yeniseisk counties). A great resource potential is concentrated within the above mentioned territory, but a considerable part of it remains economically undeveloped. Two main cargo generating areas in this zone exist and will remain in future: The Norilsk Industrial Region (with the seaport of Dudinka) and the Lower Angara Region (with the river port of Lesosibirsk).

Lesosibirsk will probably become the terminal port, not only for river transport, but also as a seaport for the whole "Yenisei – NSR" transport system. In that case, the southern border of a zone of direct service (but not a feasible one) of the future «Yenisei - NSR» transport system in AYR will coincide with the southern border of the Lower Angara Region in Krasnoyarsk Krai. Krasnoyarsk will keep its role as the main transport node of the krai, it will remain the largest passenger and cargo river port on the Yenisei, but will not become the southern terminal of the future «Yenisei - NSR» transport system. This is due to the navigation conditions of the Yenisei, and



Legend:

..... – border of Angara-Yenisei region (AYR), – zone of attraction, – service zone,

(I - VIII) – areas of intensive cargo-formation: I – Dixon, II – Norilsk, III – Igarka, IV – Turukhansk, V – Middle-Yenisei, VI – Evenk, VII – Lower-Angara, VIII – Yessei, IX – Lower-Yenisei, X – Tomsk, XI – Middle-Angara, XII – Kemerovo, XIII – South,

Of direct service: – first and (VIII) – second stage; (IX - XIII) – areas of feasible service.

— — existent railways, — · — perspective railways,

Main railway: TSR – Transsiberian Railway, NSR – North-Siberian Railway, MSR – Middle-Siberian Railway, SSR – South-Siberian Railway, BAM – Baikal-Amur Railway

1 – Krasnoyarsk, 2 – Abakan, 3 – Tayshet, 4 – Achinsk, 5 – Reshoty, 6 – Karabula, 7 – Khrebtovaya.

—··—·· – pipeline – sea terminal

Fig. 2 Transport system "Yenisei - NSP": zones of attraction and service.

the creation of new cargo flows. The competitiveness of the Krasnoyarsk river port decreased after the construction of the railway Achinsk – Lesosibirsk and the transshipping port in Lesosibirsk and especially after assimilation of the prolonged navigation in the Western section of NSR and in the Lower Yenisei.

It is not unlikely that in future the zone of feasible service of the «Yenisei - NSR» transport system will be essentially expanded due to the addition of the following contiguous areas from AYR and western Siberia: Kemerovo Oblast, Middle-Angara Region of Irkutsk Oblast and the northern areas of Tomsk Oblast, as well as the north-eastern parts of Yamalo-Nenetz Autonomous District (Fig. 2).

Within the service zone some *areas of intensive cargo generation* are distinguished. In these areas enterprises of production, dispatch and goods storage are concentrated. These areas differ in proximity to the transport system, in probability of development and in the time needed to be involved in the sphere of the transport system activity. The following types of areas are considered.

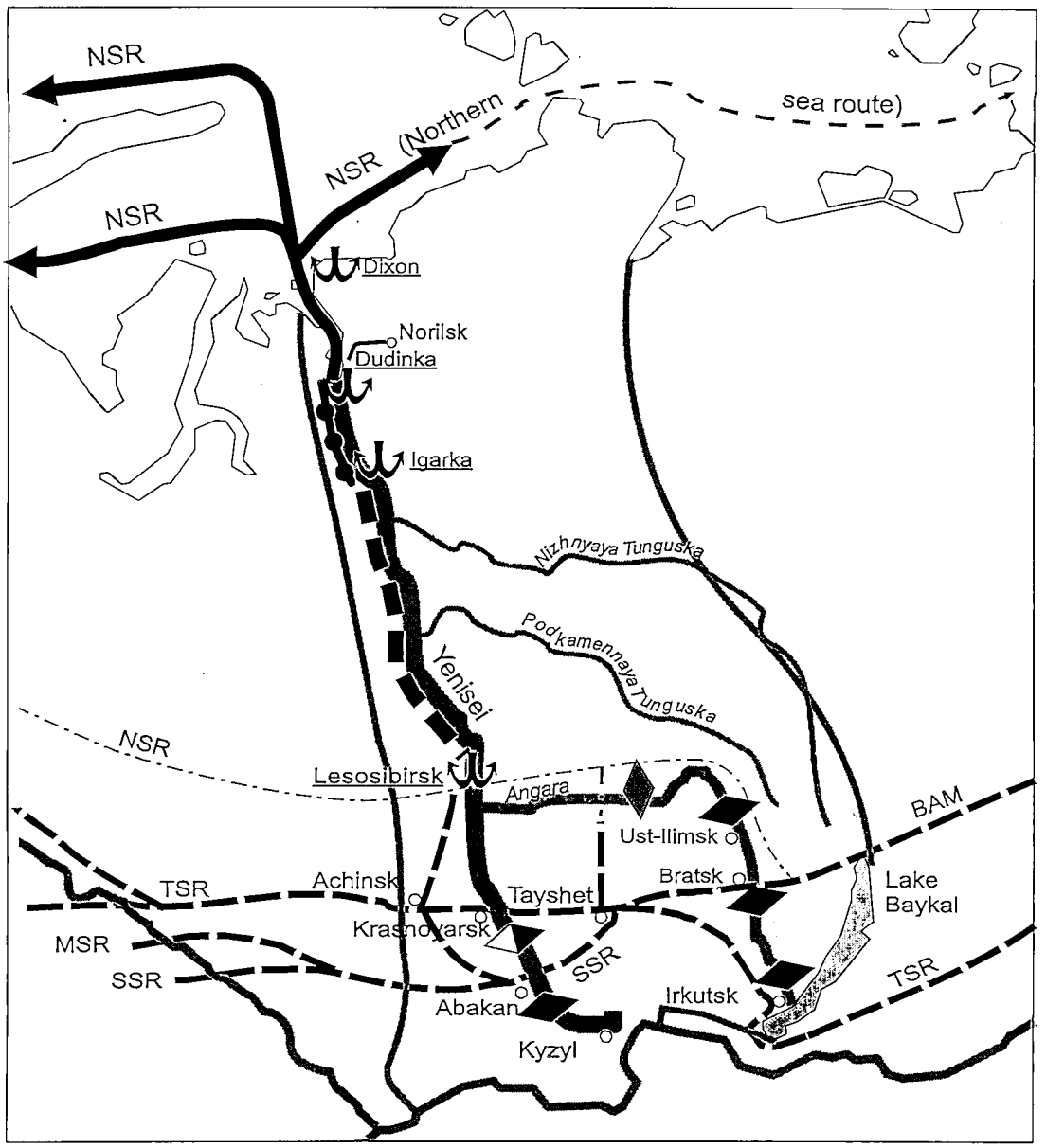
– *Areas of direct service (I VIII)*, these are the territories bordering on the Yenisei. For these areas the «Yenisei - NSR» transport system is the most important route performing massive large-scale interregional and international freightage.

– *Areas of feasible service (IX XIII)*, these are territories that may use the system, but only in case it will be more effective than using the railway.

The service zone borders will change in time, and AYR cargo generating potential for NSR will depend on the level of production development within the zone of proximity.

2. WATERBORNE TRANSPORT SYSTEM OF AYR

The Yenisei is the main watercourse transport system of AYR (Fig.3). Navigation is performed by river transport along the whole length of the Yenisei during the period of open water, and by sea transport along the NSR and in the lower Yenisei during the regime of prolonged navigation. The river and sea navigation conditions are beyond comparison with the other Siberian rivers. Navigation during the prolonged regime lasts for ten months. Ships of a modest size as well as large ships of a mixed sailing type called "river-sea" ships, are able to go



Legend:

Sea sailing:

parts accessible for ships – by 15 ths tons in the regime of prolonged navigation

– up to 10 ths tons and – up to 5 ths tons in the regime of season navigation

River sailing:

– through Yenisey,

– within the reservoir,

– shallow water ships,

– expedition supply on 'large water'

– existent railways

Hydro power station:

– under construction,

– without ship passage,

– with ship lifting.

– sea terminal

– railways under project

Fig. 3 Transport system "Yenisei – NSR": sections of sea sailing on Yenisei.

up the river as far as Lesosibirk (Table I.2.1) [29]. Even in the middle part of the Yenisei, navigation conditions satisfy international standard requirements for routes of mixed "river-sea" sailing.

Angara is used for sailing within the isolated water reservoirs, as well as in its lower part, where because of depth constraints only shallow-draft ships are able to pass.

Table I.2.1

Guaranteed river dimensions for navigation on the Yenisei

(prognosis for 2000)

Route sections	Length, km	Depth, sm	Width, m	Radius of curvature m	Navigation days
Mouth of r. Khemchik – Abakhan	1131	Reservoir of Sayano–Shushensk HPS			
Abakhan – Krasnoyarsk HPS	279	Reservoir of Krasnoyarsk HPS			
Krasnoyarsk HPS – Krasoyarsk	36	250	300	500	225
Krasnoyarsk – Mouth of r.Angara	339	290	90	600	225
Mouth of r.Angara – Yeniseisk	80	320	70	600	177
Yeniseisk – Podkamennaya Tunguska	470	320	70	600	174
Podkamennaya Tunguska – Igarka	855	340	150	1000	174
Igarka – Dudinka	274	340	175–200	1000	140–160
Dudinka – Mouth of Yenisei	407	340	12000		300
Total	3871				

At present two waterborne transport lines are functioning in the future transport system zone within AYR which complement each other (Fig.3).

River cargo-passenger line. The Yenisei ship-company performs transport between the central, northern and, less frequently, the southern parts of Krasnoyarsk Krai. For more than a hundred years (since 1863) river transport has been the only means of transport for the whole northern part of Krasnoyarsk Krai. Krasnoyarsk was the main port and the most important base for supplies to the North, while Yeniseisk, Turukhansk, Igarka and Dudinka were ports along the route. During the years of intensive development about 30 million tons of goods per year were transported down the Yenisei. The main goods comprised timber (especially on rafts floating to Igarka), oil products and other goods for the Norilsk industrial region. In recent years

the Yenisei company occasionally performs mixed sailing by "river-sea" ships from Yenisei to the ports of the Atlantic.

Sea cargo line. Since the early 1930s wood exports from Yenisei have been transported via the seaport of Igarka. More recently, as the Norilsk industrial region was created, sea shipping started between Murmansk, Arkhangelsk and Dudinka. Since 1978 there has existed a regular sea line to Dudinka with a prolonged navigation period. At present its navigation period lasts for 10 months, which makes it a serious competitor for the river cargo line. As a result, the role of Krasnoyarsk as a trans-shipping point of goods from the west for the Extreme North decreased significantly. Its importance was reduced still further in the provision of Norilsk industrial goods transportation both within the framework of interregional exchange, and in foreign trade. The transformation of a present-day cargo line into a future «Yenisei - NSR» transport system will provide most of AYR and some contiguous territories with modern communication facilities. The areas bordering on the Yenisei should become a considerable cargo-generating region in the middle of the NSR.

II.SCENARIO APPROACH TO PROGNOSIS FOR CREATION OF CARGO GENERATING POTENTIAL IN AYR FOR THE NSR

The cargo generating potential of AYR is in many respects determined by both external and internal conditions. External conditions are considered to mean the economic situation and the trajectory of country (including Siberia) development. Internal conditions are taken to mean the creation of a production complex in AYR. External conditions in this study are represented in the form of two stages and two situations (pessimistic and optimistic), the internal ones – in the form of three scenarios (evolutionary, radical, and maximal) and two variants (minimal and maximal) (Table II.1).

Table II.1

Principle of AYR cargo generating potential formation *

Internal condition expression / External conditions expression				Situation in Russia			
				Stages			
				First 2005		second 2015	
				optimistic	pessimistic	optimistic	pessimistic
Scenarios	Evolutionary	Variants	min				
			m				
	Maximal		min				
			ma	X		X	
	Radical		min				
			ma	X		X	

Stages. The prognosis period for the river part of the "Yenisei – NSR" transport system is taken from 2000 to 2015. It is divided into two stages:

– first stage – 2000 – 2005,

– second stage – 2005 – 2015.

The *first stage* is supposedly characterized as follows.

a) The "Yenisei – NSR" transport system is enhanced, making no principal changes in technical equipment and in the organization of service. The NSR preserves its status as a "national" (Russian) transport route.

b) Economic restructuring is completed and a transition to stable development is accomplished both for Russia and for AYR.

c) Protectionist politics are practiced in relation to the regions of the Extreme North, the NSR being used for interregional and international communications.

In the *second stage* the following is assumed to be accomplished.

a) A transformation of the NSR into an inter-ocean transport route of international status – NEP, equipped with corresponding technical facilities and logistical organization.

b) A realization of Extreme and Near North development programs, economic expansion of these regions, a development of profound processing technologies and a transition to valuable transportable production capable of competing on the world market.

c) Embedment of "Yenisei – NSR" into NEP, an increase in transport effectiveness resulting from the benefit of an international status and a logistics system.

Situations. Among the set of external conditions for cargo generation potential of AYR the most significant are the following:

– strength and means to overcome the economic crisis, stabilization and economic development of Russia and Siberia;

– strength and means to transform the national transport route (NSR) into an international inter-ocean route – NEP;

– form and strength of protectionist state politics in resource development of the eastern part of the country and of the new main transport routes and external trade of the regions with extreme living conditions.

The pessimistic and optimistic situations of the "Yenisei – NSR" transport system are based on an analysis of the prognosis documents elaborated in 1997 concerning the development of Siberia [11], its fuel and energy complex

development strategy [10], and the industrial exploitation of Lower Angara resources [12] (Table II.2).

Table II.2.

Generalizing indices of development of Siberia and zones adjacent to the "Yenisei – NSR" transport system

Pessimistic situation					Optimistic situation				
years	2000	2005	2010	2015	years	2000	2005	2010	2015
Siberia as a whole					Siberia as a whole				
Population m pers.	25	24	23	22	Population m pers.	25	25	25	26
GDP	57	70	85	100	GDP	64	90	130	180
IP	60	80	108	115	IP	68	108	170	220
East Siberia					East Siberia				
Population m pers	9	8	7	7.5	Population m pers..	9	9	9	9.5
GDP	57	73	88	105	GDP	66	93	135	190
IP	62	83	111	123	IP	70	110	185	235
AYR					AYR				
Population m pers.	5	4.5	4	4.3	Population m pers.	5	5	5	5.2
GDP	60	75	90	108	GDP	68	95	140	197
IP	64	85	92	125	IP	68	95	140	200
Zone of attraction					Zone of attraction				
Population m pers..	4.1	3.8	3.4	3.7	Population m pers.	4.1	4.1	4.1	4.2
GDP	59	74	89	106	GDP	67	93	138	192
IP	63	84	90	120	IP	67	94	137	196
Service zone					Service zone				
Population m pers.	0.9	0.7	0.6	0.6	Population m pers.	0.9	0.9	0.9	1.1
GDP	64	80	94	112	GDP	70	100	147	205
IP	66	89	95	130	IP	70	100	150	209

Remark: GDP – gross domestic product. IP – industrial production in percentage of the corresponding indices of 1990.

The pessimistic situation is assumed to be probable if Russia emerges very slowly from the crisis, there is a lack of demand and no available possibility to use the potential of AYR, and, hence, the idea of realizing the above prognoses would be abandoned. The impact of a pessimistic situation is represented by a development with a minimal variant of cargo generating potential of AYR for the NSR.

The optimistic situation is suggested to be feasible if there is a realization of economic development prognoses of Russia, exploration of AYR potential, active participation of the country in the world economy, and, above all, a successive transformation of the NSR into the NEP. The influence of the optimistic situation in

Russia on cargo generating potential of AYR for the NSR is reflected in radical and maximal scenarios with minimal and maximal variants of realization.

Scenarios. Three suggested scenarios for the "Yenisei – NSR" transport system represent internal regional conditions for creation of cargo generating units and infrastructure units within AYR and adjacent territories (kinds of units, scales, communication)

1. *An evolutionary scenario* means a minimal scale of prognosis project realization, development of existing units and units under construction within Krasnoyarsk Krai:

- during the period 2000–2005 economic activity is recovered and some new relations may be established, but no principal improvement of the region's economic potential and no principal changes in transport organization may occur;
- during the period 2005 – 2015 there is no principal changes of economic base, river freight turnover exists but is rather limited. Hence, the "Yenisei – NSR" transport system, satisfying 21st century conditions, is not established.

2. *A maximal scenario* suggests intensive realization of large-scale projects within the whole service zone:

- up to 2000 the economy is recovered with the help of currently existing transport facilities, and scientific proposals are elaborated;
- during the period 2000 – 2005 existing units are reconstructed, an economic base is prepared for intensive development of the region and for creation of the "Yenisei – NSR" transport system;
- during the period 2005 – 2010 a majority of the radical scenario projects are realized;
- during the period 2010 – 2015 (and later) the first stages of the large-scale projects are realized, the "Yenisei – NSR" transport system is part of the NEP and offers transport services to the whole Angara-Yenisei region and Kemerovo Oblast and, probably, to the Tomsk region as well.

3. *A radical scenario* contains the most realistic part of the maximal one.

- up to 2000 the economy is recovered with the help of currently existing transport facilities, and scientific proposals are elaborated;

- during the period 2000 – 2005 the first stages are completed of the reconstruction of existing units, and the economic base is prepared for intensive regional development and creation of the "Yenisei – NSR" transport system;
- during the period 2005 – 2010 reconstruction of the existing units is completed and new building trade complexes start to work;
- during the period 2010 – 2015 most of the project by the radical scenario is under realization in accordance with appropriate variants.

Variants are detailed ways of developing each unit. The maximal variant compared to the minimal one suggests an earlier and more intensive completion of production development in the "Yenisei – NSR" service zone.

III. CARGO GENERATING POTENTIAL OF AYR FOR THE NSR

The future volume of AYR cargo for the NSR will be determined generally by the scale of development of production units within three inter-sectoral complexes: the mining and metallurgical complex, the wood-working industrial complex and the oil-gas complex.

1. PRECONDITIONS FOR DEVELOPMENT OF THE MINING AND METALLURGICAL COMPLEX (MMC)

Most of the region's non-ferrous metallurgy enterprises are concentrated in the NSR's zone of proximity the (Fig.2). Both existing and feasible units are considered to form MMC. The existing units include the production of:

- nickel, cobalt, copper, platiniferous ores, and other simultaneous products of the integral polymetallic ore processing of the Norilsk Industrial Region (area II);
- lead, zinc, and magnesial products, based on raw materials of the Lower Angara Region (area VII);
- aluminum (areas XI, XII, XIII).

The feasible units include those engaged in producing:

- alumina, based on imported raw material (area VII);
- apatite concentrated products and phosphor fertilizers, based on the Mimecha-Kotuy resource region (area VIII).

An analysis of the world market shows a stable demand for AYR products. EC countries will remain the most likely importers. These countries' share comprises more than 35% of Russia's non-ferrous metals export [11]. Some EC countries can be reached by sea transport via the "Yenisei – NSR" system.

Different levels of completion and uncertainty of predictions on developing or creating MMC units result in different presentations. This presentation covers stages, scenarios and variants of cargo flow formation, as well as various schemes for links with seaports within the "Yenisei – NSR" transport system.

