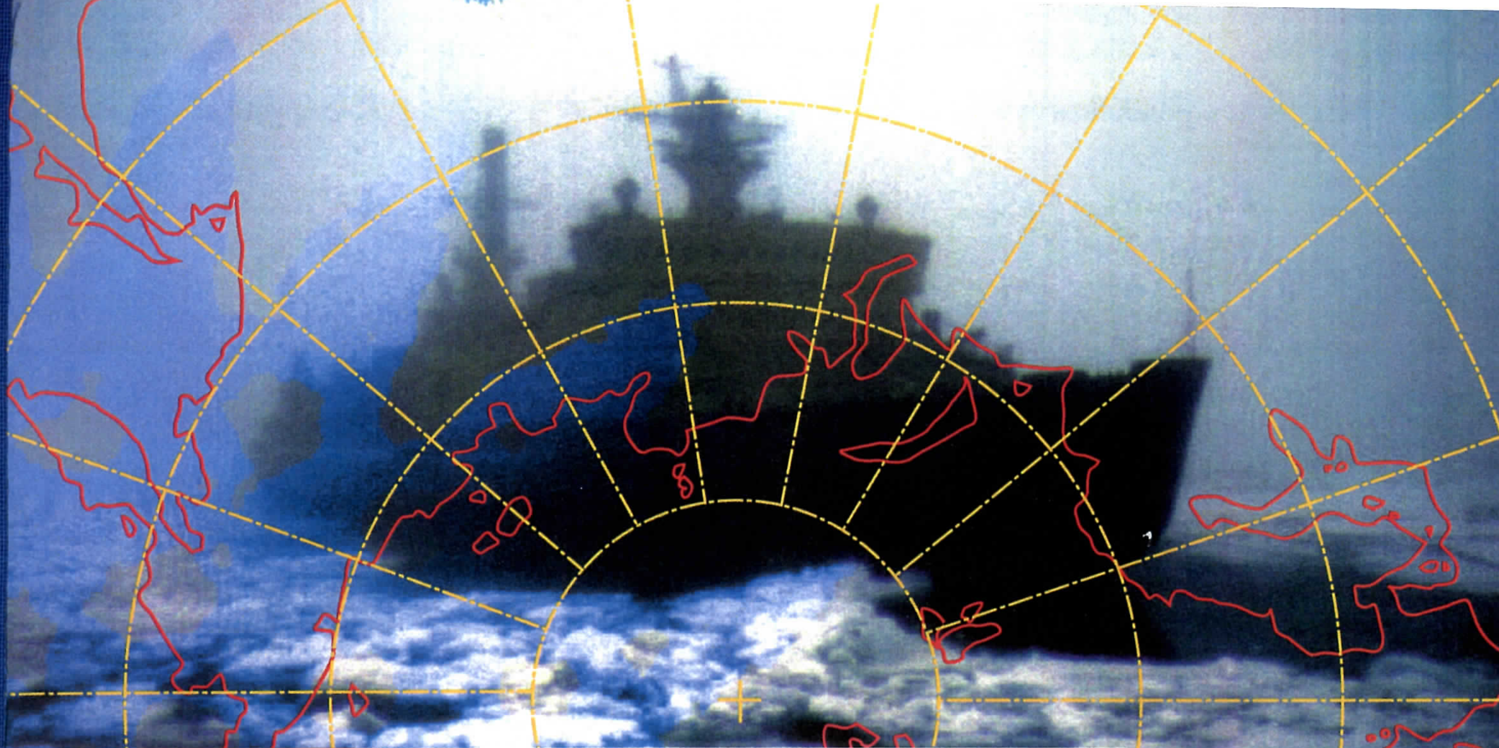

INSROP WORKING PAPER
NO. 64 - 1996, II.6.3

Requirements to NSR Shore Reception Facilities

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INSROP International Northern Sea Route Programme

Central Marine Research & Design Institute, Russia

The Fridtjof Nansen Institute, Norway

Ship and Ocean Foundation, Japan

International Northern Sea Route Programme (INSROP)

Central Marine Research & Design Institute, Russia | The Fridtjof Nansen Institute, Norway | Ship & Ocean Foundation, Japan

INSROP WORKING PAPER NO. 64-1996

Sub-programme II: Environmental Factors

Project II.6.3: Requirements to NSR Shore Reception Facilities

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Title: **Requirements to NSR Shore Reception Facilities**

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Date: 15 October 1996

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FOREWORD - INSROP WORKING PAPER

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

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

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

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

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Ship & Ocean Foundation, Japan

SUB-PROGRAM II. Environmental Factors.

II-6. Environmental Safety of Navigation.

II.6.3. Requirements to NSR Shore Reception Facilities

INSROP Working Paper

Submitted to
The Joint Research Committee
and
The Steering Committee of Sponsors

Supervisor Dr. Gennady Semanow, CNIIMF
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St.-Petersburg
1995

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Summary

The Northern Sea Route lies in the severe arctic climatic zone, and therefore such a special feature should be accounted for in both management of ship wastes and development of requirements to the shore reception facilities (SRFs). Because of large expenses needed for investigation of the peculiarities of the northern ecosystems now under increasing anthropogenic stress now, there is a need for international co-operation. The conceptual formulation of these problems to the SRFs in the NSR is the focus of the present work.

Matters of reception and treatment of ship wastes with the SRFs in the NSR were considered in the INSROP project "Shore reception facilities". Two papers were prepared the INSROP Report of 1994 (Part I) and the INSROP Report of 1995 (Part II).

Part I consists of the following sections: Introduction; 1. General description of the NSR ports; 2. Ports of the Northern Sea Route: Murmansk, Archangel, Dikson, Igarka, Tiksi, Pevek and Providenje; and Conclusions.

For the above mentioned ports the following information is given: short physiographical characterization of the port sites; berths (the number and types); types and quantities of cargoes handled; ecological state of waters in the port areas; basic data on the water use and water discharge in the ports; equipment for collection and transfer of wastes to the shore; methods of treatment of ship wastes (oily and sewage waters, garbage) on the shore reception facilities and the quantities treated; duration of navigation; and the number of ship calls. Also given are general data on distribution of the cargo flows among the NSR ports, a questionnaire for making judgement about the ship waste management, and a generalized table with data on the reception and treatment of main types of ship wastes.

Part II consists of the following sections: Introduction; 1. A conception of the ship waste management on the NSR; 2. Structure of the waste management system; 3. A scheme of the ship waste management on the NSR; 4. Requirements to the shore reception facilities on the NSR; 5. Requirements to the technology and equipment for waste treatment in Arctic ports; Conclusions.

In the Introduction it is pointed out that in the former USSR national standards of waste water treatment and discharge from ships in the Arctic basin were more limiting than the respective international standards, and that now, in Russia, they have not become less stringent. A not infrequent feature of cargo handling in the Arctic is the transshipment of cargoes from and to ships from the ice. This implies that the ship waste management in the Arctic is rather different from what is common in the ports of other climatic zones. At present, the existing scheme of ship waste treatment on the SRFs of the NSR is not institutionally and technologically fitted to severe Arctic conditions. However, the NSR local port administrations, being bound by a framework of the ship waste management scheme developed for usual (non-polar) climatic zones, were very determired and resourceful in their efforts to meet strict environmental standards.

In section 1, attention is given to the fact that a mistake, if committed, in the ship waste management system in Arctic conditions would cost very much, as the recovery of the

ecosystem would be very expensive there and the general-system ecological consequences are unpredictable.

In section 2, a conceptual suggestion on the NSR ship waste management is made: to integrate management into a double system of sea ways, the western and the eastern sections, which has been established and proved in the Arctic over several decades. At the centers (Murmansk and Archangel on the Western way and Providenje and Nahodka on the Eastern way) central treatment plants and full complexes of the SRFs should be provided. In section 2 the ship waste management which complies with the MARPOL 73/78 requirements and rules and is used at present in the NSR ports is also considered. A description is given of national types of oil-garbage skimmers, floating receiving facilities, shore facilities for disposal of oily garbage and oil residues, and of general characteristics of the above mentioned equipment above said.

In section 3 to the possibility of providing some universal SRFs in the ports of Tiksi and Dudinka is indicated. It is worthwhile to consider the use of floating facilities with shallow draught for collecting wastes from ships with deep draught (on roads beyond the port area), as berths of the SRFs may be at shallow depths. In section 4 national estimates are given of the ship waste amount per man for different types of ships operating the NSR, and the probable waste accumulation during a respective ship's voyage is calculated. Waste quantities discharged in ports are presented in the table not including the river craft which dispose wastes in river ports.

Section 5 and the Conclusions emphasise that the severe climatic conditions in the NSR should be accounted for to develop the requirements for technology and equipment for ship waste treatment in the Arctic ports. For minimization of load on the SRFs, it is recommended that the ship operating along the NSR are extensively equipped with installations for the on board utilization of wastes. The SRFs in Dudinka, Tiksi and some other ports of the NSR should be burdened only as much as to retain a reserve reception capacity for emergency actions in the NSR.

Requirements to NSR Shore Reception Facilities, Part I

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Introduction

The development of the market mechanisms in Russia is causing, in particular, an increase of the freight traffic volumes on the Northern Sea Route (NSR) and, naturally, intensifies the man-made stress to the environment. The growth of the ship traffic will result in increase of the amount of ship wastes which shall be handled in an ecologically safe manner.

Nowadays some NSR ports have shore reception facilities (SRFs) capable of receiving and treating oily and sewage waters and garbage. However data on their performance and waste utilization technologies used are scattered and not generalized. Therefore it is important to survey which NSR ports have SRFs at present, which types and amounts of wastes could be taken and treated and which treatment technologies are used. Based on the collected information and on the analysis of ship waste treatment technologies available in the world practice, requirements to the SRFs, should be subsequently developed which take account of specific polar conditions of the NSR, the most rational management of ship wastes shall be recommended.

Besides ecological peculiarities of polar waters, such as much slower self-purification of the man-made contamination than in other regions of the world ocean, here are some global-economic peculiarities in freight traffic volume. For example, the NSR ports Dudinka, Igarka and Dixon, considering from the west to the east, all are serviced with ships of the Northern and Murmansk ship companies, but those eastward of Dixon are serviced with ships of the Far East ship companies.

There is a variety of reasons for this:

- restrictions for safe navigation in the ice (mainly the time of autonomous navigation);
- economic expediency of addressing of either cargoes to the respective trade partners, etc.

To these home-to-home trips with different intensity of traffic and, correspondingly, different quantities and qualities of wastes to be utilized, are added the freight transit traffic volumes and wastes of the line Europe-South-Eastern Asia.

The present work is aimed at elucidating the recent situation with treatment of ship wastes in the NSR ports. It is a first step in the development of the requirements concerning SRFs on the NSR, as well as a rational scheme for reception and treatment of ship wastes.

Data on features of wastes produced on ships are not considered in this work, as they have been previously presented in a report on the project II.6.1 "Control of pollution from ships".

1. General specification of ports along the NSR

The main ports along the NSR are Dixon, Dudinka, Igarka, Tiksi and Pevek.

Below on Fig.1 are given data on freight traffic volumes in these ports for 1980-1992.

The significance of these ports in the cargo transshipment by the NSR is not expected to decline and may even increas in future. The NSR ports are the nodes of the transport flows, undergo most ecological stress and, naturally, could be considered as basic points of the NSR where shore reception facilities for utilizing different types of pollutants should be placed.

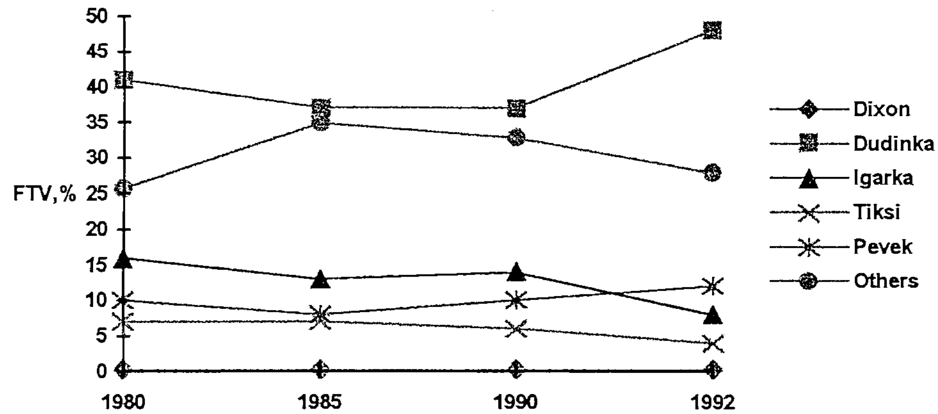

Fig.1 Distribution of freight traffic volumes on the NSR

Considering that navigation on the NSR lasts from May-June till October (except for Dudinka and Igarka), then this time span would be a restriction for utilization of different pollutants from sea transport at the shore reception facilities servicing the NSR. The ports of Archangel, Murmansk and Providence formally not appertaining to, but servicing the NSR, are year-round ports, have a developed infrastructure of means for utilizing different wastes, and are the principal consignees and consignors among the NSR ports. That is why these ports are included in the list of the NSR ports examined in the present work.

With a view to elucidating the condition of the ports and their capabilities to treat different ship wastes produced when cargoes are transported and handled on the NSR, a questionnaire has been developed, including the following items:

- types of ships calling at the port;
- the number of calls at the port, per year;
- maximum, minimum and average arrival-to-departure time of ships calling at the port;
- waste quantities disposed in port (oily waters, sludges from fuel and oil purification, sewage waters, garbage);
- types of wastes treated in the port;
- amount of wastes produced on board ship (t/d, m^3/d)*;
- amount of wastes treated on board ship (t/d, m^3/d)*;
- amount of wastes stored in port for further treatment on municipal facilities or for transfer to other ports;
- technology of waste utilization (dumping, burning, settling, biotreatment, etc.);
- capacities of treatment facilities in use and/or volumes of stored wastes to be transferred.

The questionnaire has not yet succeeded in obtaining full information about all the reception facilities in the NSR ports. To get a complete picture, it should continue gathering of information.

The questionnaire has not yet succeeded in obtaining full information about all the reception facilities available in the NSR ports, as some of the ports were difficult to reach in that time when the survey was carried out.

The present report provides information concerning the following ports: Archangel, Murmansk, Dixon, Dudinka, Igarka, Tiksi, Pevek and Providence.

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* - data are presented in the report on project II.6.1. "Control of pollution from ships".

2. Ports of the Northern Sea Route

2.1. The port of Murmansk

The sea port of Murmansk covering an area 50 hectares occupies a narrow belt of land, on the eastern shore of the Kola Bay. The port consists of 2 cargo areas and one passenger area.

1st cargo area is specialized in handling general cargoes, as well as coal and cupronickel ore.

2nd cargo area is mainly specialized in handling such bulk cargoes as apatite and iron ore concentrates, as well as mineral construction materials.