1.1. Metallurgy based on the polymetallic ore of the Norilsk Industrial Region (area II)

The Norilsk Mining Metallurgical Combinate (NMMC) provides 20% of the world market demand for nickel, cobalt, and more than 40% for platinic group metals. For Russian industry, similar figures comprise more than 70% of the demand for copper, 90% for nickel, 90% for cobalt, 100% for platinic group metals and for gold and silver, which are simultaneous products after extraction from these raw materials.

NMMC is connected with similar enterprises on the Kola Peninsula and has supplied ore and semi-finished products to these enterprises since 1970. NMMC's supplies to its external contacts are transported by sea via the river port of Dudinka. The NMMC freight turnover has some years reached 2–3 million tons per year. About 2/3 of the exported cargo is feinstein and ore, and 1/3 – non-ferrous metals [15].

Among the non-ferrous metals exported from NMMC, the share of refined nickel is about 36% (115.1 thousand tons in 1994). In 1995 and 1996, nickel exports increased to 155.1 and 167.2 thousand tons, respectively [30]. The main importers of nickel among the western European countries where cargo can be transported via the NSR are the following: Finland, France, Germany, Sweden, Belgium and Spain. The total deficiency of refined nickel in these countries amounted to 248 thousand tons in 1995 and 187 thousand tons in 1996. The demand for this metal is therefore high.

Hypothetically, the expected NMMC freight turnover won't shift seriously in volume or in structure of freight. This is due to the following factors:

- NMMC has already reached its planned production characteristics;
- the supply of ore and semi-finished products to Kola peninsula enterprises will remain as it is now;
- the total volume of non-ferrous metals export will also remain the same as today, but may be re-distributed in favor of Russian consumers.

The maximum volume of exports of ore, feinstein and other semi-finished NMMC products was achieved in the 1980s at 1,200 thousand tons. By the mid-1990s these exports were reduced to 500–600 thousand tons [15]. In this study the

volume of long-term exports are assumed to be within the range 320–500 thousand tons.

1.2. Industrial production based on raw materials of the Lower Angara Region (area VII)

The accomplishment of the Federal programme on development of the Lower Angara Region was started in 1997 [12]. This Programme envisages the development of several units.

The Gorevskoe lead and zinc deposit is the largest and only deposit that is mainly lead-based (more than 42% of industrial lead reserves) in Russia [22]. In the short term, ore output will reach 400 thousand tons. For the present, ore concentrate is exported outside Siberia. The Federal programme envisaged the construction of a lead and zinc enterprise in the Lower Angara Region. Part of this production will be exported via the NSR. This study expects that exports of lead and zinc will amount to 20 thousand tons from 2010 according to a maximum scenario and from 2015 according to a radical scenario.

At present, *the Uderei group of magnesite deposits* (one of the biggest in Russia) is being developed by small businesses. Magnesite and periclase are exported to home businesses and partially outside the country via Baltic seaports.

The magnesite raw material base exploited in Russia is nearly depleted and the present metallurgical industry requires high-quality fireproofing products. On the world market there is increasing demand for a new generation of magnesial fireproofing products. Roskill Information Services predict that the production of primary magnesium in Western countries will rise in the nearest decade and that consumption in Europe will double [23]. There is increased use of magnesite for metal magnesium production. The Federal programme outlines the development and production of a broad range of magnesial products based on local high-quality raw materials. This programme expects that part of the production (200 – 350 thousand tons) will be exported to Northern European countries via the NSR.

1.3. Production of aluminum (areas XI, XII, XIII)

The Angara-Yenisei Region is the main producer of aluminum in Russia (3/4 of total volume). In terms of generating cargo for the NSR, the aluminum producing sector may be an exporter of manufactured production on the one hand, and an importer of raw material on the other hand.

Since the beginning of the 1990s metal consumption has dropped considerably in Russia. Most (almost 90%) of the primary aluminum has been exported to the world market (in 1992 – 905.9; 1993 – 1467.3; 1994 – 2064.4 thousand tons). In 1996, compared to 1990, exports increased by the order of 2.7 [1]. AYR exports constitute 80% of Russia's total exports. Supplies are transported by railway to the seaports of the Far East and of the Baltic and Black Seas.

This study expects that part of the aluminum exports to Western European seaboard countries – Norway, Sweden, Great Britain, Belgium, the Netherlands and Germany – can be carried out with the transport system «Yenisei – NSR» (some years these countries received 400 - 600 thousand tons of aluminum). We assume that AYR aluminum plants will be able to dispatch up to 50% of export cargo via the NSR (400 thousand tons) according to a maximum scenario and up to 25% according to a radical scenario within all periods.

1.4. Aluminum production from imported raw material (area VII)

The development of aluminum production in Siberia (current production is about 2.5 million tons of aluminum) has always been considered a major factor in the creation of a non-ferrous metallurgical industry in the former USSR. However, Siberia's deposits of high-quality aluminum have not discovered. Only the Krasnoyarsk plant is provided with alumina (and not more than 60%) from an Achinsk integrated plant located in Krasnoyarsk Krai. Other plants (from Bratsk, Irkutsk, Sayan, and Novokuznetsk) are currently and in future forced to rely on distant sources of raw material.

Before the USSR break-up, the most important raw material suppliers to Siberian aluminum plants were the Pavlodar and Nikolaev alumina plants. However, the scale of alumina production in Russia is not sufficient. Siberian plants receive

raw material from Australia, France, Greece, India and other countries via the seaports of the Black and Japan seas. Russia has to use the toll system (Table III.1.1).

Table III.1.1

Provision of aluminum plants of Russia with alumina. 1000 tons (1995)*

Regions. plants	Production of aluminum	Demand for alumina	Satisfying demands for alumina by means of	
			one's own production	toll supply
Total	2790	5580	2250	3475
Including – Europe – Siberia	460 2330	920 4660	1770 480**	320 3155
Including Plants: – Krasnoyarski – Bratski – Sayanski – Novokuznetski –Iirkutski	 756 769 300 256 250	 1512 1540 600 512 500	 480 – – – –	 870 1335 530 265 155

In the mid-1990s imports of alumina to Siberian plants amounted to more than 3 million tons (about 70% of the demand). Efforts to consolidate business links with the Pavlodar and Nikolaev alumina factories have been undertaken. In all cases there will be a continued demand for alumina imports via the sea route. Alumina from Atlantic basin countries is delivered via Black and Barents Seas port cities. Alumina import in Russia via Murmansk has increased sharply over the past years. Experiences with raw material supplies to the Krasnoyarsk aluminum plant via Murmansk are positive for the «Yenisei - NSR» transport system in terms of supplying alumina to Siberian plants (Tabl. III.1.2) [1]. Brazil and Jamaica are among the leading five countries with major bauxite deposits.

Two routes are envisaged for alumina supplies to Siberian plants via the NSR, taking into account the prolonged navigation:

1. via Dudinka or Igarka with re-loading on river transport boats;
2. via Lesosibirsk.

The demand for alumina supplies to AYR is stable and amounts to 2000–3000 thousand tons, which is why this study expects that 30–40% of total alumina imports

* The table is composed according to the materials of [1]

** Production on Achinsk alumina plant with stable functioning is 1 m tons

for Siberian plants could be transported via «Yenisei – NSR» for all stages and according to all scenarios.

Table III.1.2

Costs of imported alumina transportation to Krasnoyarski aluminum plant. US $ *

Country – supplier. route of delivery	Sea freight	Railway taxes from port to plant. at the end of 1995	Total costs
Guinea (through the ports of the Black Sea)	14 – 15	51 – 53	65 – 68
Brazil. Venezuela (through the port of Murmansk)	18 – 22	51 – 53	69 – 75
Australia (through the ports of the Black Sea)	36 – 37	51 – 53	87 – 90
Australia (through the ports of the Far East)	30 – 35	55 – 58	85 – 93
Jamaica (through the ports of the Black Sea and the port of Murmansk)	20 – 23	51 – 53	71 – 76
India (through the ports of the Far East)	22 – 24	55 – 58	77 – 82
Greece (through the ports of the Black Sea)	8 – 10	51 – 53	59 – 63

Another scheme for supplying Siberian plants with raw material via the NSR has been proposed earlier, namely the creation of alumina production in AYR on the basis of raw material imported from Kola Peninsula. This report considers the possibility for supplying high-quality bauxite from the Atlantic basin countries. The location of alumina production itself is assumed to be in the Lower Angara area (VII) near Lesosibirsk. This will require important imports of raw material.

1.5. Industrial exploitation of the Mimecha-Kotuy resource region (area VIII)

After 2010 the enterprises of the Mimecha-Kotuy resource region (Yesseisk area) are expected to be feasible cargo generating units. Even at the end of the 1950s this region was assumed to become the main apatite reserve of the USSR by 2000 [28]. The scale and efficiency of Kola Peninsula apatite and nepheline ore extraction are decreasing. The problem of phosphate resources still remains. Based on this fact, our report discusses an opportunity to develop the Yesseisk area deposits and considers two routes for the area's transport links with Yenisei ports: – the construction of a railway to Igarka, – a route to Norilsk via Dudinka.

The start of development of Yessei apatite and rare earth-based metal deposits will be possible only by 2015, and the supply of equipment and materials – after 2010. Mined ore may be transported to the Norilsk Industrial Region for further processing, while concentrate will be sent to Lesosibirsk for production of phosphoric fertilizers. In the exploitation of deposits, cargo flows via the NSR may start by 2015.

Exports may amount to 750 - 1500 thousand tons and imports 300 - 500 thousand tons.

In addition, apatite concentrate can be exported via the NSR to substitute supplies from the Kola Peninsula due to the depletion of Khibine deposits.

Among production of AYR mining and metallurgical complex, the extraction of graphite should be distinguished. In the service zone of NSR there are the largest and high-quality graphite deposits. Currently, extracted Noginsk graphite (planned capacity – 50 thousand tons) is exported to Krasnoyarsk graphite plant. It has been proposed to examine possibilities of perhaps exporting small volumes of graphite to the west via the NSR. Besides, when determining cargo volumes of interregional complexes, the calculations of specialized institutes on coal export supplies from Kemerovo area have been taken into consideration.

Table III.1.3.

Cargo generating potential of the mining–metallurgical complex of AYR for "Yenisei – NSR" transport system (1000 tons)

Production	2000	Scenarios					
		Radical			Maximal		
		2005	2010	2015	2005	2010	2015
Export – total	1730	2150	2351	3322	2451	2672	4373
Including							
1. Ore. Fine matte. and other products of primary processing of NMMC*	700	1000	1100	1200	1100	1200	1200
2. Non-ferrous metals:							
a) nickel. cobalt. and others (NMMC)	330	350	400	450	400	450	500
b) aluminum of AYR	100	100	100	100	200	200	200
c) lead and zinc of Lower Angara Region	–	–	–	20	–	20	20
3. Magnesite of Lower Angara region	100	200	250	300	250	300	350
4. Apatite concentrate	–	–	–	750	–	–	1500
5. Phosphorus fertilizers	–	–	–	–	–	–	100
6. Graphite	–	–	1	2	1	2	3
7. Kuzbass coal	500	500	500	500	500	500	500
Total import	1000	1600	1700	4100	2000	4400	4800
including:							
1. Equipment and materials for NMMC	600	800	900	1000	1200	1500	1500
2. Alumina							
variant I – Dudinka	400	800	800	800	800	800	800
variant II – Lesosibirsk	400	800	800	800	800	800	800
3.Alumina containing raw materials	–	–	–	2000	–	2000	2000
4. Equipment and materials for Mimecha-Kotuy region	–	–	–	300	–	100	500

* NMMC - Norilsk Mining Metallurgical Combinate

1.6. Prognosis for creating mining and metallurgical complex cargo flows for the «Yenisei–NSR» system

Thus, the mining and metallurgical complex will supply the following cargo volume for the «Yenisei – NSR» transport system (Tabl. III.1.3).

The leading cargo generating units of the AYR mining and metallurgical complex from both an import and export angle are the NMMC and aluminum industry enterprises. And in a distant perspective – industry based on local apatite and rare earth-based metal deposits.

2. PRECONDITIONS FOR DEVELOPMENT OF THE WOOD-WORKING INDUSTRIAL COMPLEX

2.1. Resource potential

According to the wood reserve records of 1 January 1993, the wood-covered area of Russia comprises approximately 655 million hectares. The total wood reserves are evaluated to be about 73 billion cubic meters with more than half of these reserves concentrated in Siberia. Eastern Siberia's wood reserves, most of which are located in the zone of influence of the «Yenisei–NSR» system, amounts to 36.8% of the total reserves. The quantitative advantage of the Siberian regions is strengthened by the qualitative characteristics of the wood resources: 77% of Siberia's wood reserve fells are coniferous. The specific share of mature and post-mature timber comprises 58%. Certainly, not all Siberian wood regions are similar in terms of the above mentioned characteristics. For example, the share of only one area – the Lower Angara Region, located in the zone of direct service of the «Yenisei - NSR» transport system (VII), comprises 22% of the calculated felling area of Siberia. In addition, 70% is a coniferous felling area.

2.2. Wood-working industry

An analysis of the output dynamics of the major types of wood-working industrial production in Russia from 1970 shows that the maximum level was achieved in 1988 (Tabl. III.2.1). Besides, several products in Siberia had much

higher average annual rates of increment in production than in Russia as a whole within this period. The dynamics of Russia's Eastern region participation in the wood-working industrial complex is given in Tables III.2.2a – III.2.2f..

In the 1990s, no negative deviation can be observed on indicators which characterize the fixed assets of the Siberian wood-working complex, from the established «average Russian standard». However, of the total deficit of circulating assets of Russia's wood-working complex, 25% was from Siberia. The sum of such an «investment» is determined largely by the transport factor. From 1991 to 1994 the increase in transport costs for the Siberian regions surpassed the rise in prices on timber and paper-making products. By the end of 1995, these costs amounted to 60% of the total costs for timber production. This resulted in a sharp restriction on products sales and, finally in more stagnation in production.

However, during this recession, the advantages of the Siberian wood-working complex have manifested themselves significantly. In 1995 the average level of the wood-working industry's profitability in Russia as a whole «moved in a negative direction» and was minus 7.4%. But for Eastern Siberia this indicator remained positive though it had been reduced to 6.4%. Such a situation emerged mostly due to local high-quality wood reserves as well as a strong local energy sector, which helped keep efficient timber processing within the region.

Thus, the Siberian wood-working complex maintained actual preconditions for reconstructing the production scale at the 1988 level and increasing exports especially with the help of the «Yenisei – NSR» transport system.

Table III.2.1

Production of the main types of products of the wood-working complex of Russia

Types of products	Production in Russia					Siberian part. in %%				
	1970	1980	1988	1990	1996	1970	1980	1988	1990	1996
Timber logging mill. m^3	277	256	280	242	74	27.0	28.5	30.7	32.2	28.2
Sawn timber mill. m^3	92	81	85	75	22	25.3	31.2	33.2	33.8	32.0
Plywood 1000 m^3	1421	1460	1727	1597	850	7.3	11.0	17.0	16.4	13.0
Shaving wooden plates 1000 m^3	...	3491	5490	5490	1472	...	...	...	...	20.0
Fiber wooden plates mill. m^2	171	386	501	483	184	5.2	18.1	19.3	19.5	25.0
Pulp. 1000 tons	4735	6765	8349	752	4200	18.6	22.6	25.4	29.3	32.3
Paper. 1000 tons	3476	4462	5334	5240	1800	3.6	2.7	2.2	2.1	...
Cardboard. 1000 tons	1973	2536	3249	3085	1310	13.6	19.7	20.4	19.0	25.0

Table III.2.2a

Logging of the eastern regions of Russia including territories of proximity to the NSR

Production indices	1950	1960	1970	1980	1985	1988
Production volume in RF. Mill m^3	137.7	239.3	276.8	255.6	257.1	280.1
Eastern region share in %	26.7	28.1	35.2	38.0	40.0	40.2
Incl. Siberia	20.1	21.9	27.0	28.5	30.2	30.7
Far East	6.6	6.2	8.2	9.5	9.8	9.5
territories of NSR proximity	10.9	14.2	18.3	18.9	20.4	21.2
Tomsk Oblast	1.9	2.2	2.4	2.1	2.3	2.1
Irkutsk Oblast	4.3	6.4	8.4	9.9	10.9	12.0
Krasnoyarsk Krai	4.7	5.6	7.5	6.9	7.2	7.1
Increase of production per year in Russia in %%	...	7.38	1.56	–0.76	0.12	2.97
incl. eastern regions	...	2.21	1.27	–0.01	0.42	1.27
Siberia	...	1.80	0.93	–0.07	0.34	1.10
Far East	...	0.41	0.34	0.06	0.08	0.17
territories of NSR proximity	...	1.37	1.12	–0.10	0.34	0.93
Tomsk Oblast	...	0.18	0.06	–0.05	0.04	0.00
Irkutsk Oblast	...	0.69	0.75	0.07	0.22	0.73
Krasnoyarsk Krai	...	0.50	0.31	–0.12	0.08	0.20

Table III.2.2b

Production of sawn timber in the eastern regions of Russia including territories of NSR proximity

Production indices	1950	1960	1970	1980	1985	1988
Production volume in RF. Mill m^3	37.1	83.6	91.8	80.3	79.6	84.9
Eastern region share in %	24.9	28.7	32.6	39.0	40.5	40.7
incl. Siberia	18.8	20.0	23.6	28.2	29.0	29.7
Far East	6.1	6.1	7.3	7.8	7.8	7.6
territories of NSR proximity	10.2	13.2	15.7	19.2	20.1	21.2
Tomsk Oblast	1.2	1.5	2.1	2.1	2.2	2.2
Irkutsk Oblast	4.4	6.0	7.0	8.9	9.6	10.7
Krasnoyarsk Krai	4.6	5.7	6.6	8.2	8.3	8.3
Increase of production per year in Russia in %%	...	12.53	0.99	–1.25	–0.18	2.27
incl. eastern regions		3.96	0.72	0.15	0.20	1.00
Siberia	...	3.20	0.53	0.20	0.22	0.90
Far East	...	0.76	0.19	–0.05	–0.02	0.10
territories of NSR proximity	...	1.94	0.41	0.12	0.14	0.87
Tomsk Oblast	...	0.21	0.08	–0.02	0.02	0.07
Irkutsk Oblast	...	0.91	0.17	0.08	0.12	0.60
Krasnoyarsk Krai	...	0.82	0.16	0.06	0.00	0.20

Table III.2.2c

Production of pulp in the eastern regions of Russia including territories of NSR proximity

Production indices	1950	1960	1970	1980	1985	1988
Production volume in RF.						
Mill. tons	1.01	2.09	4.74	6.76	7.95	8.35
East region part in %	4.7	10.2	22.0	26.1	30.6	32.9
incl. Siberia	0	0.9	14.1	18.7	23.4	25.4
Far East	4.7	9.3	7.9	7.4	7.2	7.5
Territories of NSR proximity	0	0.9	14.1	17.0	21.8	23.3
Tomsk Oblast	0	0	0	0	0	0
Irkutsk Oblast	0	0	11.0	13.9	19.1	20.7
Krasnoyarsk Krai	0	0.9	3.1	3.1	2.7	2.6
Increase of production per year						
in Russia in %%	...	10.72	12.64	4.29	3.52	1.70
Incl. eastern regions	...	1.65	3.96	1.53	1.98	1.30
Siberia	...	1.47	3.10	1.27	1.76	1.07
Far East	...	0.18	0.86	0.26	0.22	0.23
territories of NSR proximity	...	0.18	3.10	1.02	1.72	0.90
Tomsk Oblast	...	0	0	0	0	0
Irkutsk Oblast	...	0	2.49	0.88	1.72	0.87
Krasnoyarsk Krai	...	0.18	0.61	0.14	0	0.03

Table III.2.2d

Production of plywood in the eastern regions of Russia including territories of NSR proximity

Production indices	1950	1960	1970	1980	1985	1988
Production volume in RF.						
Mill. m^3	0.42	0.90	1.42	1.46	1.59	1.73
East region part in %	6.2	9.5	10.9	13.5	17.8	19.1
incl. Siberia	1.5	6.1	7.3	11.0	15.5	17.0
Far East	4.7	3.4	3.6	2.5	2.3	2.1
territories of NSR proximity	1.5	1.9	2.7	7.4	11.9	13.4
Tomsk Oblast	0	0	0	0	0	0
Irkutsk Oblast	1.5	1.9	2.7	7.4	11.9	13.4
Krasnoyarsk Krai	0	0	0	0	0	0
Increase of production per year						
in Russia in %%	...	11.58	5.79	0.27	1.84	2.77
Incl. eastern regions	...	1.45	0.77	0.30	1.18	0.97
Siberia	...	1.18	0.55	0.40	1.18	0.97
Far East	...	0.27	0.22	–0.10	0	0
territories of NSR proximity	...	0.27	0.24	0.49	1.12	0.87
Tomsk Oblast	...	0	0	0	0	0
Irkutsk Oblast	...	0.27	0.24	0.49	1.12	0.87
Krasnoyarsk Krai	...	0	0	0	0	0

Table III.2.2.e

Production of paper in the eastern regions of Russia including territories of NSR proximity

Production indices	1950	1960	1970	1980	1985	1988
Production volume in RF.						
Mill. tons	0.99	1.94	3.48	4.46	5.03	5.33
East region part in %	6.8	10.2	9.2	7.9	6.9	6.4
incl. Siberia	0.1	0.1	3.6	2.7	2.4	2.2
Far East	6.7	10.1	5.6	5.2	4.5	4.2
territories of NSR proximity	0	0	3.5	2.6	2.4	2.1
Tomsk Oblast	0	0	0	0	0	0
Irkutsk Oblast	0	0	0.4	0.2	0.2	0.2
Krasnoyarsk Krai	0	0	3.1	2.4	2.2	1.9
Increase of production per year						
in Russia in %%		9.55	7.92	2.84	2.54	2.00
incl. eastern regions		1.32	0.62	0.10	0.02	–0.07
Siberia		0	0.63	–0.01	0.04	–0.03
Far East		1.32	–0.01	0.11	–0.02	–0.04
territories of NSR proximity		0	0.63	–0.02	0.04	–0.03
Tomsk Oblast		0	0	0	0	0
Irkutsk Oblast		0	0.07	–0.01	0.02	0
Krasnoyarsk Krai		0	0.56	–0.01	0.02	–0.03

Table III.2.2f

Production of cardboard in the eastern regions of Russia including territories of NSR proximity

Production indices	1950	1960	1970	1980	1985	1988
Production volume in RF.						
Mill. tons	0.22	0.49	1.97	2.54	2.88	3.25
East region part in %	2.8	6.7	19.7	26.4	26.6	28.6
incl. Siberia	0.4	0.7	13.6	19.7	19.9	20.4
Far East	2.4	6.0	6.1	6.7	6.7	8.2
territories of NSR proximity	0.4	0.7	12.8	13.0	13.0	12.3
Tomsk Oblast	0	0	0	0	0	0
Irkutsk Oblast	0.4	0.2	9.4	7.5	7.6	7.3
Krasnoyarsk Krai	0	0.5	3.4	5.5	5.4	5.0
Increase of production per year						
in Russia in %%	...	12.22	30.18	2.85	2.68	4.30
incl. eastern regions	...	1.20	7.26	1.43	0.76	1.87
Siberia	...	0.11	5.40	1.18	0.58	1.00
Far East	...	1.09	1.86	0.25	0.18	0.87
territories of NSR proximity	...	0.11	5.07	0.40	0.34	0.30
Tomsk Oblast	...	0	0	0	0	0
Irkutsk Oblast	...	0	3.74	0.03	0.22	0.20
Krasnoyarsk Krai	...	0.11	1.33	0.37	0.12	0.10

2.3. Wood product exports

Within the structure of the former USSR's 1988 exports, wood production as well as pulp and paper products comprised 3.5%. Wood product exports were as follows: 61% was timber logging and sawn timber products (mainly coniferous sorts), almost 25% – pulp and paper production, 4.5% – plywood, about 5% – cardboard, and 2.5% – shaving wooden plates and fiber wooden plates. The correlation between export supplies and production of specific types of wood products varied from 6% (shaving wooden plates) to 36% (goods pulp). European countries were the main consumers of almost all these products (Table III.2.3). The only exception was sawn wood products, 81% of which were imported by Asian countries (26.3% – in China, and 55.2% in Japan).

An analysis of the specific export geography enables us to make the following general description of the former Soviet Union's external trade of wood products in its «peak» year (table III.2.4).

- primary processed wood products dominated in wood exports;
- for each major product two - four importing countries can be identified, whose total share in overall imports was higher than 50%;
- more than half of the exports of processed wood fells went to SEV countries (former union of socialist countries). Serious importers were Japan, France, Finland, USA, Italy, India, and Great Britain.

The product structure of the wood exports of the former USSR and its efficiency depended almost entirely on supplies from Russia. Therefore, the above mentioned general characteristics are completely valid for Russia in the late 980s.

During the first half of the 1990s the geopolitical situation has changed crucially and so has Russia's economic situation. Because of these changes, the conditions for exports in Russia have also changed. From 1992, enterprises in the wood production sector have rapidly increased the volume of production for export even with rising transport tariffs. During the 1992–1994 period only, timber exports from the Siberian regions rose by an order of 4.7 (in natural volume), sawn products

by 8.3, pulp by 15 etc. (Table III.2.5). In 1997 25% - 95% of all produced wood products (including sawn products) were exported (Table III.2.6).

Table III.2.3

Export of main kinds of wood complex products of the USSR in 1988. (to the major consumers of the product) *

Production	Units of measure-ment	Export		Share of countries-importers- in the export. in %			
		Volume	% of output	Europe	Asia	America	Africa
Timber	mill m^3	20.5	7.3	43.4	29.3	–	–
Sawn timber	mill m^3	8.7	...	16.1	81.6	–	–
Building wood	1000 m^3	198.5	...	70.8	16.3	–	–
Sawn softwood	mill m^3	8.1	9.5	81.5	3.7	6.2	3.7
Fiber wooden FWP[1]	mill m^2	90.4	18.0	60.6	–	24.0	–
SWP[2]	1000 m ^{3}	351.7	6.4	92.2	–	4.4	–
Plywood	1000 m^3	416.2	24.1	73.8	–	11.7	4.8
Pulp	1000 tons	1055.0	35.8	77.3	–	4.3	1.7
Paper	1000 tons	1029.1	19.3	56.8	17.4	13.2	2.8
Cardboard	1000 tons	404.1	12.4	69.8	–	12.6	2.7

[1]FWP – fiber wooden plates
[2]SWP – shaving wooden plates

Table III.2.4

Countries – major wood product importers from the USSR in 1988 in % to export volume in natural measurement*

Countries – major importers	Timber	Sawn wood	FWP[1]	SWP[2]	Plywood	Pulp	Paper	Cardboard
Austria	4.5	–	–	–	–	4.0	–	0.9
Bulgaria	1.0	1.6	–	–	–	9.8	8.9	2.2
Great Britain	–	15.2	3.9	16.1	22.2	–	–	–
Hungary	6.0	10.4	5.4	9.6	5.7	10.7	14.3	22.5
Germany	3.7	20.0	18.0	27.0	14.3	14.5	21.2	25.6
India	–	–	–	–	–	–	14.4	–
Italy	2.3	7.4	–	–	8.2	8.5	–	–
Cuba	–	6.5	12.8	4.4	9.7	4.3	13.2	12.6
the Netherlands	–	5.8	–	–	2.8	–	–	1.8
Poland	0.8	1.7	26.4	24.8	11.6	11.7	6.2	6.2
USA	–	–	11.2	–	0.9	–	–	–
Finland	23.0	–	–	–	–	–	–	–
France	–	5.3	–	9.1	–	7.3	–	–
Czechoslovakia	0.8	0.7	3.2	5.0	1.2	1.7	2.8	10.5
Sweden	–	–	3.7	–	3.2	–	–	–
Japan	29.1	2.5	–	–	–	–	–	–
Total. incl. countries whose share is higher than 5%	71.2 58.1	77.1 65.3	84.6 73.8	96.0 91.6	79.8 71.7	72.5 62.5	81.0 78.2	82.3 77.4

[1] FWP – fiber wooden plates
[2] SWP – shaving wooden plates

* The table is composed using statistical data from "External economic relations of the USSR in 1988 - Moscow: 1989 -287 p.

* The table is composed using statistical data from "External economic relations of the USSR in 1988 - Moscow: 1989 -287 p.

Most of the wood product exports from the Angaro-Yenisei Region were transported by sea including transport via the NSR. This route served not only the northern countries but also the Mediterranean basin countries, as well as Cuba and Africa. Within the framework of a maximum export period from Yenisei basin region, up to 1200 thousand tons were transported via the NSR. And 300–350 thousand tons were transported from Igarka and 850–900 thousand tons were exported from the Lesosibirsk and Krasnoyarsk timber complex. One can foresee that due to its effectiveness in prospects the «Yenisei - NSR» transport system will keep its leading role in wood export activities within the Angaro-Yenisei Region and the territories located in its zone of proximity (Table III.2.7) [14].

Table III.2.5

Exports of wood products from the Siberian regions of Russia

Production	Subjects of Federation	1991	1992	1993	1994
Timber. 1000 m^3	All of Siberia	139.6	138.4	862.2	661.5
	incl. Irkutsk Oblast	51.2	18.0	263.8	258.6
	Krasnoyarsk Krai	47.5	32.8	162.3	160.8
	Tomsk Oblast.	26.4	63.6	71.4	85.5
	Tyumen Oblast	13.0	22.1	315.1	107.7
	% of territories in proximity to the NSR	89.6	82.7	57.7	76.3
Sawn wood, 1000 m^3	All of Siberia	146.2	53.5	671.3	1216.3
	incl. Irkutsk Oblast	61.3	22.7	52.5	392.3
	Krasnoyarsk Krai	79.4	19.8	209.3	648.7
	Tomsk Oblast.	0.0	4.0	108.9	130.4
	Tyumen Oblast	0.3	5.3	272.2	39.1
	% of territories in proximity to the NSR	96.2	86.9	55.2	96.3
Paper, 1000 tons	All of Siberia	1.37	29.1	21.23	88.9
	incl. Irkutsk Oblast	0.07	11.2	0.03	51.1
	Krasnoyarsk Krai	0	2.7	14.0	12.8
	% of territories in proximity to the NSR	5.1	47.8	66.1	71.9
Pulp, 1000 tons	All of Siberia	11.8	2.3	19.1	177.0
	incl. Irkutsk Oblast	8.9	0.8	12.8	176.8
	Krasnoyarsk Krai	1.2	0.3	...	0.2
	% of territories in proximity to the NSR	85.6	47.8	67.0	100.0
Shaving wooden plates, 1000 m^3	Siberia. Total	0.03	0.32	2.1	25.4
	incl. Krasnoyarsk Krai	0.02	0.02	0.5	10.9
	% of territories in proximity to the NSR	66.7	6.2	23.8	42.9

Table III.2.6

Exports of main timber–production complex products from Russia

Products	Volume of export			Share of export in production, %		
	1995	1996	1997	1995	1996	1997
Timber mill. m^3	18.50	15.90	17.40	20.0	21.0	26.5
Sawn wood mill. m^3	5.90	4.60	4.90	22.3	21.3	25.7
Plywood mill. m^3	0.68	0.61	0.61	72.2	63.2	63.5
Pulp mill. tons	1.34	1.10	1.14	74.6	85.7	95.6

Table III.2.7

Costs of transporting sawn wood from Lesosibirsk to foreign consumers

Transport scheme	Terminal point	Expenditures. US $ /m^3			
		Total	Incl. kind of transport		
			Railway	River	Sea
Yenisei and NSR	London	50–52	–	12.5	37.5–39.5
	Egypt	58	–	12.5	45.5
Railway and sea via St. Petersburg	London	71.5–82	38–44	–	33.5–38
Railway and sea via Novorossiysk	Egypt	69.5–75	42–47	–	27.5–28

2.4. Prognosis for creation of cargo generating, wood-working areas

One of the most important aspects of territorial restructuring of the wood-working industrial complex in Russia is a prohibition of timber logging export from Siberia while increasing production capacities for deep timber processing. This direction was determined by a comparison between the potential of Siberia and other forest regions.

An analysis of available data on the prospects for development of the Siberian wood-working industry reveals the following initial preconditions for devising strategies for such development [11, 12, 22, 24].

1. Siberia will not be able to essentially change the production and geographical structure of its wood-working complex before 2005 and seriously increase its timber product output. Even with major investments, the envisaged objectives may be achieved after 12–15 years. The reliability of this precondition has also increased because of the current poor financial situation of the Russian economy and, therefore, lack of investments in the wood-working industry before 2005. This is why it is not improbable that the goal will be achieved 10 -15 years later.

2. The primary task of the Siberian wood regions at this time is a rehabilitation by 2005 of available production capacities to the level of the late 1980s. This task is most likely of the highest priority for the first five years of the 21st century. Only this may permit a increase in major wood production in Siberia by an order of 1.5–2 during the 1997–2005 period (Table III.2.7). The main part of the increment will be provided by territories located in the zone of proximity or service of the «Yenisei – NSR» transport system.

3. The vital region for development of new wood areas in the above mentioned zone will be the Lower Angara Region (Nizhnee Priangarie), whose production reserves of timber are evaluated to be about 2.9 billion cubic meters. According to an adopted federal special-purpose program of Nizhnee Priangarie development, the share of this region in production of selected products in Siberia will increase to 40% in 2005(Table III.2.8) [12].

4. In future, as the demand for wood products (especially of natural solid timber) will rise, the production structure of the wood-working industry in the zone of service of the «Yenisei – NSR» transport system, will change considerably. In case the scope of production output of AYR traditional deeply processed wood products remains as it is, the development will cover such profitable directions as furniture production (of high demand preferably), customized parquet, furniture and construction items (especially of massive wood), pre-fabricated wooden houses (under various combinations of assembly), and plywood. The major arguments for this choice are the following:

Table III.2.8

Prognosis for main wood product production in Siberia.
(incl. zone of direct service of "Yenisei–NSR" transport system»)

Wood product	Production in 2015		Share of Lower Angara area
	Siberia	Lower Angara area	
Timber, mill m^3	31.1	9.0	28.9
Sawn wood, mill m^3	10.3	2.5	24.3
Pulp, 1000 tons	902.0	350.0	38.8

- availability of large reserve of valuable timber;
- possibility for Siberian regions to occupy their own niche on external markets only through the export of ecologically pure products, which will keep the structure and features of natural wood;
- possibility of expanding the geography of new product exports by using the «Yenisei – NSR» transport system in Siberian regions.

1. The economic expediency of constructing new wood-working plants in the zone of service of the «Yenisei – NSR» transport system is based on the federal target programme for 2005. The list of the largest units is given in Table III.2.9. The construction expediency of several units from Table 3.2.6 is considered only from the point of view of raw material provision and of regional interest in resource use.

Table III.2.9

New units provided by the Federal Target Programme "Siberia" in the "Yenisei–NSR" service zone

Region of cargo flow formation for NSR	Units of wood industrial complex				
	Wood processing producing	Timber processing producing	Pulp producing	Pulp and paper	Pulp and cardboard
Krasnoyarsk Krai	Boguchanski Pitski Kodinski	Vanavarski	Kodinski	Boguchanski Osinovski Yeniseiski	
Tomsk Oblast	Beloyarski	Togurski		Asinovski Prokhorkinski	Beloyarski Kolpashevski

2.5. Prognosis for creation of AYR wood-working cargo flows for the «Yenisei – NSR» system

The primary reasons for evaluating the AYR wood-working industrial complex potential as a territorial cargo generating element for the NSR, can be classified by periods.

Before 2005.

1. The main export cargo will be sawn timber.

2. The main areas of wood export cargo for the NSR will still be the Lesosibirsk and Igarka areas. A change in the volume of wood cargo flow to the NSR will depend on the realization of measures and events aimed at the economic stabilization of the Northern Siberian areas. The Lesosibirsk area will increase the scope of exports according to the realization of the program of Nizhnee Priangarie development. Igarka has the task of maintaining its wood export potential or to reduce it minimally. Otherwise, the port of Igarka will lose its cargo, the inhabitants of the city – their jobs, and the city itself – its social and economic basis to function.

3. The potential cargo flow from the above mentioned regions to the NSR (based on capabilities of wood production) will be maximum 400–500 thousand tons by 2000. It should be stressed that the realization of this cargo flow is rather problematical especially in the case of keeping exports from Igarka at a level of 170–200 thousand tons.

After 2005.

1. A stable increase in wood exports to the NSR cannot be seen before 2005 because of the planned development of the Lower Angara Region resources. At the same time, the goods structure of the cargo flow will be widened. In addition, the potential users of the NSR may be located in the north-eastern part of the Tomsk region (Asin–Beloyarsk wood complex – area X of the second stage of direct service by the «Yenisei – NSR» transport system) and the northern part of the Irkutsk region (Middle Angara – area XI of feasible service by the «Yenisei – NSR» transport system) if the construction of the North Siberian Railway becomes an economic necessity in Russia during the first ten years of the 21st century. The motivation for including these regions is different. For the latter region, the motivation is an additional transport route for exporting, and for the former, which now only has the one outlet to the Trans-Siberian railway, it is the increased reliability of performance in external relations.

One cannot exclude the possibilities of using «combined» export routes in the Siberian regions, based on the links of the NSR with the Belomor-Baltic Channel.

2. The absence of official documents and a legislative foundation for export and import questions for the future until 2015, resulted in the adoption of a large lag of uncertainty in predicting what share of exports will be included in the production volume. Therefore, this study adopts a 3-5% variation for traditional products (sawn timber and pulp, for example) and 10–20% for new products (of prestige demand).

A minimal share of cargo flow to NSR from the Irkutsk region for various products is expected to be up to 5% of total exports. From the Tomsk region, taking into account the importance of the North Siberian railway for generating its export policy, this share is expected to increase from 10 to 15% by 2015.