At present the apatite concentrate is overloaded with a special conveyer system, and the iron ore concentrate and construction materials do with use of a crane scheme of mechanization.

The Kola Bay where the port of Murmansk is situated is under strong man-made stress as it takes untreated domestic and industrial waste waters from the cities of Murmansk, Kola, Severomorsk and others situated on the shores of the bay.

The territory of port does not have a storm collector or local shore treatment facilities.

The Kola Bay waters at large are contaminated from the treatment facilities operated on berths of the fishery port. In 1992 an average contamination of the water area was as follows: oil hydrocarbons 1 MAC (maximum 5-7 MAC), detergents 1 MAC, phenols 6 MAC (21 MAC in the trade port) and DDT not present. According to a general classification, the Kola Bay waters are "polluted".

4 oil-garbage skimmers owned by the port of Murmansk have serviced, on average, 298 ships per year. In so doing the results were 364 t of bilge waters and 349 m^3 of garbage collected from ships and 1185 m^3 of garbage from the water area.

2 bilge water boats have treated on board 1723 t of bilge waters, 6373 t of domestic waste waters and 28 t of garbage from ships. A floating cleansing station "Kokand" with treatment capacity of 9200 t has serviced about 47 ships per year.

A biological treatment station has treated 46 500 t of oily waters per year. A part of solid wastes from ships (in average, 700 t per year) are burned on the incinerator plant and the remaining part is removed to the municipal dumping place (about 300 t per year) together with operational port solid wastes (about 10 t per year). The sludge from fuel separation (approx. 1 t per year) is burned as a fuel in a boiler plant.

The main parameters of water use in the port are as follows (thousands of tons/year):

1. Consumptive use of water, total draw off		2945
including:	from municipal water conduit	2031
	from artesian wells or water area	914
	for domestic water use	1378
	for industrial purposes	653
	for ship bunkering	876
2. Water discharge, total		2151
including:	domestic waste waters	730
	industrial waste waters	1421

2.2. The sea trade port of Archangel

The port area is about 200 hectares. The water area of the port is formed by the Northern Dvina River forked into numerous arms near Archangel city. The main navigable channel is the Maimaksa River.

The port consists of 5 cargo areas spaced as far as 20 km apart, and a passenger area.

The Bakaritsa area is situated on the left shore of N. Dvina River, facing the Okulovskaya Koshka island, between the timber mill and the mouth of the Isakogorka River. The area is specialized in handling cargoes for Near North, the Norilsk industrial complex, and the coastal regions of the White Sea.

The Left Side area is situated on the left shore of the N.Dvina River and specialization of the area is the transshipment of coal and construction materials.

The Moseev Island area is situated on an island of the same name, where N.Dvina River is forked into the Kuznechiha and Maimaksa Rivers. There is a highway to the city. The area has a berth on which construction materials are handled.

The Economia area is situated on the Povrakul'ski island between rivers Dolgaia Schel' and Vaganiha. The berths are intended for handling export-import cargoes, as well as cargoes for the Norilsk industrial complex.

The joint passenger area with sea and river berths is situated on the right side of the N.Dvina River in the central part of the city. Here the general, bulk and lumber cargoes are handled.

In 1992 pollution of the water area of Archangel port was low, the average concentration of oil hydrocarbons being 0.8 MAC (maximum allowable concentration). However an oily film was observed on the water surface during the whole ice free period.

The detergent content was 1 MAC, on average. Chlororganic pesticide pollution was relatively low. An average phenol concentration was 1 MAC, but it should be noted that phenols were measured only in August and October, whereas the spatially homogeneous distribution of phenols in the two months seems to be characteristic of the whole year.

In comparison with the previous year, the water pollution in Archangel port was lower.

To collect waste waters and garbage from ships, the port has an oil-garbage skimmer, a bilge water boat and a self-propelled barge. These auxiliary vessels have serviced some 2078 ships per year by collecting in average 26 527 t of bilge waters which were delivered for treatment at oil reception facilities of the petroleum bulk storage and 6 229 t of garbage which was removed to the disposal area (food wastes are delivered to a subsidiary farm).

Waste waters from ships are shipped by the collecting vessels to municipal treatment facilities. To treat storm waters, there are settlement basins, filters and oil traps.

The water use in the port has the following parameters (thousands of tons per year):

1. Consumptive use of water, total draw off		960
including:	from municipal water conduit	673
	from water area, artesian wells	287
	for domestic purposes	667
	for industrial purposes	293
	for ship bunkering	214
2. Water discharge, total of waste waters		746
including:	domestic waste waters	453
	industrial waste waters	293
	from ships: oily waters	0.054
	sewage waters	0.015

From the discharged waters 459 000 t are removed into municipal sewers and 287000 t into surface waterbodies without treatment, as standard-clean waters.

There are local treatment facilities for treating polluted waters from the automotive transport shop - a settling basin, an oil trap and filters for mechanical treatment. The capacity of local facilities is 73 000 m^3 per year.

The maximum number of ships treated	38
the minimum	5

Navigation is year-round, with an icebreaker from December to May.

2.3. The sea trade port of Dixon

The port of Dixon is situated at the north-eastern tip of the Enisei Bay at the south-eastern part of the Kara sea, on lands of the Taimyr National Disrict of the Krasnoyarsk Territory. Well sheltered and perfectly suited for mooring ships, the bight of the port has three exits to sea through the Vega, Lena and Preven straits.

Dixon is the only sea port on the shores of the Kara Sea and serves as a base for sea transport ships and icebreakers. The roadstead of the port provides a place for concentrating seagoing ships and icebreakers to form convoys guided eastward through the Vilkitski Strait. In Dixon the seagoing ships are supplied with fuel and water and, if necessary, repaired.

In 1992 the water area of Dixon was polluted at the following levels: oil hydrocarbons - 1 MAC (in certain cases up to 5 MAC), detergents - 1 MAC (annual average) and DDT traces.

The operating berthage of the port is disposed in the Portovaya Bight. On the island, only one berth is operative.

The cargoes are delivered to Dixon by sea ships from Archangel and Murmansk or by river ships down the Enisei River.

The main cargoes in the total volume handled are bulk cargoes (coal and mineral construction materials).

The oil storage on the Sakhalin Island has been damaged and the berth was closed and its tanks dismantled and scrapped. Thus it is only on the northern shore of the Portovaya Bight where oil storages are available to the port.

Tankers are moored to a floating berth. Oil products are transferred into the shore tanks by pumps of the storage. There are mounted facilities for environment protection.

An oil-garbage skimmer and a bilge water boat are owned by the port.

The oil-garbage skimmer MNNS-7, is not afloat, but under conservation on the shore. The bilge water boat SLV-392 "Crab", was previously servicing, on average, 33 ships annually, collecting about 66 t of bilge waters. At present, because of the high cost of oil water reception, ships have had to give up the drawing off of the on board oil water.

Water supply of the settlement is effected from a reservoir 5 km away. From year to year a shortage of fresh water is observed. In 1989 the main reservoir was redesigned to fully satisfy the fresh water requirements of the village and to make water supply more stable. In case of water supply failure, water is delivered by water lorries from the river Lemberova 18 km away.

Water use of the port has the following parameters (thousands of cubic meters per year):

1. Consumptive use of water, total draw off		1600
including:	from municipal water conduit	710
	from water area, artesian wells	890
	for domestic purposes	620
	for industrial purposes	90
	for ship bunkering	210
2. Water discharge, total of waste waters		1390
including:	domestic waste waters	410
	industrial waste waters	980

Garbage	470 m^3/year
including: from ships	320
and from shore installations	150
Operational wastes	
from shore installations	150
from ships	280
Consumer wastes from ships	30
Food wastes from ships	10

All kinds of solid wastes are removed to a disposal site.