3. The goods structure of wood exports to the NSR will be widened compared to the 1990s, by supplying pulp, plywood, pre-fabricated wooden houses, furniture of solid wood, customized parquet, and furniture and construction items of massive wood.

Under the expected conditions, the annual cargo flow to NSR from the wood-working industrial complex areas, which are located in the zone of service of the «Yenisei – NSR» transport system or close to it, will rise from 400 to 1300 thousand

tons by the 2000–2015 period according to the radical variant, and from 500 to 1500 thousand tons according to the maximal variant (Table III.2.10). It is considered that in the maximal variant the average annual increase in cargo flow will sharply decrease by 2015: from 12.5% in 2000–2005 to 3% in 2010–2015 by increasing exports of high- quality products. In the radical variant, the behavior of this indicator will be practically stable within the whole period. Up to 2010, it will amount to 8.4%, and by 2015 will drop only to 7.6%. This fact stresses again the large share of the Lower Angara area in cargo generation for the «Yenisei - NSR» transport system.

Table III.2.10.

Prognosis for generation of cargo flow in the wood industrial complex of AYR for the "Yenisei– NSR" transport system, 1000 tons

Areas of cargo generation	Radical variant				Maximal variant			
	2000	20005	2010	2015	2000	2005	2010	2015
Direct service of the 1st stage	400	600	760	970	500	900	1080	1170
incl. Lower–Angara area (VII)	200	400	560	770	300	700	880	970
Igarka area (III)	200	200	200	200	200	200	200	200
Feasible service of the 2nd stage	–	–	140	330	–	–	220	330
incl. Tomsk area (X)	–	–	60	180	–	–	120	180
Middle Angara area (XI)	–	–	80	150	–	–	100	150
Total cargo flow	400	600	900	1300	500	900	1300	1500

3. PRECONDITIONS FOR OIL-GAS COMPLEX DEVELOPMENT

3.1. Resource potential

The most promising oil-gas territories within AYR boundaries are located in the Irkutsk region and Krasnoyarsk Krai. Of these only the northern part of Krasnoyarsk Krai and Evenk can be classified as part of the zone of proximity to the «Yenisei - NSR» transport system. From these regions oil can be exported via the NSR and transported for further processing in Achinsk and Lesosibirsk, while the obtained oil products can be transported to the north.

Krasnoyarsk Krai with Evenk and Taymyr Autonomous Districts have enormous oil and gas resource potential (second after Tyumen Oblast in Russia).

More than 20 oil and gas deposits have been discovered. These deposits have considerable extractable resources of hydrocarbons (Table III.3.1). The prospects for expanding the resource base of the oil and gas complex are favorable. The predicted extractable resources of the region, including the total volume of hydrocarbons, amount to 32.3 billion tons of conventional hydrocarbons, including oil with condensate – 9.1 billion tons, and gas – 23.2 trillion cubic meters [19].

Table III.3.1

Located extracted reserves of hydrocarbons in the zone of proximity of the «Yenisei - NSR» transport system (by 1.1.1995)

Areas	Oil, mill tons		Gas. bill m^3		Condensate. Mill tons	
	C_1	C2	C1	C2	C1	C2
Evenk (VI)	65	0.4	252	428	17.5	34
Lower Angara (VII)	–	–	0.6	30	–	–
Norilsk(II)	0.5	33	217	35	8	7.4
Turukhansk (III)	116	247	114	105	1.5	2.1
Total	181.5	280.4	583.6	598	27	43.5

3.2. Prognosis for hydrocarbon production

For hydrocarbon consumption, the Krasnoyarsk Krai is still oriented towards oil supplies from western Siberia. Currently, the Krai consumes more than 5 million tons of oil products. The extraction of hydrocarbon raw material in production – about 5 billion cubic meters of gas – is now being implemented only in the north of the Krai for the NMMC (area II). The small volume of oil and condensate extraction is carried out on a number of deposits in Evenk (area VI) to satisfy local requirements. The major supplier of oil products is the Achinsk oil-processing plant, whose annual production in crude oil processing is 6.5 million tons. Under severe conditions of economic crisis in the western Siberian oil industry, oil supplies from western Siberia were reduced and their increase in the near and distant future is hardly expected.

According to our predictions, oil consumption in the Krai may increase to 6 million tons by 2005 even under a severe energy saving policy. In the Krasnoyarsk Krai an initial resource base has been established for the following large regions of oil and gas industry: the Norilsk (area II) and Sobinsk (area VI) gas-extracting regions, the Yurubchen-Tokhom (area VI) and Turukhansk (Area 3) prospective oil

and gas-extracting regions, as well as the Lower Angara (Area VII) prospective gas-extracting region.

The largest deposit in Evenk is the*Yurubchen-Tokhom deposit*, which is essential for the creation of an oil and gas industry in the Krasnoyarsk Krai. The oil extraction in this region may be more than 6 million tons by 2005, 28 million tons by 2010 and 58 million tons by 2015 (Table III.3.2). The transport of crude oil is possible by two variants:

Table III.3.2

Prognosis for oil extraction in the zone of proximity of the «Yenisei - NSR» transport system mill. tons

Areas	2000	2005	2010	2015
Evenk (VI)	0.9	6.7	28	58
Turukhansk (III)	0.5	14	14.5	18
Total	1.4	20.7	42.5	76

- via an oil pipeline to Lesosibirsk and further by railway to Achinsk with processing at the Achinsk oil-processing plant;
- via oil pipeline to the Karabula station and further by railway to Achinsk and Angarsk.

Within the *Turukhansk* prospective *oil and gas extracting region* (area IV), four deposits have been discovered: Vankor, Lodochnoe, Tagul, and Suzun. The Vankor deposit will be the first to be launched, then, with short intervals, the Lodochnoe, Tagul, and Suzun deposits. The total oil extraction from these deposits may be 14–15 million tons by 2010, and 17–19 million tons by 2015 (Table III.3.2).

Together with the oil-extracting development in the Krai, the Achinsk oil-processing plant will be completely supplied with oil from the Krai's local deposits. In addition, the construction of small-sized oil and condensate-processing plants on the territory of the Krai will be economically reasonable to meet the local demands of northern areas.

In addition to the *Norilsk gas-extracting region* (area II), satisfying the demands of the Norilsk Industrial region, new gas-extracting units of Near and Far North of Krasnoyarsk Krai may be developed (Table III.3.3).

Table III.3.3

Prognosis for gas extraction in the zone of proximity of the "Yenisei–NSR" transport system. bill m^3

Areas	Years			
	2000	2005	2010	2015
Evenk (VI)	0.9	9.5	9.5	44.2
Lower Angara (VII)		0.4	22.5	22.5
Norilsk(II)	2.2	3.5	3.5	3.5
Turukhansk (III)		3.1	7.2	9.8
Total	3.1	16.5	42.7	80

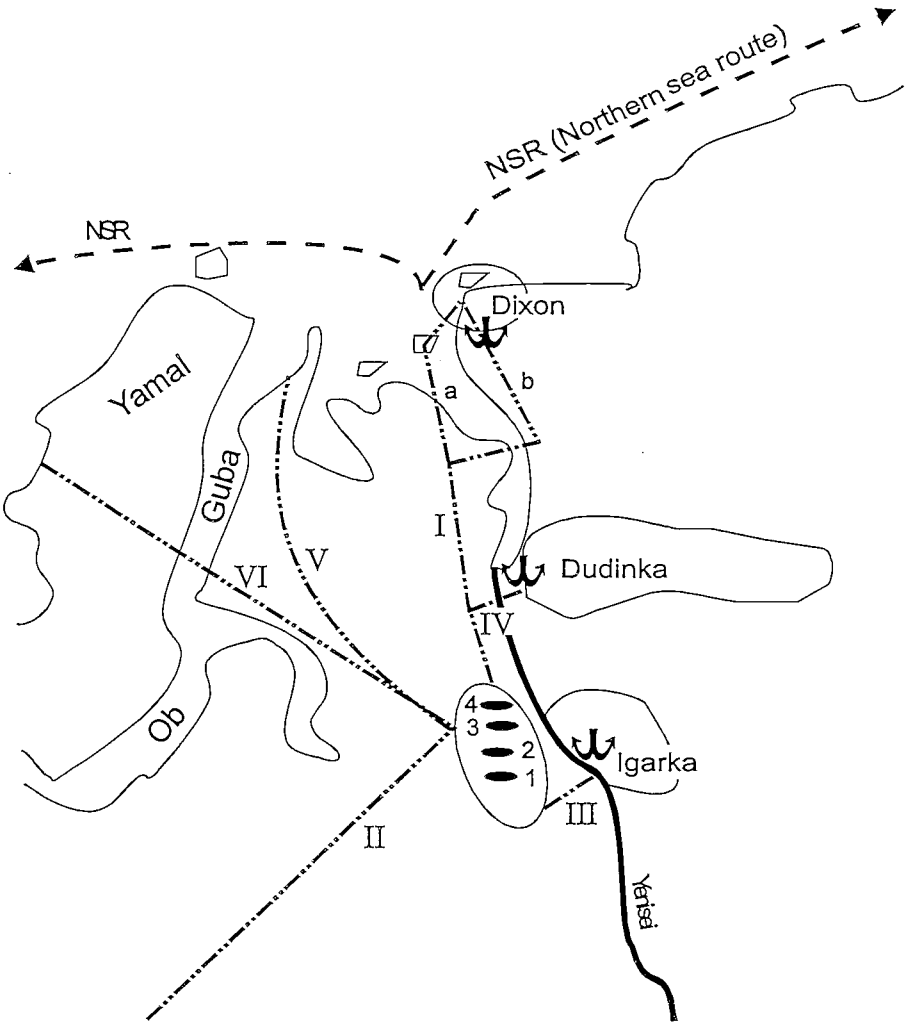
Within the framework of the oil and gas complex of Krasnoyarsk Krai, together with extracting sectors and oil-processing, helium, oil, gas and chemical industries should be developed. This region can become a large importer not only of oil and gas, but also of petrochemical, deep helium and oil-processing products. Layer waters of oil and gas deposits of the Krai have a unique multi-component composition and can be the source of production of lithium, rubidium, calcium etc.

3.3. Prognosis for the creation of AYR oil-gas cargo flows for the «Yenisei – NSR» system

The considerable volume of oil from the Turukhansk area deposits, as well as gas and condensate from Norilsk and the Lower Yenisei area deposits will be exported via the NSR through the ports of Dudinka or Dixon. Meanwhile, oil products from the Achinsk and Lesosibirsk oil-processing plants will be deposited in bunkers or exported through Lesosibirsk to Dixon or Dudinka.

The transport of oil which is extracted in the Turukhansk area is very complicated and needs considerable development. Several scenarios have been considered, among them variants of constructing pipelines to Igarka or Dudinka and Dixon. Taking into account the terms of navigation and the navigation period, study work accepts Igarka as a viable option, along with two other possibilities – Dixon and Dudinka. The preferable one is Dixon, though the distance from the deposit is larger than for Dudinka, but navigation can be annual and the use of vessels with larger draught than in Dudinka is possible (Fig. 4).

As complicated as the problem of oil and gas supply to consumers are the problems of provision of mass cargo necessary for geological prospecting work, extraction of hydrocarbons, as well as provisions for exports of finished products. To



Legend:

– deposits (1 - Tagul, 2 - Lodochnoye, 3 - Vankor, 4 - Suzun)

– pipelines directions:

I - North (suggested in the report)
a) left-bank variant,
b) right-bank variant
II - South,
III - Igarka,
IV - Dudinka,
V - Ob,
VI - Yamal.

Fig. 4 Transport system "Yenisei - NSP": transportation variants of oil from Turukhansk deposit group.

predict the extent of transport, a pilot calculation is made of the possible volume of transportation of major types of mass cargo, namely casing pipes, pump and compressor pipes and oil-well cement. The initial basis for this prediction is considered to be the dynamics of oil extraction in the described prospect areas and the corresponding standards of specific costs of pipes and cement per one ton of extraction.

To enable oil extraction in the Turukhansk area before 2015 year the demand for supplying casing pipes will be 930–940 thousand tons, and oil-well cement – 840–850 thousand tons. According to extraction dynamics, which expects the main increase in 2001–2005, the share of mentioned cargo to be transported during the same period or even beforehand, would have to constitute 60%. Thus, the beginning of transportation should be planned from 2000–2005 (Table III.3.4).

Table III.3.4

Oil–gas complex cargo generating potential in the zone of proximity of the «Yenisei - NSR» transport system. 1000 tons

Regions. production. route variants. ports	Scenarios						
		Radical			Maximal		
	2000	2005	2010	2015	2005	2010	2015
	Turukhansk area						
Export of oil by the variants							
I. Dixon	–	9000	12600	13500	12600	13500	16200
Dudinka	–	0	0	0	0	0	0
II. Dudinka	–	8500	12100	13000	11850	12750	15450
Dixon	–	0	0	0	0	0	0
Import of equipment by NSR – total	20	140	80	25	170	100	40
incl. Igarka	17	120	70	15	145	90	30
Dudinka	3	20	10	10	25	10	10
	Evenk area						
Import of equipment – Lesosibirsk	25	35	60	65	60	110	120

The largest increase of oil extraction in the Evenk area is supposed to be in 2005–2010 (22 million tons) and in 2011–2015 (29 million). One of the supply routes may be the NSR with discharging in the port of Igarka. The size of the cargo flows will be the following: 2050–2100 thousand tons of casing pipes; 450–460 thousand tons of pump-compressor pipes; and 1800–1820 thousand tons of oil-well cement. Up to 75% of this volume will be transported during the 2005–2015 period. The cargo for the Evenk region may be transported via the NSR with reloading in Lesosibirsk. It should be stressed that the above mentioned cargo flows are the part of the real transport activities as they include demand only for production of oil. Another

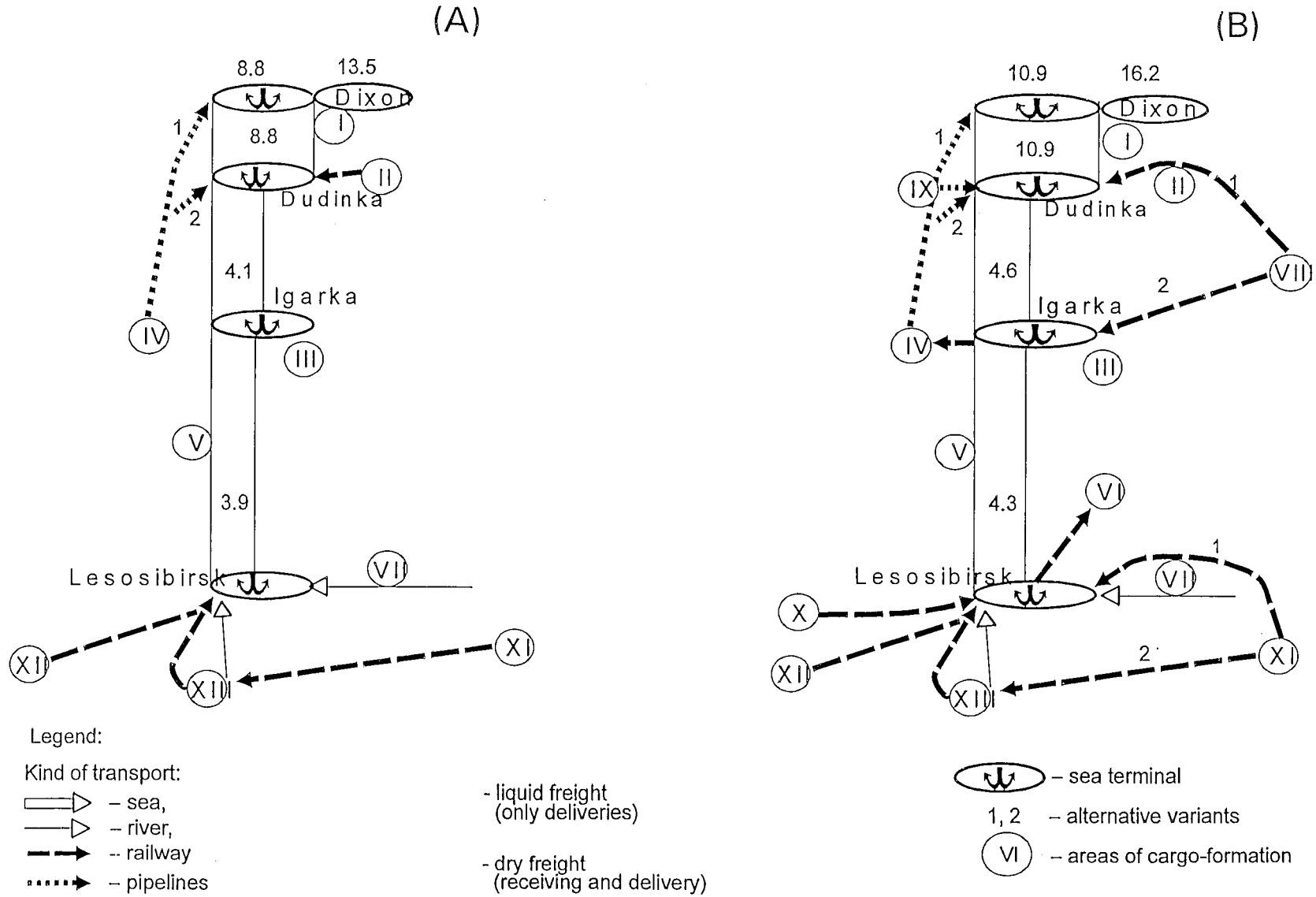


Fig. 5 Transport system "Yenisei – NSR": prognosis of possible cargo flow (shipping) in prospects to 2015 year, according to the radical and maximum (B) scenarios (million tonnes).

important and large-scale cargo flow will be connected with the geological prospecting work and the construction of units of production and social infrastructure.

One particular question is the provision of the AYR oil and gas complex with pipes for construction of the main pipelines. Taking into consideration the experience of hydrocarbon resources development in Western Siberia, one could expect that some of the pipes and equipment for areas within the "Yenisei – NSR" proximity zone, may be transported to the NSR via the Dudinka and Igarka ports (for areas I, II, IV, IX) and Lesosibirsk (for areas VI, VII). (Fig. 5).

IV. LOCATION OF CARGO GENERATING POTENTIAL AND "YENISEI – NSR" CARGO FLOW

1. CARGO GENERATING POTENTIAL OF INTER-BRANCH AYR COMPLEXES

An analysis of the development of AYR's production factors and, above all, its distinguished industrial sectors shows that only three inter-branch complexes can supply the «Yenisei - NSR» transport system with 5.2 - 8.6 million tons of dry cargo by 2010 and 8.8 - 10.9 million tons by 2015. In addition, in the case of establishing a tanker fleet in Russia, and further intensive development of hydrocarbon transportation by sea in the regime of prolonged or year-round navigation in the western part of the Arctic region, AYR will be able to also offer 9 - 16.2 million tons of oil and other kinds of hydrocarbon raw material by 2015 (Table IV.1.1). The "other kinds" of cargo for the Norilsk industrial region have been also considered. The supply of "other kinds" of cargo to all regions except Norilsk will generally not be implemented via the NSR.

Table IV.1.1

Cargo generating potential of inter-branch complexes of AYR for the "Yenisei–NSR" transport system, mill. tons

Inter-branch complexes	2000	Scenarios					
		Radical			Maximal		
		2005	2010	2015	2005	2010	2015
Export of production – total	2.1	11.7	15.9	18.1	15.9	17.5	22.1
incl. complexes:							
Wood–industrial	0.4	0.6	0.9	1.3	0.9	1.3	1.5
Mining–Metallurgical	1.7	2.1	2.4	3.3	2.4	2.7	4.4
Oil–gas	–	9.0	12.6	13.5	12.6	13.5	16.2
Import of production – total	1.0	1.8	1.9	4.2	2.2	4.6	5.0
incl. complexes:							
Mining–Metallurgical	1.0	1.6	1.7	4.1	2.0	4.4	4.8
Oil–gas	–	0.2	0.2	0.1	0.2	0.2	0.2
Total	3.1	13.5	17.8	22.3	18.1	22.1	27.1
incl.:							
Dry cargo	3.1	4.4	5.2	8.8	5.5	8.6	10.9

Cargo flows in 2000 are taken for all scenarios to be equal, since within two years of 2000 no drastic changes in cargo suppliers' activities or transport system may occur. However, by 2000, it is considered that aluminum plants will receive raw material imported by sea transport via the NSR instead of Murmansk port. During this

period one expects that alumina imports will amount to 400 thousand tons. In addition, it is planned to export 500 thousand tons of coke from Kuznetsk. If this fails, cargo turnover will remain as it is today.

By 2000 it is expected that the cargo flow will increase by 30% according to a radical scenario and by 70% according to maximum. This is based on the different rates of increase of alumina imports, wood product exports and exports of NMMC production (see Table III.1.3.). During this period it is planned to start imports of equipment and materials for supplying the oil deposits in the Turukhansk area.

Under a maximum scenario it is expected that by 2010 there will be an important increase in cargo turnover. This scenario envisages principal changes in the schedule of providing aluminum plants with raw material. If alumina imports are maintained, large-scale imports of bauxite for the construction of an alumina plant in AYR is considered. Of the traditional cargo, only wood production is expected to increase sharply.

Under both scenarios, a large increase in cargo turnover is expected by 2015. According to a radical scenario, this increase will be determined by the increase of wood product exports, the beginning of bauxite imports (planned by 2010 in maximum scenario) and the emergence of new cargo – apatite concentrates. In a maximum scenario the cargo structure will be as in a radical scenario, but cargo flows will increase greatly.

Under all scenarios and stages, oil exports are anticipated from the deposits of the Turukhansk oil-gas region via Dixon port. The hydrocarbon cargo turnover will be defined by the potential of the «Yenisei - NSR» transport system. Taking into account the specific cargo and uncertainty of its transportation by sea, dry cargo is highlighted in a separate line in Table IV.1.1.

If the AYR development hypothesis suggested in this study is not fully realized, i.e. the current scheme of Siberian aluminum plants alumina supply is maintained, the Mimecha-Kotuy ore deposits are not exploited, and the Kuzbass coal is exported via Arkhangelsk, then the indices of probable dry cargo volume given above in Table IV.1.1. in the perspective of 2015 would be lowered by almost 50% according to both the radical and the maximal scenarios (table IV.1.2). However, even in that case, the total cargo of the "Yenisei – NSR" system will exceed the

corresponding indices of the best years in the 1980s by 20–25 % if the radical scenario is realized, and by 45–50 % if the maximal one is realized.

Table IV.1.2.

Total volume of cargo delivered and received in "Yenisei – NSR" system by 2015, mill. tons.

Situation / Scenarios / Operations	Pessimistic		Optimistic	
	Radical	Maximal	Radical	Maximal
Delivery – total	3.1	3.4	18.1	22.1
Incl. dry cargo	3.1	3.4	4.1	5.9
Receiving – total	1.1	1.7	4.2	5.0
Incl. dry cargo	1.1	1.7	4.2	5.0
Total	4.2	5.1	22.3	27.1
Incl. dry cargo	4.2	5.1	8.8	10.9

2. CARGO GENERATING AREAS AND THEIR RELATIONS TO SEAPORTS

The cargo generating areas are formed as a result of inter-branch complex development, each with a certain specialization. The zone of direct service of the "Yenisei–NSR" system in the first stage of its functioning (2000 – 2005) includes Norilsk, Igarka, Turukhansk, Middle-Yenisei, Evenk, and the Lower-Angara areas (Fig.2).

The Norilsk area (II) has the largest turnover and its activity depends directly on the reliability and effectiveness of NSR functioning. The main cargo generating unit in the area is the Norilsk Mining Metallurgical Combinate (NMMC). It is a completely formed industrial complex, whose production will recover soon and achieve the levels of the late 1980s in coming years. Transport is performed via Dudinka.

The Igarka area (III) implements both the industrial and the transport one function. The area has been formed on the basis of wood processing (sawn timber) which is transported on the Yenisei, and exports of wood products both produced on location and received from the Lower-Angara and Southern areas.

The Turukhansk area (IV) will develop in connection with the exploitation of the Turukhansk region's oil and gas deposits, above all the Vankorskoye oil deposit. After 2005 oil transportation by the NSR will be feasible via Dixon or Dudinka, while the equipment may be supplied via Dudinka even after 2000.

The Middle-Yenisei area (IV) is a base for timber supplies by the Yenisei from the raw material source zone to the wood industries of Igarka north of Yeniseisk.

The Evenk area (VI) plays a cargo-generating role only as receiver of equipment for oil and gas exploitation. Oil is proposed pipelined southwards to the Achinsk and Lesosibirsk oil-refining plants, whose products will be delivered via Lesosibirsk to Dudinka or Dixon for bunkering ships going by NSR or for export.

The Lower-Angara area (VII) is a large-scale cargo generating area for the "Yenisei-NSR" system. The Federal Target Programme for development of the area is under implementation. In the area there are wood processing plants and some new ones are to be constructed, as well as mining-metallurgical and oil refining complexes. Communications with NSR are performed via Lesosibirsk.

The Dixon area (I) performs only transport functions. The organization of a base for ship bunkering and construction of a terminal for shipping of oil and, probably, liquid gas, which will be extracted within the area, is to be realized in this perspective.

The zone of direct service in the second stage (2006 – 2015) of the "Yenisei–NSR" transport system functioning includes the Yessei area (VIII). The creation of this area depends completely on decisions concerning the development of Mimecha-Kotuy apatite – a rare earth metallurgical region. If so, the region will become a large-scale supplier of cargo for the NSR, both as an exporter of produced goods, and as a recipient of needed equipment. The area's communications will be attained via Dudinka or Igarka.

The zone of proximity of the «Yenisei - NSR» transport system comprises the areas of feasible service: Gydan, Tomsk, Middle-Angara, Kemerovo and Southern areas (Fig.2)

The Lower-Yenisei area (IX) may obtain the exit to the ports of "Yenisei – NSR" system (Dudinka or Dixon), if the construction of a shipping terminal in the Ob estuary is proved to have no utility.

The Tomsk area (X) may find itself in the zone of proximity to the NSR only if the North Siberian Route is constructed, this may happen after 2010 at the earliest. The area will export part of its wood-working production via Lesosibirsk.

The Middle-Angara area (XI) comprises the industrial region of Irkutsk Oblast with its large non-ferrous plants and wood-production complex. The cargo flow of primary aluminum may even now be directed to Lesosibirsk via Krasnoyarsk. When the North Siberian Route is completed, not only aluminum, but also wood products may go via Lesosibirsk.

The Kemerovo area (XII) (Kuzbass) is a highly developed region. From here coal, ferrous metals, aluminum and fertilizers are exported directly by railway or via seaports – Vostochny, Novorossiysk, and even via Arkhangelsk. Some variants of Kuzbass coal exports are considered in the perspective of 2000 and 2010 in volumes about 10–15 and 15 – 20 million tons, respectively [10]. In 1996 exports from Kemerovo area amounted to more than 10 million tons of coal, about 80 thousand tons of ferroalloys and more than 200 thousand tons of aluminum. At the same time, imports of technological products exceeded 400 thousand tons.

An increase in transport taxes conditioned the search for new exits for produced goods onto the world market. Some variants of Kuzbass coke exports using the river systems of Ob and Yenisei are studied in a number of designing institutes. Transport by Ob is hard due to the conditions of transshipping from river ships to sea sailing in the estuary of the Ob. The most probable of all "river-sea" routes is along the Yenisei. Two transportation schemes are feasible: from Lesosibirsk to Dudinka and then by the NSR, or from Lesosibirsk on "river-sea" ships down the Yenisei and further by the White Sea – Baltic channel to European countries. Railway communications Kuzbass – Lesosibirsk are available. The problem needs additional study from two points of view: capability to transport several million tons of goods produced in Kuzbass, and competitiveness of its production on the world market. A railway – sea route via Arkhangelsk may become a serious competitor to the Yenisei route.

The problem of delivering coal along the Yenisei route is likely to be eliminated after the direct railway route from Perm to Arkhangelsk is completed and the sea terminal is constructed there. In this case the cargo turnover through "Yenisei – NSR" (Tables III.1.3 and IV.1.1) will decrease by 500 thousand tons. The preliminary work to create a special-purpose terminal is being carried out in Arkhangelsk with the participation of enterprises from the Kuzbass and Pechora coal basins.

The Southern area (XIII) includes the large industrial centers of Krasnoyarsk Krai and Khakassia, producing non-ferrous metals, chemical, petrochemical and wood products. The area may supply primary aluminum and oil-products for transport along the NSR via Lesosibirsk or Dudinka. If the variant of importing alumina to AYR by the NSR is realized, the aluminum plants of the Southern and Middle-Angara areas would obtain stable sources of raw materials. The Southern area might become a supplier of liquid fuel both for bunkering ships of the NSR and for export.

Thus, the Norilsk and Lower-Angara areas are the main areas that provide a stable cargo flow for the «Yenisei - NSR» transport system up to 2005, while by 2015 the Yessei area will join them. All transport communications of the cargo generating areas in AYR, performed by the NSR, are serviced by one or several seaports of the "Yenisei – NSR system (Table IV.2.1.).

Table IV.2.1

Communication of cargo generating areas of AYR with sea ports "Yenisei–NSR" transport system

Ports years	Areas												
	Dixon	Igarka	Norilsk	Turukhansk	Middle–Yenisei	Evenk	Lower–Angara	Yesseysk	Lower-Enisei	Tomsk	Middle–Angara	Kemerov	Southern
Dudinka													
2000			+	+									+
2005			+	+									+
2010			+	+				+	+				+
2015			+	+				+	+				+
Igarka													
2000		+		+	+		+						
2005		+		+	+		+						
2010		+		+	+								
2015		+		+	+			+					
Dixon													
2000													+
2005				+									+
2010				+			+						+
2015				+			+						+
Lesosibirsk													
2000							+				+	+	+
2005						+	+				+	+	+
2010						+	+			+	+	+	+
2015						+	+			+	+	+	+

3. SEAPORT TURNOVER AND CARGO FLOW IN THE YENISEI SECTION OF THE "YENISEI - NSR" TRANSPORT SYSTEM

Dixon, Dudinka, Igarka, and Lesosibirsk are considered as seaports of the Yenisei part of the "Yenisei – NSR" system. Each of them has its own history, economic specialization, functions, current state and development conditions. An analysis of the perspectives for cargo generating area development and communications with seaports allows a determination of the total freight volume, as well as the amount of work in each port (Table IV.3.1).

Table IV.3.1

Delivery and receipt of goods by seaports of the "Yenisei–NSR" transport system (mill. tons)

Ports	2000	Scenarios					
		Radical			Maximal		
		2005	2010	2015	2005	2010	2015
Dudinka – total	2.2	3.1	3.4	4.7	3.7	4.3	6.3
incl.:							
Delivery	1.2	1.5	1.7	2.6	1.7	1.9	3.5
Receipt	1.0	1.6	1.7	2.1	2.0	2.4	2.8
Igarka – total	0.2	1.3	0.3	0.2	0.3	0.3	0.3
incl.:							
Delivery	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Receipt	–	0.1	0.1	–	0.1	0.1	0.1
Lesosibirsk – total	0.7	1.0	1.5	3.9	1.5	4.0	4.3
incl.:							
Delivery	0.7	1.0	1.4	1.8	1.4	1.9	2.2
Receipt	–	–	0.1	2.1	0.1	2.1	2.1
Dixon: delivery	–	9.0	12.6	13.5	12.6	13.5	16.2

All ports of the "Yenisei – NSR" are closely interrelated, the volume of their work will be conditional not only of the availability of goods, but also of the navigation period, and the actual freight turnover that may be performed by "river-sea" ships, as well as the level of transport organization. In case of an overload of Dudinka and Lesosibirsk the need will arise to maintain Igarka for transshipping from river to sea and vice versa.

Dudinka. The turnover of the port will increase twofold by 2015 according to the radical scenario, and threefold – according to the maximal one. The cargo structure will essentially not change. The service of the Norilsk industrial region (more than 50 % of the freight) will remain the main task of the port of Dudinka. Moreover, variants of servicing new developing regions – Turukhansk and in a distant perspective the Lower Yenisei and Yessei – are also under consideration.

The possibility of transshipping goods coming by river from the Southern area to Dudinka is also not excluded.

The service zone economic base, the local natural conditions and the development of the western section of the NSR are sufficient grounds to suggest that Dudinka will maintain its role as the main seaport of the "Yenisei–NSR" transport system.

Lesosibirsk. This port is the newest and has the best prospects in the «Yenisei - NSR» transport system, it will also be a major transport node of Middle Siberia in the first half of the 21st century [11,12,23]. This role of the port is based on the economic-geographic situation and economic basis of the town of Lesosibirsk, as well as on the realization of the Programme of Lower-Angara development together with NSR transformation.

Lesosibirsk is ready to perform this function at the initial stage of the formation of the «Yenisei - NSR» transport system. In 1995 the port's turnover was 1.6 million tons. Lesosibirsk is a permanent supplier of wood product exports, part of which are transshipped from river to sea in Igarka.

In the future Lesosibirsk will be an important seaport, whose turnover may reach 0.7 million tons already in 2000 and increase to 3.9 million tons by 2015 according to the radical scenario, and 4.3 million tons according to the maximal one. The main goods exported via the port will continue to be wood products, and the goods received will still be raw materials for the aluminum plants of Siberia.

Igarka. In the future there are plans for Igarka to service both its own wood industrial complex and the Turukhansk area, even though the production volume of the wood processing plants of Igarka will remain stable at about 200 thousand tons during the whole period. Moreover, the equipment for hydrocarbon exploitation in the Turukhansk area will also go via Igarka (no oil exports by NSR via Igarka are proposed). The external relations of the Yessei area via Igarka may become feasible, only if that proves to be more effective economically and technologically than via Norilsk. If the port of Lesosibirsk is overloaded (taking into account the sailing conditions and navigation period) and the mixed river-sea sailing is poorly organized, then the role of Igarka as a transshipping base will increase.

Dixon. During the 1990s all kinds of activity were drastically reduced. Dixon practically lost its significance as an important transport node of the NSR. This happened both because of the drop in NSR turnover and the change in transport technology.

The port together with the coastal belt along the Yenisei gulf have favorable natural conditions (well covered bays and sufficient depth), but, nevertheless, the future is uncertain. The two following solutions for port revival are considered.

1. Transformation of the port into a base for bunkering ships sailing along the route or in transit along the NSR [4,27]. The economic and geographical situation make Dixon the most suitable port of all on the Arctic shore for fulfilling such a role. In fact, it is located in the middle part of both the NSR and the NEP. It has the best conditions for liquid fuel supply – along the Yenisei from Achinsk and in future from the Lesosibirsk oil refineries. There are also favorable conditions for bunkering.

2. The creation of a terminal on the Yenisei gulf shore for shipping of export crude oil, condensate and liquid gas, extracted from the deposits of hydrocarbon in the Extreme North of Krasnoyarsk Krai and North-East of Tyumen Oblast. The distance from these deposits to Dixon is larger than to the ports of Igarka or Dudinka, but Dixon's navigation conditions are more favorable. That is why construction of a terminal and a pipeline is proposed in Dixon (Fig.2, 4, 5).

Which of the above two solutions for Dixon development that will be implemented, how much time it will take and how large the turnover will be – are questions that still need to be answered. In this study the prognosis of geological and oil extraction organizations are chosen as the initial data (table III.3.2, III.3.3) [19,27].

Thus, the broad-profile ports Dudinka and Lesosibirsk will become the main ports of the «Yenisei - NSR» transport system. The specialization of Igarka will be exports of wood products and of Dixon – hydrocarbon exports. It is positive that Dudinka and Lesosibirsk maintain a balance between imports and export at all times.

V. THE INFLUENCE OF EXTERNAL CONDITIONS ON THE CARGO FLOW OF THE «YENISEI – NSR» SYSTEM (experiences with behavioral simulation)

The realization of predictions (how the cargo generating potential of AYR for the NSR is arrived at) within an accomplished scale and a determined period depends largely on the external conditions of the region, namely:

- the attitude of users of the NSR to transforming it into a part of the international ocean-crossing transport system the NEP;
- Russia's economic strategy in development of domestic production (system of priorities).

The external conditions may facilitate as well as complicate the process of incorporating AYR into the «Yenisei - NSR» transport system. The processes of generating cargo flows in this region for the NSR and transforming the NSR into the NEP are closely linked. An analysis of situations resulting from these processes and the design of possible consequences and the AYR reaction to these processes have both research and practical interest.

Among the external conditions (for the region, not for the NSR) having an impact on the cargo generating potential one can distinguish the following (Fig. 6).