2.4. The seaport of Dudinka

The port is owned by the combinate "Norilsk Integrated Plant". It is intended for different modes of fleet: river, river-marine and sea ships. The Enisei Steamship Company is servicing the port with river ships and the Northern and Murmansk Companies deal with sea ships. Dudinka is the largest polar port in terms of freight turnover, the percentage of the total freight turnover by the NSR being as follows: 1980 - 41%, 1985 - 37%, 1990 - 37% and 1992 - 48%.

There are berths for sea and river dry-cargo ships, as well as two more petroleum berths for either river or sea ships.

Both sewage waters and garbage are handled in the port. The amount of sewage waters treated in the port equalled from 10 t to 20 t per day or, respectively, from 3650 t to 7300 t per year. The waste utilization technology is biological treatment for sewage waters and land dumping for garbage.

A limited amount of black waters are discharged into the municipal sewerage from May 15th till October 1st. The limitation is caused by inadequate capacity of transportation facilities servicing the fleet.

2.5. The port of Igarka

The water area of the port is about 3 sq.km. The port serves both river, river-marine, and sea ships.

The freight turnover in 1993 was 295 400 t of shaped timber. Weight of Igarka in the overall NSR freight turnover equalled: 1980 - 16%, 1985 - 13%, 1990 - 14% and 1992 - 8%.

A non-self-propelled discharge base DB-11 with lifting capacity of 705 t was converted in 1987 from a lighter with lifting capacity of 1000 t and is owned by the river port of Igarka. The base does not have any pumping or treatment facilities. Bilge waters are taken away from river ships in charge of the ENOPR and sometimes other organizations.

A non-self-propelled bilge water boat, type T-77, with lifting capacity of 100 t is available, owned by the Igarka timber plant. The boat has no treatment facilities and takes away oily waters from motor boats and floating cranes of the ITP. 57 t of bilge waters collected in 1992 were transferred to the DB-11, as well as more 159 t from ships of the auxiliary fleet.

The municipal sewerage is available. Neither the town nor the Igarka timber plant have treatment facilities. Liquid and solid wastes from sea transport ships are not taken away. Only limited volumes of oily waters are taken away from the short- range ships to the cleaning plant of the Igarka river port.

There are no reception tanks for ship sewage.

Data on the consumptive use of water are not available. Poorly treated and untreated waters are discharged into arms of the Enisei River.

Volume of sea traffic: 1991 - 134 ships, 1992 - 83 ships and 1993 - 88 ships (including 67 ships in the 3rd quarter and 21 ships in the 4th quarter).

Navigable period for river ships: 1991 - 154 days, 1992 - 126 days and 1993 - 138 days. For sea ships the navigable period could last up to 10 months. Navigation is ensured by the use of icebreakers and is interrupted for the flood season.

No storage tanks are available.

The port waters are classified as "conventionally clean".

2.6. The sea trade port of Tiksi

The port of Tiksi is situated in the Tiksi Bay of the Laptev Sea, 45 km from the Lena River delta.

The port has two stead roads, the inner and outer ones. The roads (5-7 miles off the shore) is used for partial unloading of ships.

At present the port is a member of the stock company "Arctic Sea Steamship Line".

The port of Tiksi is a point of transshipment of cargoes carried from Lena River to shore points in the Laptev and East Siberian seas or delivered by sea from ports of the Far East and North-West to settlements on the rivers Lena and Yana for local organizations.

In the port the export round timber is overloaded from rafts and river ships to be delivered by the NSR to ports of Japan.

Besides the supply of the port and local organizations with oil products, the petroleum bulk storage is used for bunkering ships of the transport, local and trade fleet. The fuel is transferred from ships by either their on board facilities or the storage pumps.

In 1992 the oxygen conditions in the Tiksi Bay were good. The mean annual oxygen content in surface waters was 12,41 mg/l.

The average content of oil hydrocarbons was under 1 MAC (a maximum measured equaled 3 MAC).

The content of phenols was 7 MAC, a maximum 24 MAC being observed in September.

The detergent content was well below 1 MAC.

Both village and port, as well as ships, are supplied with water from the Melkoe Lake situated 2 km to the south-east of the village Tiksi. Off the lake, a water conduit is laid and pumping stations installed. The ships are supplied with water during the on-berth cargo works through distributive hydrants or the roadstead with use of a water barge.

In dry summer the water requirements increase greatly, and the water supply runs on schedule. The sewer networks have an extent about 30 km and are made of 200-300 mm tubes. The functioning treatment facilities (settling basins) pass through 3800-4000 m^3 per day. Following the settling and hydrochlorate disinfection, the effluents are discharged into the bay, and solid residues are removed on a landfill. Because of the necessity to maintain temperature conditions, the biological treatment is impractical in terms of the high cost.

Since 1988, reception of bilge waters from all transport ships and from port auxiliary service fleet is accomplished by a tanker on which the subsequent treatment is made. Also two more disposal vessels are available in the port. An oil-garbage skimmer MNNS with a reception tank of 20 m^3 and a bilge and black water boat, the project 1582 UD, with tanks of total volume 406 m^3

The OGS and BWB collect annually, on average, 393 t of garbage, 88 000 m^3 of sewage waters from ships and 20 t of bilge waters.

A shore treatment plant is available in the port, converted from a lighter and a tanker. Approx. 35 ships per year are handled. The plant performs mechanical treatment of sewage waters, followed by chloration of the discharged effluents. The sewage waters are mainly derived from the village and partially from ships serviced by tank-cars. Nine boom defenses of Anakonda type are available, each one being 84 m long.

The oil products extracted from oily waters, dirty fuel, and waste lubricating oils are utilized in boilers of the central heating-and-power plant of the port.

1. Consumptive use of water, total draw off		105000 m^3/year
including:	for domestic use	25000
	for industrial use	75000
	for ship bunkering	5000

2. Water discharge, total		95000 m^3/year
including:	domestic waste waters	25000
	industrial waste waters	70000

2.7. The sea trade port of Pevek

The port is situated on the eastern shore of a bay of the East Siberian Sea, the Chauna Bay, well sheltered at the north by the island Aion and Bolshoi and Malyi Rautans.

The sea trade port of Pevek is a component of the largest transportation junction of the Northern Chukotka. A set of all-weather highways connect the port with the aerodrome at Apapelhino (11 km away) and with populated localities of the Chauna region.

Pevek is also the most important node in the Arctic sea transportation system. In addition to the loading complexes, here are bases of servicing for sea transport ships and icebreakers, including bunkering, supplying and emergency repair operations. But the works all are low-powered and need expansion and reconstruction. Meanwhile they play a great role in servicing fleet which operates far from the large technical and supplying bases of ports of the Primorski Krai and the North.

The port is specialized in handling cargoes delivered for mining industries and exploration crews of the Chauna region and Pevek, as well as in transshipment and storage of cargoes delivered for industries and settlements situated in the lower and middle reaches of the Kolyma River.

From Pevek to ports of the Primorski Krai are shipped tin concentrate and metal scrap and to ports of the Zelenyi Mys and Shmidt Mys do products of the local construction industry. By the Zelenyi Mys - to Pevek line the coal is stably shipped to Pevek.

The petroleum bulk storage situated in the Chauna Bay south of the port is intended for reception by means of tankers and for overhatch loading and bunkering by means of the storage.

The treatment facilities available do not meet the requirements of modern technology. The existing facilities are low-powered (10 l/s) and satisfy only the operational needs of the storage.