- The rank of main sea route. The NSR may either achieve the standing as the NEP or maintain its rank as a Russian main transport sea route (national level).
- The level of transport servicing activities. Servicing will be organized on the level of an expanded logistics system (international standard) or on the level of a traditional system of transport services (national standard).
- Tariffs. It is expected that there will be a possibility for the establishment of different tariff rates within the NSR (high, average, low). This correlates with the rank of main sea route and with the development of the logistics system.
- Federal support of economic development in the zone of NSR proximity. Such support is a guarantee for the needed achievement of the expected

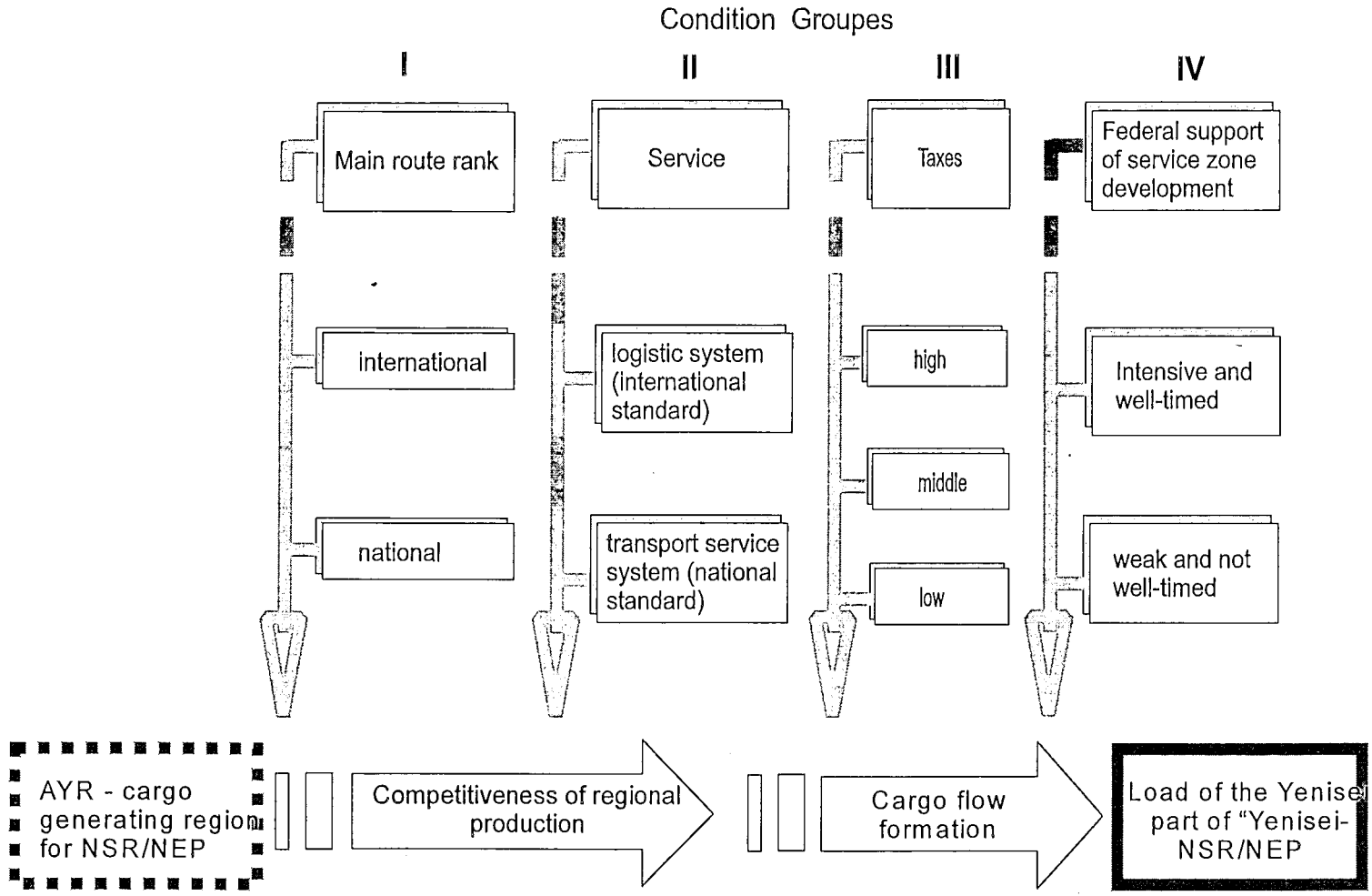


Fig. 6 Transport system"Yenisei - NSR": external conditions of AYR embedding into NSR/NEP

AYR production development. The absence of such support may lead to a delay in the supply of AYR cargo for the pioneer stage of the NEP.

The choice of the above mentioned four groups of external conditions is not accidental (Fig. 6). They largely determine the following.

- The volume and regularity of the main sea route cargo (main sea route rank, service level, tariffs). International routes with a high service level are the most attractive ones for cargo receivers and cargo suppliers in comparison with national routes.
- The demand for production from the proximity zone (rank of the main sea route, service level, tariffs etc.). Low tariffs increase the region's cargo competitiveness. Meanwhile, high tariffs can make the import of more than 2/3 of the production and services from AYR unprofitable.
- The availability of cargo in AYR for the NSR (federal support, tariff levels). Poor federal support of AYR will influence the investment attractiveness of the region and, therefore, the scale and rate of production development in AYR.
- Generation of additional cargo to the NSR from AYR cargo receivers (extent of federal support, tariff levels). A rapid development of the region and a flexible tariff policy can make waterborne schemes for transporting necessary products into the region (equipment, materials, semi-finished products) more profitable.

In reality, the number of such conditions is much higher and the relations between them are very complicated. However, even taking these conditions as examples enables us to highlight and analyze how external situations influence the realization of predictions concerning the «Yenisei - NSR» transport system. Fig. 7 shows five situations (A, B, C, D, and E) out of 17 possible.

An analysis of conceivable situations (Fig. 7) obviously shows that a complete and effective realization of cargo flow predictions may be within the framework of one single situation (A). The unique combination of two external conditions in this situation, namely the international rank of the main sea route and the high level of logistics, will permit a total involvement of all accumulated cargo generating potential

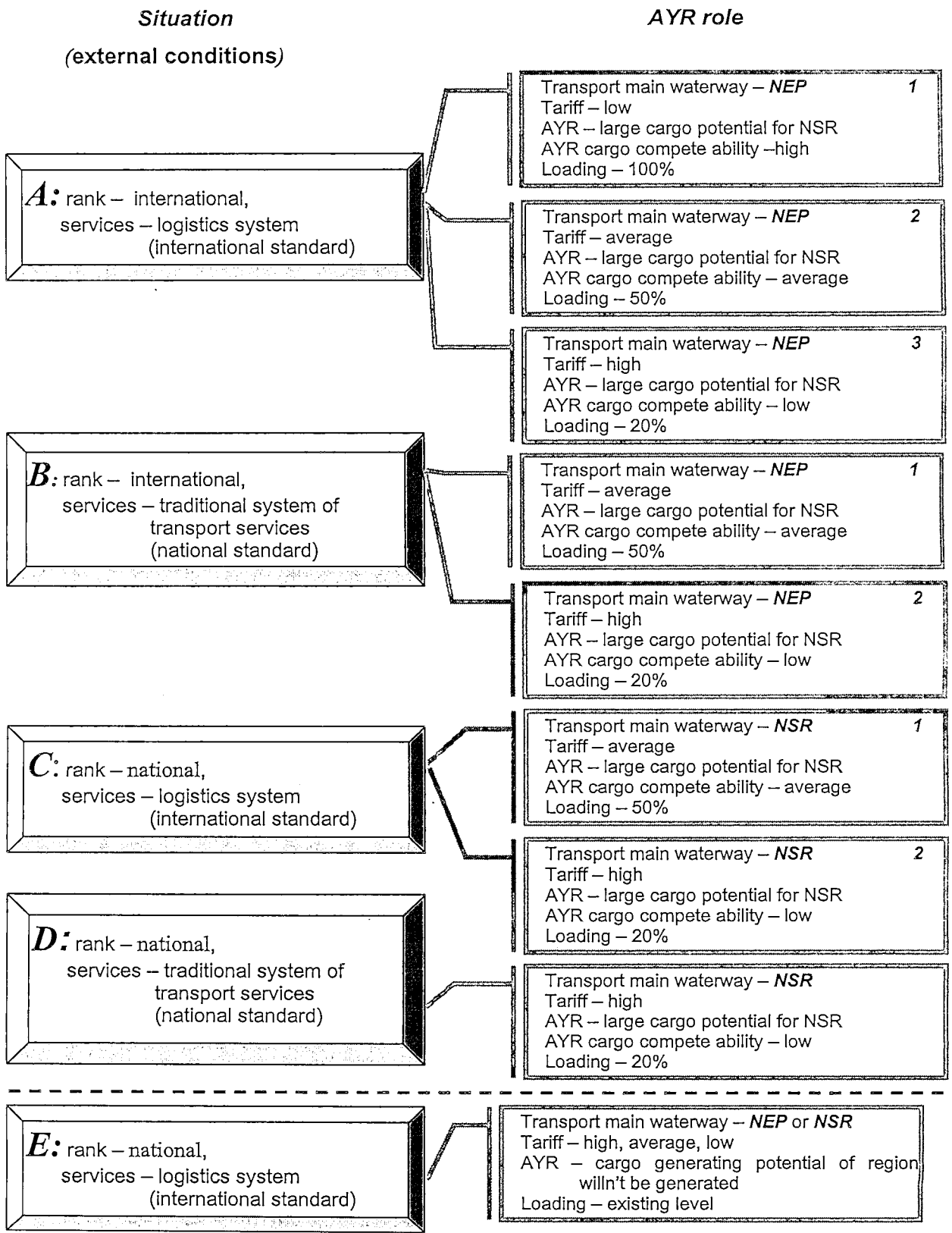


Fig.7. «Yenisei - NSR» transport system: the situations of the AYR cargo flow using in the formation of NSR/NEP cargo flow

in the region (Fig. 7) and ensure the stable development of this part of the «Yenisei - NSR» transport system to full capacity.

Under all other situations, a similar level of AYR cargo generating potential involvement is unachievable. Moreover, the realization of planned AYR development will not be possible either when the service level is lower (*situation B*, 20–50% load), or when the rank of the main sea route remains the same (situation C, load not more than 50%). The situation B (Fig. 7) apparently has the necessary preconditions: the readiness of the region to regularly export its cargo on the world market and the availability of the NSR for this purpose. However, the service level of this part of the «Yenisei - NSR» transport system is not satisfactory according to international standards. Thus, this will not permit the region to reduce transport tariffs more than average, and such tariffs would lead to a sharp reduction in competitiveness of AYR products and to a serious decline in cargo flows to the NSR.

The *situation C* (Fig. 7) illustrates another condition. Here AYR has a high level of development and the NSR a high service level, but since the main sea route is not part of the international transport routes, a reduction of tariffs is not possible. The result is that the competitiveness of AYR products and the volume of cargo flows via the «Yenisei - NSR» transport system will decline greatly even if the NSR is re-constructed and re-equipped. Therefore, one cannot expect a quick payoff from investments in the development of the region and in the technical re-equipment of the NSR, if the NSR rank remains purely national.

An analysis of different behavioral situations proves that favorable external conditions for NSR reconstruction (Fig. 7) should be expanded with similar protective federal policy towards the development of Siberia's resource potential and the development of foreign trade and new transport routes. A solution to the problems of NSR formation in time will not provide a successful incorporation of AYR into «Yenisei – NSR» transport system. The most full involvement of AYR cargo generating potential is possible only under conditions covered by situation A (Fig. 7). But this will only occur if tariffs are minimal (Fig. 8). Low tariffs and high regular cargo for the main sea route can be achieved if the NSR be transformed into the NEP. And if these conditions are accompanied by high or even average tariffs, the result will be a «washing» of cargo flows away from the «Yenisei – NSR» transport system and a narrowing of the range of products exported from AYR (Fig. 7).

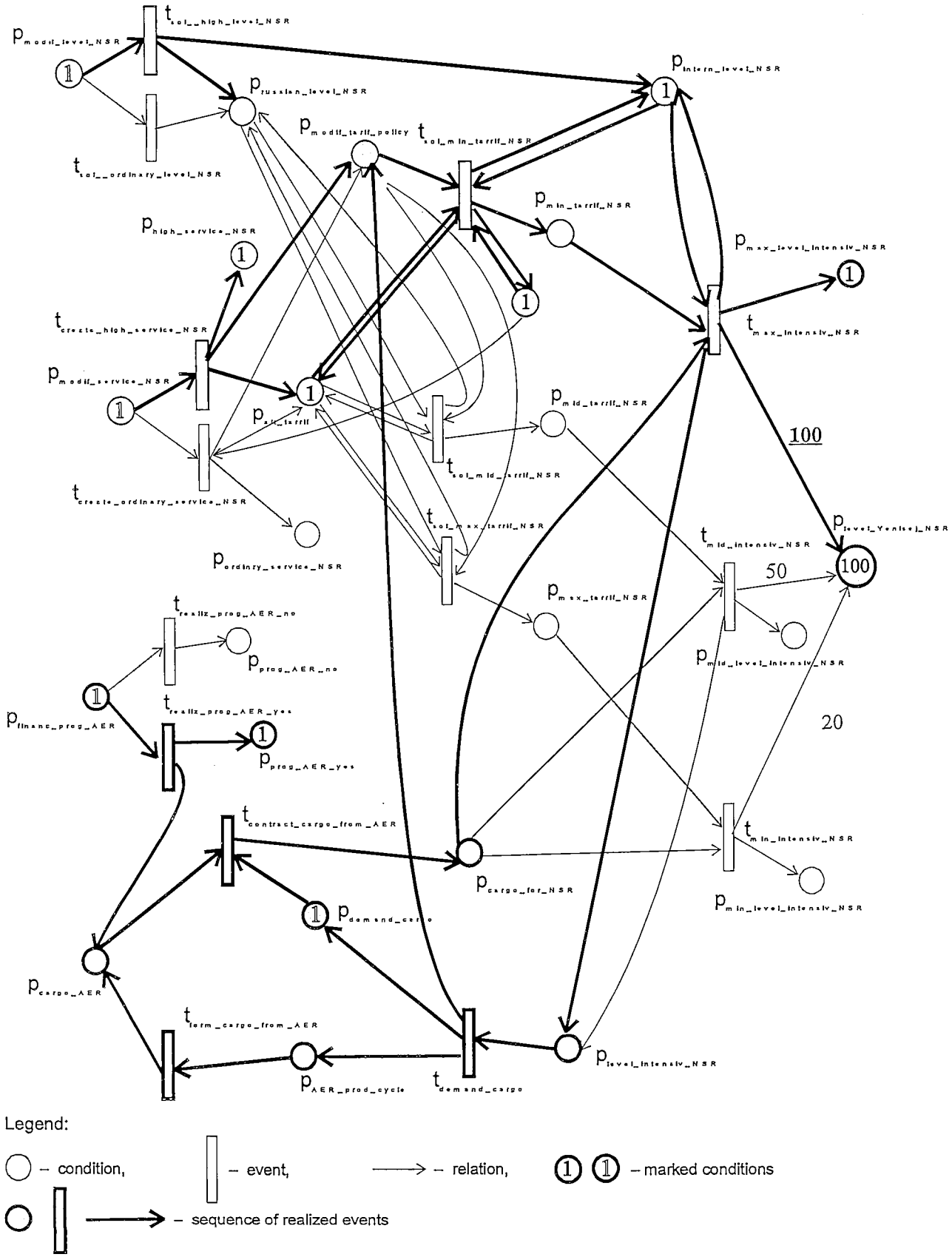


Fig. 8 Transport system "Yenisei - NSR": prognosis realization under the situation A (development trajectory 1)

Legend for Fig. 8–10

Transitions	Positions		Interpretation
	Input	Output	
$t_{sol\_high\_level\_NSR}$			The decision to transform the NSR into an international ocean-crossing transport system NEP is solved
	$p_{modif\_level\_NSR}$		The rank of main sea route may be changed
		$p_{intern\_level\_NSR}$	The NSR may gain the rank of the NEP
		$p_{Russian\_level\_NSR}$	The NSR may maintain the rank of Russian main transport sea route (national level)
$t_{sol\_ordinary\_level\_NSR}$			The decision that the NSR is to remain a Russian main transport route (national level)
	$p_{modif\_level\_NSR}$		The rank of main sea route can be changed
		$p_{Russian\_level\_NSR}$	The NSR may maintain the rank of Russian main transport sea route (national level);
$t_{create\_high\_service\_NSR}$			The decision on the establishment of transport logistics (international standard)
	$p_{modif\_service\_NSR}$		The level of the NSR transport services can be changed
		$p_{high\_service\_NSR}$	Transport service at the level of logistics (international standard)
		$p_{modif\_tariff\_policy}$	The tariff policy within NSR can be changed
		p_{alt_tariff}	The different tariff rates are alternative
$t_{create\_ordinary\_service\_NSR}$			The decision on the establishment of transport service system (national standard)
	$p_{modif\_service\_NSR}$		The level of the NSR transport activities services can be changed
		$p_{ordinary\_service\_NSR}$	transport service standard)
		$p_{modif\_tariff\_policy}$	The tariff policy within NSR can be changed
		p_{alt_tariff}	The different tariff rates are alternative

Continuation of legend for Fig. 8-10

$t_{sol\_min\_tariff\_NSR}$			The decision on establishment of low tariff rates within the NSR
	$p_{modif\_tariff\_policy}$		The tariff policy within the NSR can be changed
	p_{alt_tariff}		The tariff rates are alternative
	$p_{intern\_level\_NSR}$		NSR may gain the rank of the NEP
		$p_{min\_tariff\_NSR}$	The level of transport tariffs within NSR is low
		$p_{intern\_level\_NSR}$	NSR may gain the rank of the NEP
$t_{sol\_mid\_tariff\_NSR}$			A decision on the average tariff courses establishment within NSR
	$p_{modif\_tariff\_policy}$		The tariff policy within the NSR can be changed
	p_{alt_tariff}		The different tariff rates are alternative
	$p_{russian\_level\_NSR}$		NSR may maintain the rank of Russian main transport sea route (national level)
		$p_{mid\_tariff\_NSR}$	The level of transport tariffs within the NSR is average
		$p_{Russian\_level\_NSR}$	The NSR may maintain the rank of Russian main transport sea route (national level)
$t_{sol\_max\_tarif\_NSR}$			A decision on the establishment of high tariff rates within the NSR
	$p_{modif\_tariff\_policy}$		The tariff policy within the NSR can be changed
	p_{alt_tariff}		The different tariff rates are alternative
	$p_{russian\_level\_NSR}$		The NSR may maintain the rank of Russian transport main waterway (national level)
		$p_{max\_tariff\_NSR}$	High transport tariffs within NSR
		$p_{Russian\_level\_NSR}$	The NSR may maintain the rank of Russian main transport sea route (national level)

Continuation of legend for Fig. 8-10

Transitions	Positions		Interpretation
	Input	Output	
$t_{realiz\_prog\_AER\_no}$			A rejection of federal support of economic development in the zone of NSR proximity
	$p_{fin\_prog\_AER}$		Investment support of economic development in the zone of NSR proximity is necessary
		$p_{prog\_AER\_no}$	Cargo generating potential of AYR will not be formed
$t_{realiz\_prog\_AER}$			A decision on federal support for economic development of the proximity zone of NSR is necessary
	$p_{fin\_prog\_AER}$		Support of economic development in the zone of NSR proximity is necessary
		p_{prog_AER}	Cargo generating potential of AYR will be formed
		p_{cargo_AER}	Cargo in AYR is available
$T_{contract\_cargo\_from\_AER}$			A decision to export goods by the NSR
	p_{cargo_AER}		Cargo in AYR is available
	p_{demand_cargo}		There is demand for AYR cargo by the NSR
		$p_{cargo\_for\_NSR}$	Cargo in AYR is available
$t_{max\_intensiv\_NSR}$	$M(p_{level\_Yenisei\_NSR})=100$		The level of loading of the «Yenisei – NSR» system is high
	$p_{cargo\_for\_NSR}$		Cargo in AYR is available for export of goods by the NSR
	$p_{min\_tariff\_NSR}$		The level of transport tariffs within the NSR will be low
	$p_{intern\_level\_NSR}$		NSR may gain the rank of the NEP
		$p_{max\_level\_intensiv\_NSR}$	The level of loading of the «Yenisei – NSR» system is high
		$p_{level\_Yenisei\_NSR}$	The level of loading of part of the «Yenisei – NSR» system
		$p_{level\_intensiv\_NSR}$	Use of the NSR is necessary