No reception tanks for oily waters from any ships are available.

Trellebort boom defenses 300 m long are available, as well as bulldozers, cranes and cesspoolage trucks to use in case of an accidental spill on shore. On the berth of port there are containers for disposal of garbage and other wastes.

In 1992 the oxygen regime in the Chauna Bay was good, in average 100% of saturation in surface waters and 85% at the bottom. The mean content of oil hydrocarbons was under 1 MAC (a maximum 2 MAC). Detergents are absent.

The water supply to meet the needs of both the port and transport ships is effected from the municipal water conduit which was reconstructed in 1988-89. The conduit is fed from a water storage basin at the 7th kilometer where a chlorination plant is also situated.

An emergency water storage basin, the Rautan Lake, is situated 15km from the town and is accessible only by a winter road. For the last 3 years the emergency basin has not been used.

1. Consumptive use of water, total draw off		130000 m^3/year
including:	for domestic use	30000
	for industrial use	17000
	for ship bunkering	10000

2. Water discharge, total		45000 m^3/year
including:	domestic waste waters	30000
	industrial waste waters	15000

An OGS and BWB are available in the port. The wastes collected from ships are all removed to a landfill.

2.8. The sea trade port of Providence

The sea trade port of Providence is situated in the eastern part of the Anadyr Gulf, viz. the Emma Bay (Komsomolskaya Bay).

The port is intended for transshipment of dry and oil bulk cargoes and is a passenger port as well.

There are ship repair plants servicing transport ships and port auxiliary fleet.

An OGS available handles annually, in average, 25 ships and collects approx. 420 t of bilge waters that are transferred to a bunker base to be treated on separator VEF-5 followed by a slime-gravel filter with cleaning degree of 15 mg/l.

The port has a shore plant for treatment of oily waters from ships and from shore industries. The total volume of tanks is 750 m^3 . The cleaning degree of separator BUEA is 15 mg/l at capacity of 5 m^3 hourly. The sludge separated is removed to the municipal landfill.

The ship repair plants have their own facilities to clear water from oil.

A source of water supply for the sea trade port of Providence are natural waterbodies, the Istihat Lake (year-round) and the streams Krasivyi and Gniloi (in summer). The port makes water available to the villages Providence and Urenliki.

Wastewater discharge of the port		790000 m^3/year
including:	domestic waste waters	450000
	(including from village	9800
	and from stock-breeding farm	11000)
	industrial waste waters	340000
	ship oily waters	80000

It should be noted that no treatment facilities for domestic waste waters are available and that ships and port discharge their domestic waters into the Komsomolskaya Bay.

The Table gives general information about Arctic port capabilities in ship waste treatment.

Table

Collection and treatment of ship-generated wastes in ports of the NSR

Port	Types of ship wastes, ton/year		
	Oil water	Sewage water	Garbage
Murmansk	2087.4/46500*	6373	1561.5
Archangel	26527/50000**	***	6229
Dixon	66	280	330
Dudinka	300*)	7300	***
Igarka	216*)	***	***
Tiksi	2000/4000	8800	393
Pevek	___	___	***
Providence	8420	81.2	***

Note: * - project capacity;
** - the same after reconstruction;
*** - transform to city facilities or land fills;
*) - from service ships;
___ - don't receive.

Conclusions

A preliminary survey has been made of the ports Archangel, Murmansk, Dixon, Dudinka, Igarka, Tiksi, Pevek and Providence, aimed at elucidating their capabilities in ship waste treatment.

The ports Archangel, Murmansk and Tiksi take away and treat oily and sewage waters, as well as garbage, but other ports do not take oily waters from transport ships. The ports of Dixon, Dudinka and Igarka take away sewage waters only in a limited volume and garbage is removed there on landfills. The port of Pevek doesn't take away sewage and bilge water.

No retention storages are available for reception of wastes from sea ships.

The NSR ports do not have treatment facilities to handle the whole volume of ship wastes.

For subsequent development of the ship waste utilization system and formulation of requirements for the shore reception facilities, it is necessary:

- to continue gathering of information about the NSR ports;
- to analyze the existing technologies of waste utilization and
- to propose optimal technologies for treatment of different wastes, which are suitable for the NSR ports.

List of abbreviations

BWB - bilge water boat
EE - engineering effort
MAC - maximum allowable concentration, MAC for oil is 0,05 mg/l
OGS - oil-garbage boat
RE - research effort
SNR - the North Sea Route
MNNS - type of oil skimmer

Requirements to NSR Shore Reception Facilities, Part II

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Introduction

In the former USSR, protection of the environment, including the sea, was a matter of priority. A number of authorized guidelines were issued for the purpose of regulating permissible discharges and emissions in the Arctic basin. Sometimes the limits were more stringent than those in other countries, e.g. for discharge of waste waters. The national regulatory acts included also directions on the development of the environmental logistics, including the shore-based facilities for reception and treatment of ship-generated wastes.

Climatic conditions of navigation, the seasonal dependence of operation, and difficulties experienced in delivering the energy carriers (coal and oil products) and handling the ships alongside the fast ice have prevented the use of such technological schemes for reception and treatment of ship wastes in ports of the Far North as used in most ports in other seas of the former USSR. During the 1980s, no conception, as applied to the Arctic ports, was developed in this sphere of the environment protection activity.

Due to this reason and because no equipment and technology were economically effective in the Arctic, and energy and labour resources were very limited, the waste treatment on the NSR was carried out only by temporary schemes. The problem became less acute for a time, and the allowable limits for discharge of regulated pollutants always observed.

In the 1990s, after disintegration of the USSR and transition of Russia from the state-regulated economy to market relations, situation in the development of the shore base of waste treatment became not better, but even worse.

The causes of this are as follows:

- essentially complete removal of state support for development of the waste treatment system;
- a sharp increase of the prices for energy carriers;
- labour outflow from towns and cities of the Far North;
- diminution of the tax proceeds because of a drastic decrease of the traffic volume.

One glaring contradiction which should be taken into account concerning the sea protection measures in the Arctic is that, on the one hand, the NSR lies in extra vulnerable areas which deserve especial protection and, on the other hand, the hard climatic and economic conditions of operating the NSR exclude fast implementation of a perfect waste management system to comply with strict nature protection regulations.

When searching options to treat the ship wastes, one should also take into account that owing to the extensive development of the Arctic, waste volumes to be treated in the nearest future will be 2-3 times larger than now.

The present work is aimed at the following matters:

1. Review of the existing equipment and the technology for reception and treatment of wastes.
2. Development of a management system for ship-generated and port-generated wastes.
3. Development of the requirements to the shore-based facilities for reception and treatment of ship wastes.

Here terminology which corresponds to documents of the MARPOL 73/78 Convention is used. When references in the textual citations are made to other documents, their terminology is preserved.

1. Conception of a waste management system for the NSR.

The ship wastes received ashore are part of the general waste stream of the port. Both ship-generated wastes and shore-generated wastes should be handled in an ecologically sound way. Otherwise, the anti-pollution activity may merely transfer the problem from the sea to the land or vice versa.

A second reason is that although the proper management of wastes is expensive, the costs for remedial actions, especially in the Arctic, are in general ever higher. As a rule, the pollution impact in the North cannot be completely eliminated. That is why the principle "first think, then do" is of high importance when selecting the options of the waste disposal. An integrated approach to waste handling which incorporates the entire life cycle of waste ("from cradle to grave", or from the moment of generation until the final disposal) may save considerable future expenses.

Also, the ship-generated wastes , as well as the shore-generated wastes , may contain valuable materials, which can be reused. To discard such wastes means to waste resources.

An essential task for a management system is minimization of their quantities as to save expenses for transportation, treatment and disposal of waste. A waste management should outline how, and by whom, waste is managed , which practical actions are needed for collection, transportation and disposal of waste, and with which mechanisms to control these operations. The control should monitor the movement of waste from the moment of discharge to the reception facilities until the moment of final disposal. The control is facilitated by use of notifications or way-bills which contain information about the type and quantity of the waste portion of interest, the mode of transportation, the source of generation, the transport firm, and the company responsible for the final disposal.

The respective signs are made in the documents at each step of treatment and transportation of wastes.

2. Elements of a waste management system.

The system includes the following elements which shold preferably be implemented simultaneously, but not in a sequence:

1. Standards for water quality , and a control system to emsure compliance.
2. Information on types and quantities of wastes.
3. Co-operation of parties involved.
4. Review of the available experience in waste treatment, technology and technical means to implement the prescribed standards.
5. Identification of sources of finance and resources.

Information concerning the two items above is given in reports of 1993: Project 11.6.1 "The control of ship pollution on the NSR" and Project 11.6.3 "The shore reception facilities on the NSR". The reports provide data on the discharge limits of harmful substances in the Arctic seas, as well as on quantities and composition of harmful substances generated on ships navigating the NSR.

2.1. Co-operation of the parties involved.

In the Arctic ports, co-operation of the parties involved comprises

1. Interaction between the port city, the port itself and the industries in collection, treatment and final disposal of wastes.
2. Port-to-port interaction in collection, transportation and neutralization of wastes.

The first option could be accepted in the scheme only in such port communities which have their own adequate treatment facilities. But cities in the NSR do not have treatment facilities satisfying the imposed requirements.

The port-to-port scheme of interaction in collection, treatment and final disposal of wastes means that wastes can be discharged at any port and then transported to a central treatment plant. In the Arctic conditions such a strategy is most advisable both ecologically and economically. The strategy must be applied in two directions: westward and eastward.

For example, the wastes generated in the western sector of the Arctic should be handled on the treatment facilities of Archangel and Murmansk, while the wastes generated in the eastern sector should preferably be handled in the ports of Providenje and Nahodka, e.g. where adequate reception facilities are available.

Such a strategy of waste treatment is recommended due inter alia to the following factors: quantities of wastes received, finance expenditures for implementing the proper technologies in individual ports, including availability of energy and labour resources, periodical operation of most ports and specific technologies of waste treatment and disposal. Implementation of such a strategy presupposes development of specific rules of handling wastes in the NSR.

2.2. Review of the available experience in collection and treatment of wastes on the NSR.

The standards and rules concerning the environment protection are adhered to only when adequate equipment is available, proper technology is used, and a set-up to operate such equipment and technology exists.

a. Oil waters

Oil waters include the bilge waters from engine rooms of ships, as well as the ballast and wash waters from tankers. As the sanitary rules of water protection prohibit discharge of the oil water in areas of Arctic ports, ships while staying in a port must collect their bilge waters in storage tanks and then discharge the collected waters either to shore reception facilities or in some designated areas. Ballast waters are usually not discharged on the NSR because at present, after delivering the oil to the Arctic ports, tankers sail in ballast to Archangel or Murmansk where the ballast waters are disposed of.

At present, the following technologies of oil water treatment are used:

1. Gravitational settling;
2. Flotation;
3. Separation and filtration;
4. Biochemical treatment;
5. Ultra-microfiltration on membranes.

On shore treatment facilities such a combination of technologies is commonly used as, for example, gravitational settling/pressure flotation, sometimes with use of special chemical additives (flocculants). Biochemical treatment is usually applied on a final stage of treatment - to polish effluents to the required limits. Membrane filtration is a rather recent technology approaching high quality of treatment , but it is an energy-consuming technique. Therefore, it is not widely used in treatment of ship wastes and applied on industrial plants to eliminate some very toxic substances.

All the oil water treatment technologies need high expenditures of energy. Therefore most Arctic ports take only limited quantities of oil waters because their treatment capabilities are not sufficient to deal with large volumes of water treated up to the required quality standard. In the North technologies such as gravitational settling and separation are those mainly used, but in larger ports flotation and biochemical treatment are also used.

b. oily sludges and residues.

Annex 1 of MARPOL 73/78 includes in this category such wastes as residues of fuel and lubricant separation or of treatment of oil waters, deposit from settling tanks, oily rags, and solids (oily sand, rust) left after washing the cargo and fuel tanks of ships. A part of wastes from this category may be burned in ship incinerators or boilers, e.g. rags or sludges from fuel separation. However, sludges from settling tanks or deposits from the cargo and fuel tanks are rather difficult to demolish on board and they are usually to be discharged to the shore facilities. This apparently simple process becomes a very complex problem, especially in the Arctic conditions, as the residues present an asphalt-like mass which is rather difficult to pump. In practice, the sludge has to be discharged manually into barrels and transported to the shore reception facilities. Because most ports - and all the Arctic ports - lack equipment and technology for the disposal of such sludges, the ports refuse to receive sludges or, otherwise, treat them in the simplest way, by sending them to landfill. If, for some reason, the separation residues cannot be utilized on board, they are sent to the shore boilers. Most Arctic ports receive and dispose of such wastes.

c. Treatment of sewage waters.

The MARPOL 73/78 defines sewage waters as liquid wastes from toilets, medical centers, cattle sheds etcetera, i.e. so-called "black waters". Liquid wastes from cabooses, wash places and showerbaths are termed "gray waters" which are not considered as sewage wastes and not regulated by MARPOL. In the Russian legislation, the black waters are classified as house-fecal waste waters, and the gray waters as household waters. Waste waters having the coliform index exceeding 10^3 bacillus per liter are prohibited to be discharged in the areas of Arctic ports. All other waste waters must be collected in storage tanks and discharged to the shore facilities or in the designated sea areas. At present, only Dudinka (in May-September), Tiksi and partially Dikson receive black waters for treatment. The Treatment scheme includes such technical solutions as the collection of sewage waters in settling tanks, basins, their chlorinating or, in some ports, biological treatment and finally discharge of effluents in specially designated places.

d. Treatment of garbage.

A large proportion of garbage, which is stored on ships and discharged to the shore reception facilities in the NSR, consists of packing materials, broken containers (wooden boxes, glass, metal) and food residues. The major option of garbage disposal in the NSR ports is transportation of garbage to municipal facilities (dumps) or to places designated by sanitary authorities. The NSR ports and communities do not have capabilities to perform garbage treatment. Therefore some ports (Igarka, Pevek) receive only limited quantities of garbage from coasting ships.

2.3. The technology and equipment for collection and disposal of wastes.

The collection and disposal of wastes in the northern Russian ports is made by means of:

- port oil-garbage skimmers ,
- boom defenses,
- floating receiving facilities,
- shore facilities for storage and removal of wastes,
- autonomous facilities for oil recovery from spills,
- shore sewage decontamination facilities and
- shore oil water treatment facilities.

a. Port oil-garbage skimmers.

The "Rules for prevention of coastal sea pollution" contain a provision that special floating facilities should be available in ports to keep the port area clean. Such a requirement is sound considering that though measures are taken to preclude discharges of oil and garbage from ships the hydrometeorological and operational conditions in the ports are so complex that the discharges are not impossible. Rivers inflowing to the sea near the ports are also a source of pollution by oil and garbage. In all the NSR ports the oil-garbage boats are general means of cleansing the port areas polluted by oil and garbage. As a rule, these are the OGBs of the first generation, a port type 2550/3 (for sheltered port areas). In some ports the OGBs of the second or third generation are also available - types OGB 2530/4 and OGB 2550/5 (for servicing the port and open roads). These types are very effective and appropriate for use in the sea ports in summer. But in the ice the OGBs are almost incapable of operating and can collect oil only in the brash ice. In some ports the OGBs are used for reception of oil and garbage from the sea transport ships and transportation of the wastes to the shore.