Continuation of legend for Fig. 8-10

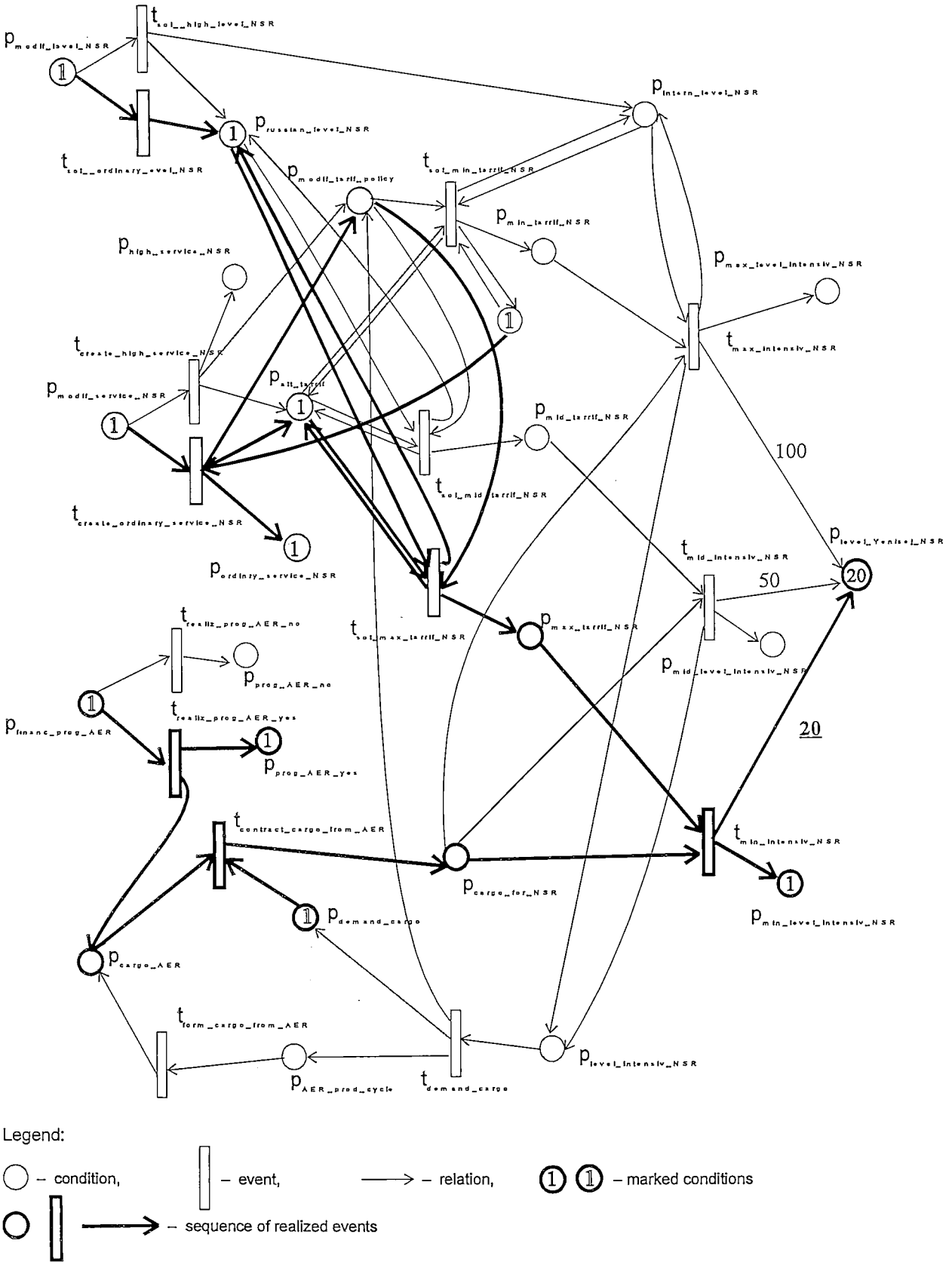
Transitions	Positions		Interpretation
	Input	Output	
$t_{mid\_intensiv\_NSR}$	$M(p_{level\_Yenisei\_NSR})=50$		The level of loading of the «Yenisei – NSR» system is average (50%)
	$p_{cargo\_for\_NSR}$		Cargo in AYR is available
	$p_{min\_tariff\_NSR}$		The level of transport tariffs within NSR is average
		$p_{mid\_level\_intensiv\_NSR}$	The level of loading of the «Yenisei – NSR» system is average
		$p_{level\_Yenisei\_NSR}$	The level of loading «Yenisei – NSR» system
		$p_{level\_intensiv\_NSR}$	The level of loading of the NSR is normal
$t_{min\_intensiv\_NSR}$	$M(p_{level\_Yenisei\_NSR})=20$		The level of loading of the «Yenisei – NSR» system is low (20%)
	$p_{cargo\_for\_NSR}$		AYR cargo for NSR is available
	$p_{max\_tariff\_NSR}$		The level of transport tariffs within NSR is high
		$p_{max\_level\_intensiv\_NSR}$	The level of loading of the «Yenisei– NSR» system is low
		$p_{level\_Yenisei\_NSR}$	The level of loading of the «Yenisei– NSR» system
t_{demand_cargo}			Decision on delivering cargo from AYR to NSR
	$p_{level\_Yenisei\_NSR}$		The level of loading of the «Yenisei – NSR» system
		$p_{AER\_prod\_cycle}$	Regular attraction of cargo potential of AYR is possible
		p_{demand_cargo}	AYR cargo demand for NSR
$t_{form\_cargo\_from\_AER}$			The decision to use the NSR for cargo exports
	$p_{AER\_prod\_cycle}$		Regular attraction of cargo potential of AYR is possible
		p_{cargo_AER}	AYR cargo is available

The cargo generating potential of AYR may be practically unused or minimally used (no more than 20%). This is reflected in situations D and E. They envisage a lack of coordination between the development of the main sea route and the AYR economy. The described groups of external conditions (Fig. 6) influence AYR to an equal extent. On the one hand, additional federal support to the region and the zone of NSR service cannot compensate the consequences of a lowering of the rank of main sea route and its service level. On the other hand, if this support is absent, even the availability of a highly equipped main sea route cannot guarantee or accelerate the development of AYR.

The situations D and E present the special case of Russia's economic development from a pessimistic angle. The situation D, at first sight, does not lead to any difficulty in AYR development. The cargo generating potential of AYR develops dynamically, but no serious qualitative changes in AYR occur. This region remains within the rank of a national Russian transport route. To change the future of the region even in the form of investments on its territory is not achievable (Fig. 7, Fig. 9). The development of AYR with established circumstances will evidently lead to the formation of large cargo generating potential. However, 80% of production cannot be exported to the world market. Federal and regional authorities have no opportunities to manipulate with tariffs. The cargo of the «Yenisei – NSR» system may be five times smaller than the predicted cargo generating potential of AYR (Fig. 9).

The situation E is similarly unfavorable for AYR (Fig. 7). It is opposite to situation D. Its point is that the region will not develop seriously when the external economic environment is strongly transformed. Therefore, cargo-generating flow will not be formed. And a highly equipped main sea route will lack AYR cargo (Fig. 10).

The use of behavioral simulation will enable a description of possible situations more adequate to actual conditions and evaluate the consequences of these envisaged situations. This study explored and confirmed the correctness and necessity of including the interrelations of the «Yenisei - NSR» transport system and the AYR economy into a system of analysis and prediction. It was carried out with the help of Petri nets methodological techniques.



Legend:

○ – condition, | – event, ⟶ – relation, ① ① – marked conditions

○ | ⟶ – sequence of realized events

Fig. 9 Transport system "Yenisei - NSR": prognosis realization under the situation D

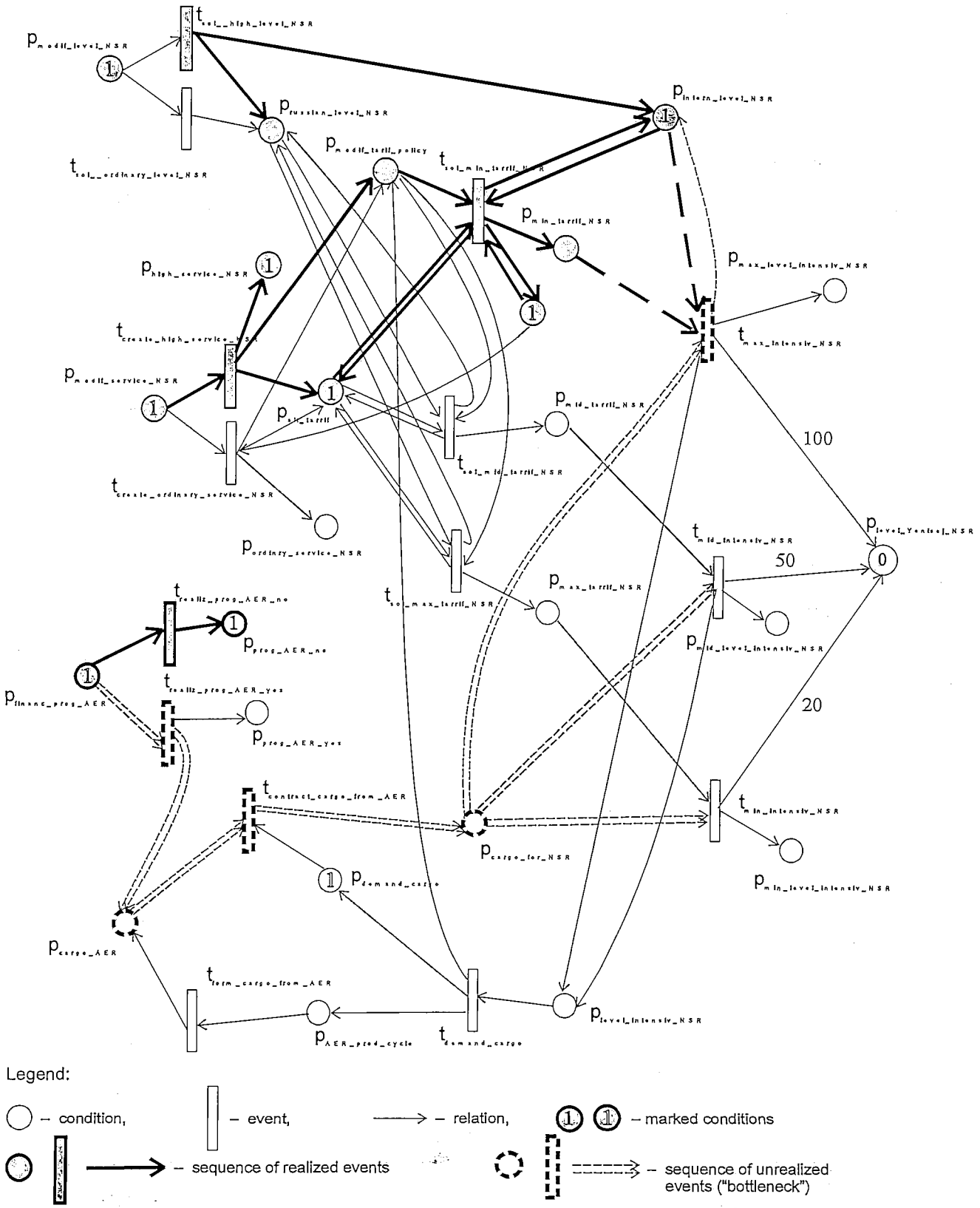


Fig. 10 Transport system "Yenisei - NSR": prognosis realization under the situation E

CONCLUSIONS

AYR has a considerable cargo generating potential, its relations with the northern regions of the European part of Russia and the ports of the Atlantic Ocean are traditionally stable. The cargo flow volume is conditional both on development of production and the conversion of the NSR into an international logistics system. The above two processes are closely interrelated, i.e.

– the cargo volume on the river part of the "Yenisei – NSR" transport system will depend on the realization of the cargo generating potential of AYR;

– the realization of the cargo generating potential of AYR will be conditional on the technological and economic indices of NSR (NEP) functioning (taxes, cargo turnover volume, level of logistics and others).

The limits, volume, and structure of the cargo generating potential will vary during the long-term service zone formation process. The latter is dependent on the economic situation in the country, as well as the development of the zone of proximity scenario and its variant under implementation, depending also on the organization level of the transport system. Two stages of service zone formation in the perspective of 2015 are distinguished. The transition from the first stage to the second one will be smooth and proceed following the restructuring and the development of particular sectors of the national economy, as well as the inclusion of Russia into the international economic system. The transition time in the project is expected to be a period between 2005 and 2010. Hence, it follows that the realization of the considered cargo generation scenarios may be shifted, especially concerning the second stage of the radical scenario. The predicted cargo volume range in a relatively wide interval depending on scenarios, constitutes for dry cargo 5.2 - 8.6 m tons in 2010, and 8.8 - 10.9 million tons in 2015. (Fig.11).

The minimal levels of predicted freight turnover correspond to the completely developed economic complex in the zone of proximity with highly processed low capacity production. This is characterized by a decrease of exports due to the increased demand in the internal market. The maximal levels are feasible only if the production complex structure changes principally due to the creation of new industries based on local (oil, gas, apatite-rare earths) and imported (bauxite) raw material, and because of the changed transport conditions (NEP, pipeline to the Dixon region, North-Siberian railway).

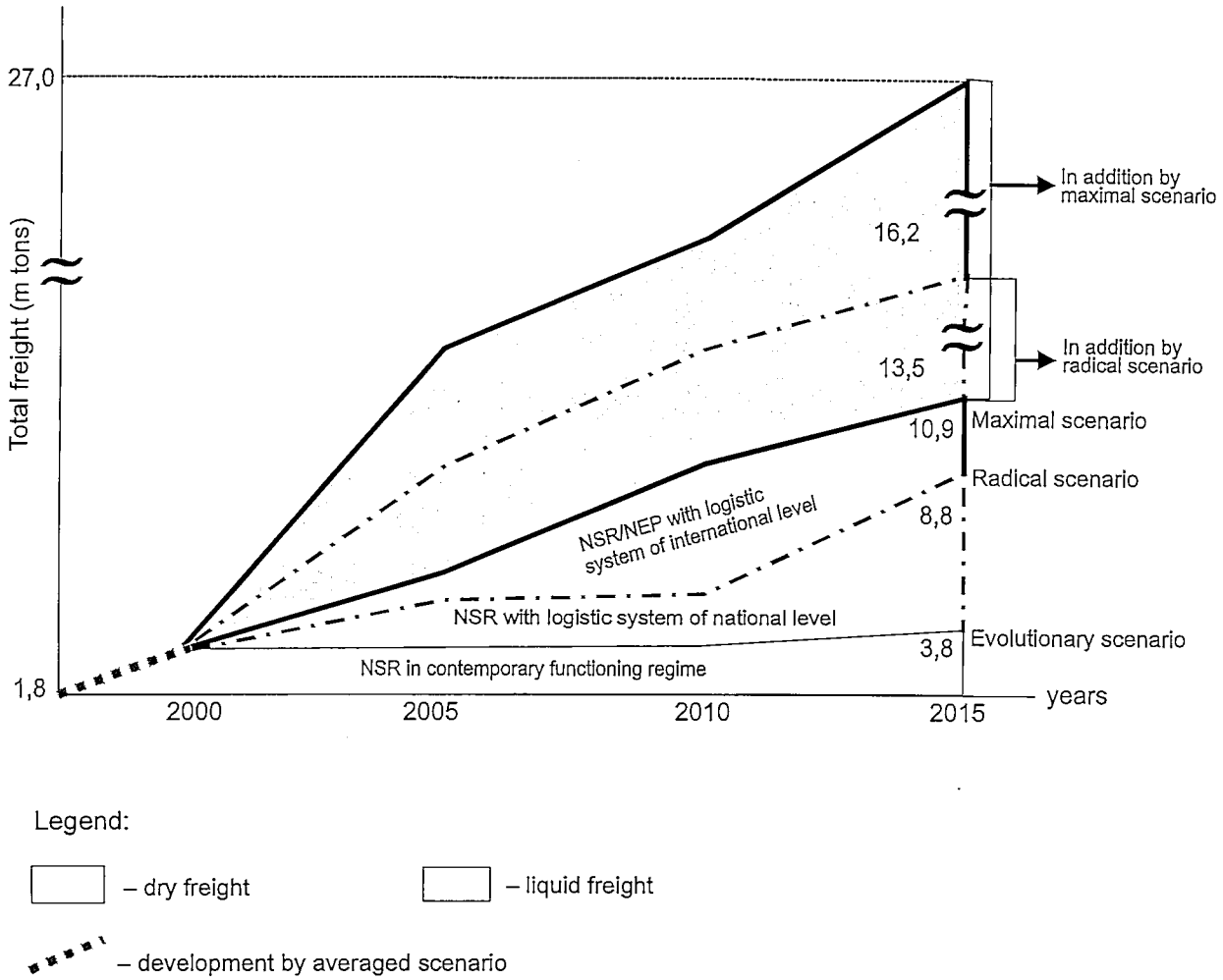


Fig. 11 Transport system "Yenisei - NSR": prognosis and conditions of cargo generating potential exploitation

As opposed to the rivers Ob and Lena, Yenisei, due to its geographical situation and navigation conditions, may really become the most important section of the NSR. Connecting the NSR with the remote continental part of Middle Siberia the Yenisei will provide the solution to the following problems:

– creation of a qualitatively new exit for the Siberian regions to the world market;

– formation of bases for route servicing (bunker, meteo, avia and other services) on the border between the western and eastern sections of the NSR (NEP).

Inclusion of the "Yenisei – NSR" system into the main international inter-ocean transport route (North-East Passage) would enhance the achievement of technical and organizational level, meeting the demands of the beginning of the 21st century.

After the break-up of the USSR, the new geopolitical position of Russia, and, hence, that of Siberia, have activated the need to forecast the role of the «Yenisei -

NSR» transport system in solving the transport problems of the whole country [4, 5]. Among those problems are the following:

– creating new exits to the world market for Russia including Siberia ;

– strengthening the position of Russia in the realization of projects of "transport bridges" between Europe and South-East Asia.

The question has been raised of introducing a regular commercial cargo line Dudinka – Delfzeil/Eemshaven (the Netherlands, province Groningen): It would perform communications between AYR and the internal regions of West European countries using the regime of prolonged navigation in the western section of the Arctic [5, 8]. The utility of pursuing a detailed study of the above question was supported at the presentation of the report of IEIE SD RAS to the Delfzeil/Eemshaven Port Authority in 1995. [9].

In the perspective 2010 – 2015 the question may also be raised about embedding part of the «Yenisei - NSR» transport system into the intercontinental transport system "Europe – Asia". The organization of surface-water corridor functioning in parallel with the widely known ocean and surface routes is proposed, which will comprise the ports of Russia and China on the Pacific shore (Vanino, Vostochny, Lianyungang), – railways (TransSiberian or North-Siberian) – Siberian rivers (Ob, Yenisei, Lena) – and ports of North-European countries. In our opinion, the navigation and transshipping conditions do not permit the rivers Ob and Lena to become sections of the transport corridor. Among all the Siberian rivers only the Yenisei is capable of fulfilling this function [7, 23]. Nevertheless, this question needs to be thoroughly studied.

Generally speaking, the Transsiberian railway, the NSR and the Siberian rivers do not so much compete, as complement each other's routes with various functions. None of them is able to provide effective communication between their service zones. An elaboration of a basic framework is needed for transport network formation plans and transport organization within all of Asian Russia.

* * *

The presented study enables us to draw a number of principal conclusions concerning AYR and the cargo generating potential of the «Yenisei - NSR» transport system in the perspective to 2005 – 2015. These are as follows:

1. AYR possesses necessary conditions to provide cargo for the transport system.

2. The scale and direction of the potential development in AYR are conditional of the economic situation in the country.

3. Broad use of the Yenisei part of the NSR is of national significance for solving both immediate and future problems concerning resource supply, and to enhance the position of Russia on the world market (the supply of raw materials to Siberian aluminum plants, the export of wood products, oil and the development of new resource regions in the Extreme North).

4. Even the evolutionary scenario, if realized, makes it possible to regain the volume of operations achieved by the transport system during the late 1980s.

5. A realization of the radical scenario requires a modernization of the system and very intensive operations already by 2005.

6. Planned freightage according to the maximal scenario can only be realized if the NSR is transformed into the NEP with the highest level of logistic system.

7. The main, most realistic scenario is considered to be the radical one with an optimistic situation.

8. The imperative realization conditions both for the radical and especially for the maximal scenario are as follows:

– engineering, technological and organizational transformation of all sections of transport system operations;

– the assimilation of large-scale transport of hydrocarbons by sea transport along the NSR;

– the organization of large-scale freightage by ships of mixed "river-sea" sailing under seasonal conditions on the Yenisei and the NSR;

– large-scale involvement of the Yenisei river transport into the "Yenisei – NSR" system operations.

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APPENDIX:

List of tables

List of figures

Review of INSROP Project III.01.5: The Angara and Yenisei Region, Cargo Generating Area for the NSR.

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Title of Discussion Paper: Cargo Generating Potential of the Angaro-Yenisei Region for the Northern Sea Route

Authors: M.K. Bandman, V.V. Vorbieya, T.N. Yesikova, V.D. Ionova and B.V. Robinson

This discussion paper has a clear focus, namely, to investigate and forecast the cargo generating potential of the Angaro-Yenisei Region for the "Yenisei - Northern Sea Route" transport system up to the year 2015. Within this research mandate, the eminently qualified research team explores six questions: (1) potential role of the Yenisei - Northern Sea Route in any revival of the inter-ocean North-East Passage (NEP); (2) delimitation of the feasible service zone for the "Yenisei - NSR" in Middle Siberia; (3) a prognosis for the economic development of cargo generating activities within the Yenisei part of the "Yenisei - NSR" transport system; (4) identification of the major cargo generating units and areas along with the transport routes linking them to "Yenisei - NSR" sea ports; (5) elaboration of different scenarios and variants to forecast potential freight turnover for the Yenisei part of the "Yenisei - NSR" for the years 2000, 2005, 2010, and 2015; and (6) determination of the main specialization and cargo turnover forecasts for the seaports of the "Yenisei - NSR" transport system.

Long-term forecasting is under the best of circumstances more art than science, despite the employment of sophisticated optimization and simulation models such as those used in this study. Given the seemingly contumacious and pervasive disarray in the post-Soviet Russian economy, these questions are all the more difficult to explore with confidence. To their credit the authors openly concede these limitations and acknowledge that there have frequently been contradictory results among the numerous previous prognostic studies completed by various Russian scientific organizations offering little room for generalizations. Accordingly, the authors' assertion that the emphasis at this stage of research should be on determining the reality for creating "a direct 'exit' for Middle Siberia to the world market" (page 6); and hence, the possible role of the "Yenisei - NSR" in the formation, really a resurrection, of the inter-ocean, North-East Passage rather than on the calculation of possible freight turnover; seems precisely on target.

What follows are some comments on some of the strong, as well as weak points in the various sections of the discussion paper. In the first section, "Angaro-Yenisei Region and Northern Sea Route," the report's strong points include the comprehensive, accurate and detailed nature of the information with regard to multimodal transport networks and their capacities, and the identification of major industrial complexes and natural resource extraction enterprises within the region. These items are presented in a clear and dispassionate manner; however, in some instances this reporting style potentially masks the magnitude of the difficulties which exist. For example, as indicated correctly in the text and on Figure 3, there are no shipping locks at the hydroelectric dams on the Angara at Irkutsk, Bratsk and Ust-Ilimsk and on the Yenisei at Sayano-Shushenskaya. While the latter ship-blocking dam may not be of great significance in terms of being an obstacle to the development of freight cargo turnover within the Angaro-Yenisei region; the lack of shipping locks at the three Angara locations definitely is. Second, it seems very unlikely that the perspective North-Siberian railroad will be completed. Third, while the report makes no such unequivocal claim (page 13); nonetheless, there seems little likelihood

that the "Yenisei - NSR" will be able economically to capture away from railroads much of the existing freight cargo originating within the West-Siberian Economic Region.

The following are some suggestions to improve the clarity of the section II. First, in the version of the report which I received the cells of the fourth column (between "Variants" and "Optimistic") as well as the cells of the fifth and seventh columns in last and third from last rows of Table II.1 (page 17) have printed some incorrect bold face characters. Presumably, the cells in the fourth column should read in alternate rows: "min." or "minimal" and then "max." or "maximal". If this is correct, then the choice of the word "Maximal" as one of the scenario names and then using the word again as a variant is a bit confusing. Again, presumably, the character in the other four cells should be an "X". Perhaps it would be advisable to switch the position of the two rows of the "Radical" scenarios with the two rows of the "Maximal" scenarios in Table II.1. As a result, Table II.1 would more logically follow along with the text presentation of the scenarios (pages 20-21) in which the "Radical scenario" is discussed last.

Section III focuses on detailed presentations of the three major cargo-generating potential complexes within the Angaro-Yenisei Region: 1) mining and metallurgy, 2) timber and wood-working, and 3) oil-gas development. This section has a number of strong points. For instance, the report's conclusion that the Noril'sk Mining and Metallurgical Complex is and long will be the leading cargo-generating enterprise is solid and well documented. Secondly, alumina imports to the numerous AYR aluminum plants appear stable and as the report's authors argue somewhere between 30-40% of the total alumina import could very well make use of the "Yenisei - NSR." (Note misprint on title of Table III.1.1). On the other hand, indeed, probably only in the far distant future will local apatite-based phosphate deposits become economically viable freight-generating activities. Then, too, a major point made during the discussion of the wood-working industry is the fact that as highly subsidized transport rates have evaporated much of the timber industry throughout Russia has stagnated except for Eastern Siberia where profitability was still a positive 6.4% in 1995. Yet despite the dramatic increase in transport tariffs, there has been nearly an across the board significant increase in the export of timber products. While the report (pages 38-39) acknowledges that it will take a significant lead time of (an optimistic - reviewer CZB) 12 to 15 years to achieve major structural adjustments in the wood-working industry toward more value-added product mix; such capital investment needs seem unlikely to be met domestically. Given the devolution of the central command economy, one would like to hear more about the operational specifics of the federal special-purpose programme for the development of the timber resources of the Nizhnee Priangarie [cited in reference 12]. It seems plausible that even if some of the major value-added restructuring of the Angaro-Yenisei Region's wood-working industries were to come to fruition (e.g., furniture manufacturing) that this would lead to increased railroad rather than water transit freight flows. More background information and specifics are desirable with regard to the information contained in Table III.2.9. For example, how are the "new units" listed on this table to be financed? Is there any realistic substance behind this federal target programme up to the year 2005? Finally, the report's conclusions for wood-working cargo for the period before 2005 seem realistic in terms of product-mix, origin, and quantity. While the cargo flow formation forecasts for the forest industries in the post-2005 to 2015 time period also seem realistic; they are in fact quite dependent on the development of the timber resources of the Lower Angara area and completion of the North Siberian railway, I believe, for both the "Radical" and "Maximal" variants.

The final portion of section III is a well reasoned assessment of potential oil-gas development within the AYR boundaries. A number of highly useful tables are included (Table III.3.1 has some misprints of column labels). It would be helpful for the authors to supplement Figure 4 (page 47) with a map showing the locations of the various oil and natural gas deposits. Also Figure 4 (black and white version) makes no clear distinction between railways and pipelines and the "short-dash" transport lines in the northwest do not exist on the legend; perhaps, they are the theoretical pipelines. While realistically the forecasts for potential export tonnage of oil vastly exceeds the imports of pipe and other oil-gas equipment, both the radical and maximal variants could be highly optimistic for a number of reasons: 1) problematic sources and quantities of requisite capital investment, 2) the region's potential competitive disadvantage compared with less remotely located oil-gas reserves in other former Soviet republics, and 3) uncertain future global markets. This latter statement is not a criticism of the report's "Radical" and "Maximal" scenarios and their assumptions per se; rather it is a suggestion that indeed these two scenarios are well named as being "Radical" and "Maximal."

This last comment comes into play again in section IV. This is true because whereas in the year 2000 the oil-gas industry generated no cargo, by 2015 in the "Radical" scenario it generates 13.5 million tons of export cargo (out of total forecast cargo of 22.3) and in the "Maximal" scenario 16.2 million tons (out of total forecast cargo

of 27.1). Thus, oil and gas development in the region is both very important for "Yenisei - NSR" development, yet at the same time nearly totally dependent on new industrial development in remote, often rahter inaccessible regions. None of the other potential cargo generating growth components in the AYR is nearly as dependent on the development of new activities in the region, except the unlikely case of apatite development and some other less quantitatively important mining and mineral extraction and processing activities. Also, the other AYR inter-branch sources of potential cargo involve essentially dry cargo as opposed to liquid. Accordingly, the overall the total "Yenisei - NSR" cargo flow by 2015 would be dramatically less without petroleum development. Nonetheless, compared with the year 2000, the forecast 2015 cargo flows would still expand by a respectable 284% (Radical variant) and 352% (Maximal variant). In the worst case scenario the authors note that cargo tonnage would still be from 20% to 50% above the best years of the 1980s. (Note typographical error on first line of title of Table IV.1.2). The second portion of section IV presents a concise, yet quite a comprehensive, discussion of the various cargo generating areas in the "Yenisei - NSR" system and their relations to sea ports. One of the most interesting items is the admission (page 52) that a railway - sea route via Arkhangel'sk may become a serious competitor to the "Yenisei - NSR" for a number of products. The third and final portion of section IV consists of an informative discussion of the major sea ports of the "Yenisei - NSR" transport system, namely Dudinka, Igarka, Lesosibirsk and Dixon. At the same time, this portion would benefit from an elaboration of the existing and "planned" infrastructure at these four major ports and historical data series of freight turnover through these ports.

In Section V of the report the authors introduce a number of external conditions which potentially could influence cargo flow on the "Yenisei - NSR" system. They do this by a provocative, clever, yet well reasoned series of behavioral simulation models using Petri nets methodological techniques. Stella(TM) or ithink(TM) dynamic simulation software would also seem highly appropriate for this sort of simulation modeling.

In their conclusion the authors make the plausible argument that the transport systems of the region the Transiberian railroad, Siberian rivers, and the North Sea Route are more complementary than competitive. On pages 73-74 the authors present eight general conclusions concerning the AYR and the cargo generating potential of the "Yenisei - NSR." None of these conclusions is outlandish. All seem rational and well reasoned. Perhaps the most interesting and conservative conclusion is number 4 in which even the so-called "evolutionary scenario" (pessimistic) indicates that the "Yenisei - NSR" will return to cargo levels of the late 1980s soon. Two of the most challenging conclusions are that serious modernization of the system and intensive use must be completed by the year 2005 and that the NSR must be transformed into a NEP system for maximal tonnage to be realized. Given the current economic situation in Russia with regard to supplies of investment capital and the deteriorated state of the Arctic nuclear icebreaker fleet; this maximal scenario seems remote indeed. To their credit the authors have the integrity to admit they do not foresee this as the most realistic scenario.

Overall, I found this study scientifically sound and of high merit and have suggested areas for strengthening it. Granted the report in its current state does need a careful and extensive English language editing which I understand will be forthcoming. Finally, I can not remember seeing anywhere in the text or in a table any actual historical cargo tonnage data for the "Yenisei - NSR". If I have missed these data, I apologize. If I am correct, then I would strongly urge that the authors add such time series transport data for the system overall and for individual ports in the system. They would greatly add to the overall clarity and perspective of their forecast efforts. Presumably, development of the "Yenisei NSR" transport system will require foreign capital both directly and indirectly in terms of potential cargo generating industrial and resource development projects within the AYR. Accordingly, this strengthened report could be of use in such efforts to attract investment capital.

Sincerely,

Craig ZumBrunnen

Reply to the Reviewer

We are grateful to prof. Craig ZumBrunnen for extremely careful reading of our report, as well as for the support of our understanding of the main task of the study and the clear view of long term prognosis and programme implementation conditions in our postsoviet Russia.

Most part of reviewer comments are accepted and taken into account when completing the report. A figure "Location of Turukhansk group of oil deposits and possible routes of oil transportation from them to the consumers" was added in section 3.2. Typographical and stylistic faults and misprints in the text, in Fig.4 and in several Tables are corrected. The doubts of prof. ZumBrunnen about feasibility of certain projects (development of local apatite-based phosphate deposits, construction of a part of North Siberian, radical reconstruction of woodworking plants) are quite natural, but we assumed, that the maximal scenario should include all known projects. Moreover, as noticed in the report, the radical scenario is considered to be the most feasible, and even in case of economic stabilization in the whole country. The comment on English language editing is also taken into account, the text is improved according to our capability.

Some other comments of prof. ZumBrunnen need more detailed explanations.

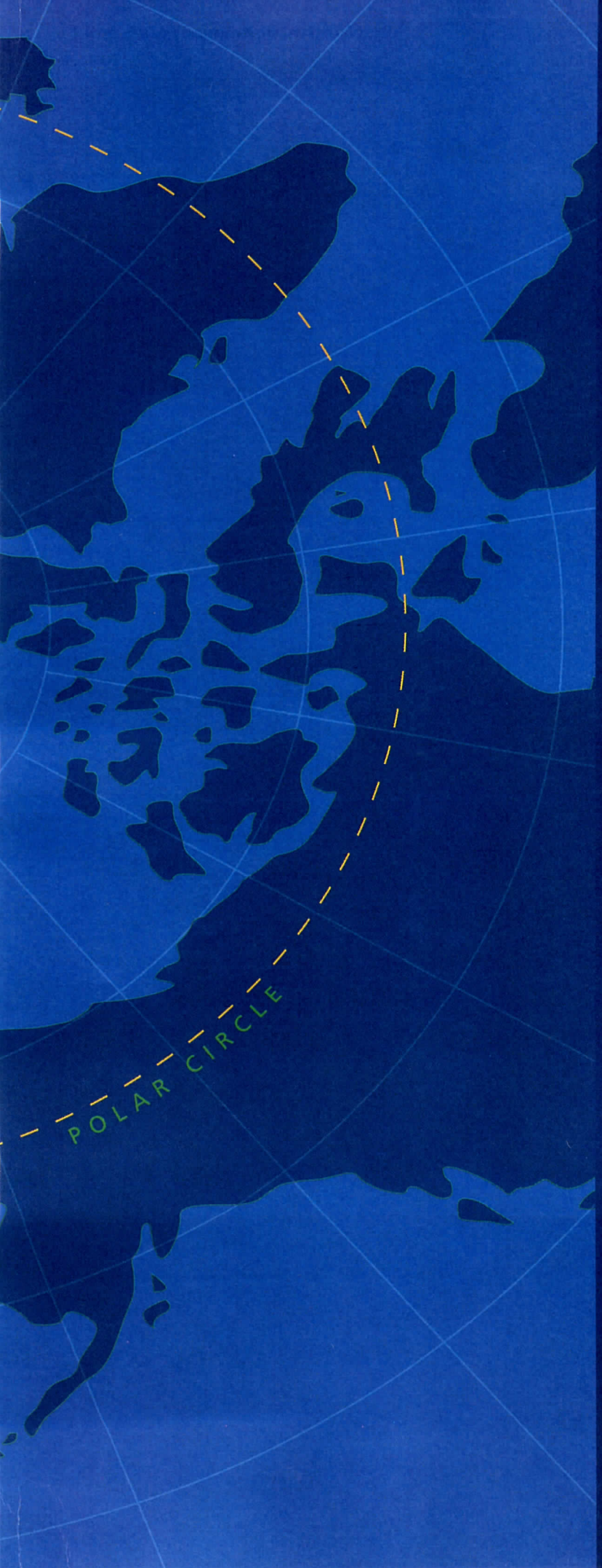
1. Concerning the absence of shipping locks at the hydroelectric dams on Angara. Those shipping locks are of no use, because there is no considerable cargo-flow in the river basin. Cargo from the Transsiberian is supplied to Bratsk and Ust-Ilimsk by the existing railway Taishet - Bratsk - Khrebtovaia - Ust-Ilimsk. If the Programme of Lower Angara development is realized, then a segment of North Siberian railway Lesosibirsk-Ust-Ilimsk will be constructed, because the season river navigation along Angara would not be able to provide the required level of transport service in the region.
2. Concerning the question whether there is any realistic substance behind the federal target programme of Lower-Angara development. "Federal target programme for Lower Angara Region development" is an official document, confirmed by the Resolution of the Government of Russian Federation (N 203 of 22.02.1997). The perspective of its feasibility depends on the economic situation of the country.
3. Concerning the development of woodworking industry. In the Programme of Lower Angara Region development the problems of woodworking industry are elaborated in details. Materials from the Programme are widely used in the project. Also there are published papers in Russian [22].
4. Prof. ZumBrunnen considers the data on Turukhansk group of hydrocarbon deposits development and probable oil cargo flows to be very optimistic. Maybe, he is right, but all data are taken according to the document [19]. Indeed, if the Turukhansk group of deposits is not developed, or the variant of oil exporting by NSR is rejected, then the total freight turnover of the system "Yenisei - NSR" will drastically decrease. Although, there is a good reason to assume, that the project will be realized. We

agree, that the import of pipe is taken rather low. The reason is in the fact that pipe requirement for main pipe lines was not included.

5. Concerning prof. ZumBrunnen note, that "it seems very unlikely that the perspective North Siberian railroad will be completed". Our opinion is that after the break up of the USSR the need and the probability of North Siberian railway construction became more evident.
6. Concerning the lack of materials on the history of the route from Murmansk to the ports of Yenisei, as well as on the history and on modern infrasrtucture of Yenisei ports. All these topics are not included, because they are the subjects of other reports already done in the framework of INSROP {2,3,15,16,18).

Authors of the report are grateful to prof. ZumBrunnen for the attentive consideration of their work and for valuable comments.

Supervisor of the report Doctor of economical science prof. Mark Bandman



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.