Table 1.

Specifications of oil-garbage skimmers (OGB)

Feature	Project		
	2530/3	2530/4	2550/5
Period of construction	1967/1977	1974/1985	1985
Application	port	port, roads	port, roads
Length overall (m)	14,85	17,71	18,95
Breadth (m)	4,3	4,3	4,5
Depth (m)	2,0	2,4	2,4
Extreme draught (m)	1,6	1,6	1,7
Unloaded displacement (m^3)	29	41	50
Main engine power (kW)	99	99	99
Fuel consumption en route (t/day)	0,682	0,682	0,682
Storage capacity for collected oil (m^3)	13	20	18,3
Storage capacity for garbage (m^3)	4	4	5
Operating width when collecting oil from the water surface (m)	11,0	7,5	8,0
Sailing speed (knots)	3,8	5,0	6,15
Operational speed (knots)	1,5	1,5	1,5
Range (miles)	port	10 miles from port of refuge	10 miles from port of refuge
Crew at 3-shift work (number of men)	6	6	6

b. Boom defenses.

Booms are usually used in open water, they are not effective in ice conditions.

c. Floating receiving facilities,

To collect oil mixtures, sewage waters and garbage from ships some ports use special nature-protection vessels, such as the self-propelled port receiving boats (PRB) of the types

15824 and 1582 UD or the separating type 76084 DS. These specifications are given in Table 2.

The use of the separating type of PRBs is now a very effective way of oil water disposal in the Arctic ports because quantities of such waters are relatively small. But the implementation is held back because of lack of an approved quality limit for effluents. Separator units with different filter-polishing attachments make possible approaching, in an economically sound way, of the effluent quality 2-5 ppm. This value is considerably higher than the ALC (admissible limiting concentration) of 0.3 oil ppm (or 0.1 ppm for sour oils) in waters for domestic use, and of 0.05 ppm in fish water , as required by regulating authorities. Experts of marine transport believe that a pollutant's ALC should not be referred to the effluent. The oil concentration in the discharged waters (admissible limiting discharge) should be determined in terms of contamination level of the waterbody, discharged volumes, conditions of discharge, the self-purification capacity of waterbodies, degree of dilution, existing currents, etc. The question of identification of the discharge limits for Arctic ports needs a special study.

The following ways may be thought to improve quality of oil water treatment:

- to organize reception of high-contaminated waste waters separately from low-contaminated waters;
- to better the level of treatment on separators by polishing their effluents on filter attachments using some local or regenerable sorbents;

to implement the membrane technology , as well as use of strong oxidizers (ozone), to polish effluents.

Table 2.

Specifications of waste receiving boats.

Feature	Type		
	SLV-15824	SLV-15824D	SLV-7608
Period of construction	1973-1980	1981	1984
Application	port, roads	port, roads	port, roads
Ice grave	UL-3	UL-3	UL-3
Length overall (m)	29,5	35,17	35,17
Breadth (m)	7,58	7,58	7,58
Depth (m)	5,6	5,6	5,6
Draught (m)	3,12	3,12	3,12
Storage capacity for oil waters (m^3)	242	350	240
Storage capacity for domestic waste waters (m^3)	57	80	80
Storage capacity for garbage (m^3)	5	5	5
Storage capacity for separated oil wastes (m^3)	25	25	70
Range from port of refuge (miles)	20	20	20
Sailing speed (knots)	7,5	8,1	8,1
Crew (number of men)	13	13	16

d. Shore facilities for disposal of oily garbage and residues.

As mentioned previously transport ships generate oil sludges, i.e. residues of separation of fuels, lubricants and waste waters. Also, the oil residues are accumulated in course of operation of the coasting ships and the service craft. The quantity of such wastes is not large, usually 0.1-0.3 m^3/day in Arctic ports. Oil wastes from the coasting ships and service craft are usually sent to the shore in barrels of 0.2 m^3. Universal and ecologically safe technologies for disposal of such wastes have not yet been created. In some ports the wastes are burned in incinerators or on thermal power plants. But this way of disposal transfers the pollution problem from the sea to the air, and not all types of wastes can be demolished.

The most effective and ecologically safe incinerators are those produced by the TEAMTEC/GOLAR (Norway) firm, as well as the SP-50 and PMU-700 (Russia). Their specifications are given in Table 3.

Disposal of wastes to a landfill is a cause of pollution of soils and groundwaters. Waste treatment with use of the oil-oxidizing bacteria is low-effective in the Arctic conditions as the time when bacteria are able to recultivate soils is very short. Other ecological reasons prevent also using the wastes in road construction.

Table 3.

Specifications of some incinerators (the TEAMTEC/GOLAR firm's and Russian ones).

Trade-mark	Rate of garbage incineration (cu.dm/h)	Volume of combustion chamber (cu.dm)	Fuel consumption for burning (1/h)	Energy consumption (kW/h)	Rate of incineration of liquid oil wastes (1/h)
OG-120	50-100	255	6	3	15
SP-50	50	300	6,5	16	50

3. A ship waste management scheme for the NSR.

Operational conditions in ports of the NSR are so diversified that a unified scheme of waste management adequate for each specific port, cannot be developed. In ports with large traffic and/or in ports of year-round operation (Dudinka, Tiksi, Pevek) collection and disposal of any types of ship wastes according to the following scheme is feasible (Fig. 1).

Such a scheme has the following features.

Ship-generated oily, food, and solid wastes are led individually through their own "shore conveyer of utilization". The ship wastes may be sent to the port on the oil-garbage boat or discharged directly on a cargo-passenger berth. Large pieces of garbage may be delivered by the port transport facilities to the landfill, while food wastes and the equipment, contaminated by them, are subjected to sanitary treatment. The food wastes are sorted for either crushing (and then burning) or decontamination. To decontamination are sent large-sized garbage and ship equipment contaminated by food wastes, as well as wash waters from the settling tank. After decontamination the large-sized garbage is finally sent to the landfill.

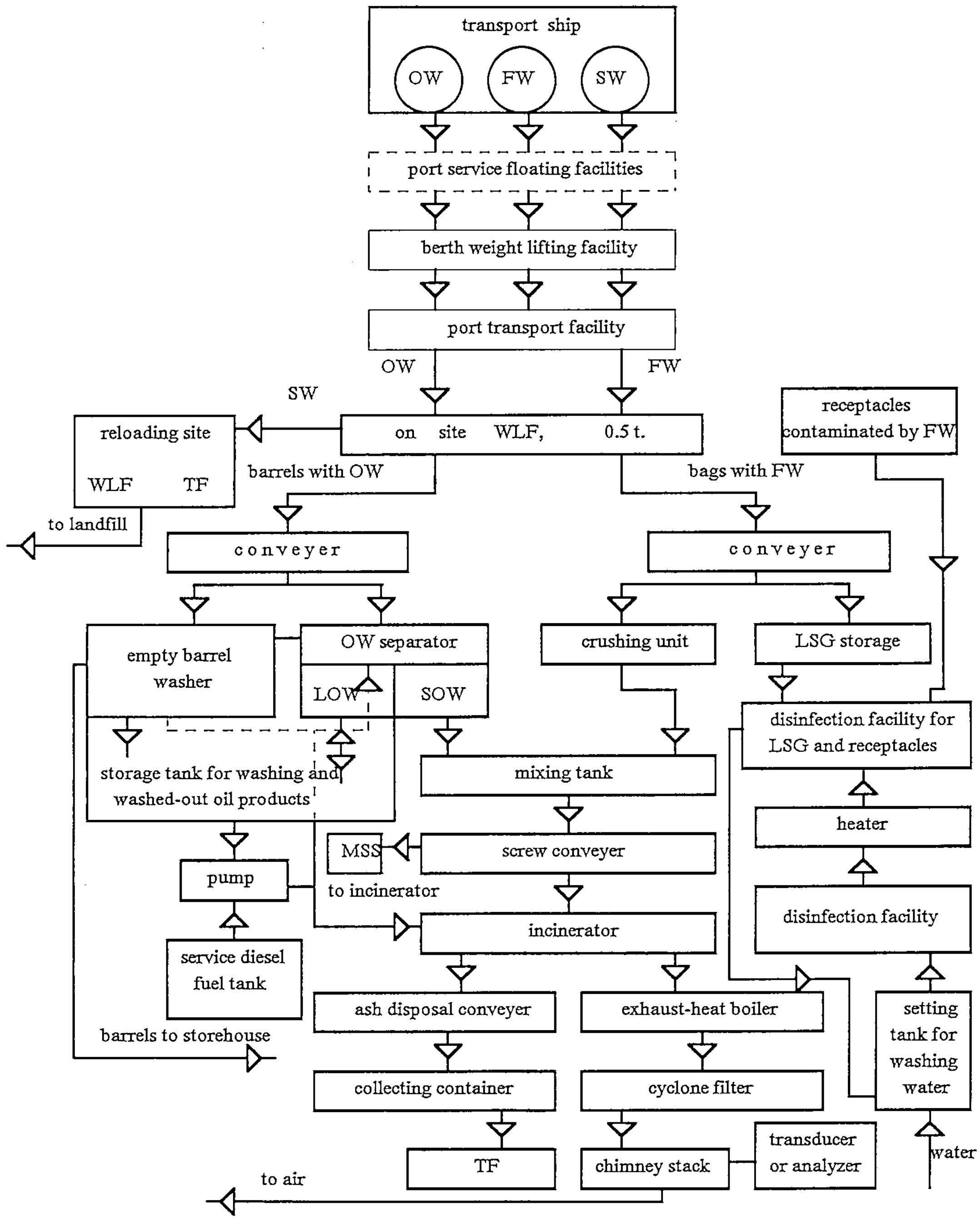


Fig.1 Flow chart of collection, transport and disinfection of ship wastes in port

Abbreviations adopted: OW - oily wastes, FW - food wastes, SW - solid wastes, WLF - weight lifting facility, TF - transport facility, LOW - liquid phase of OW, SOW - solid phase of OW, LSG - large-sized garbage, MSS - municipal sewage system.

For proper treatment the ship-generated oil wastes are sent in barrels to the shore. Initially the oil wastes are separated into solid and liquid phases. The solid phase together with the crushed garbage is sent to a mixing tank and then, after being passed through the screw conveyer, the mixture goes to the incinerator.

The liquid oil waste phase is led to a collecting tank for the washing and out-washed oil products (together with waters from washing of the emptied oil barrels), from which the combined mixture is pumped to the incinerator together with diesel fuel from the feed tank. The smoke from combustion of oily wastes in the exhaust-heat boiler is sent to the cyclone filter and gas analyzer and then is finally emitted through the chimney stack into air. The ash from the incinerator is collected into containers and is discharged to the landfill. The clean oil-waste barrels are stored in the warehouse.

In ports with relatively small traffic and/or in ports with a short period of operation (Dikson, Igarka), the reception and disposal of oil wastes and possibly sewage waters should be restricted by collection of oil waters and possibly sewage waters, followed by their transportation at the end of navigation to the nearest central treatment plants, e.g. in the Dudinka or Tiksi. But it would be economically feasible only on condition that intensive non-interrupted international shipping is be organized between European and Asian ports. Moreover, the development of the port cities is needed for such a scheme. At present, the most expedient scheme may comprise the reception of ship wastes in the NSR ports followed by their treatment and final disposal of facilities in the ports Archangel, Murmansk, Providenje and Nahodka.

Ship wastes are usually collected by the use of some mobile facilities or the on-berth conduits having a standard fitting.

Experience shows that the most suitable floating reception facilities would be some specially equipped self-propelled boats (to collect the bilge and sewage waters and garbage) or non-self-propelled barges with shallow draught which is important in shallow Arctic seas. Such reception facilities should manage primary treatment, separation of wastes and pressing of garbage. Wastes from barges would be discharged to vehicles and then sent to a stationary reception point.

4. Requirements to the shore reception facilities.

According to previous parts of the report the following requirements should be made to the to the facilities:

1. location of reception facilities;
2. quantity and quality of recovered and treated wastes;
3. equipment and technology of on-shore treatment.

4.1 Requirements to the location of reception facilities.

An important aspect of implementation of the reception facilities is the selection of a suitable location for the facilities.

The treatment and storage of wastes are equally dangerous as chemical production, and the same requirements are to be followed in selecting a location. The facilities should be located so that occasional malfunction and emissions do not adversely affect vulnerable areas and sensitive landscapes. Therefore selection of a site for port reception facilities is a responsible task. It should be noted that the facilities do not need to be located in the port area. Usually applied requirements to the site of reception and/or treatment facilities are as follows:

- good accessibility both from sea (when in port) and land;
- provision for energy supply (heat, electricity);
- sufficient space to avoid dangerous situations and to allow for future extensions;

– sufficient distance from populated areas and sensitive environments.

Food wastes are a probable source of human and animal infectious disease and may thus give rise to epidemics. The ports that handle transport ships arriving from abroad with food wastes are to comply with those legal regulations of Russia which ban exportation from a port of such wastes, until treated. Therefore, some special sites for discharge and decontamination of the wastes should be designated in ports. It is only after treatment that such wastes could be transported to a plant for their final disposal.

Sites for initial storing of garbage should be sheltered from precipitation and created with a view to not interfering with the work of the cargo handling complexes.

4.2. Requirements regarding the type and quantity of wastes for reception

As mentioned previously there is no need to create waste treatment facilities in every port, but it is expedient to provide sites for storing ship wastes in all large ports. In this case the different types of wastes should be stored separately: food wastes, solid garbage, oil solid wastes, oil waters, and oil sludges. The capacity of the receptacles is calculated according to the number and the type of visiting ships, their populations, duration of staying in the port and daily rates of waste accumulation.

a. The total quantity of ship-generated wastes per day is estimated by formula

$$Q = q_{SC} + q_{CC} + q_{CS} \qquad (1)$$

where q_{SC} is the quantity of waste from the port service craft;
q_{CC} is the same from the cabotage craft;
q_{CS} is the same from the cargo ships.

In turn, the above three items are correspondingly calculated as follows:

The quantity of food wastes from the port service craft will be

$$q_{SC} = N_{SC} \times R_{SC} \times P_{SC} \quad \text{in kg/day} \qquad (2)$$

where N_{SC} is the number of service ships which are to discharge food wastes;
R_{SC} is the average daily rate of waste generation: $R_{SC} = 1$ kg/day per man;
P_{SC} is the average number of seafarers on board a typical port service ship: $P_{SC} = 5$ men.

The quantity of food wastes from the cabotage craft will be

$$q_{CC} = N_{CC} \times R_{CC} \times P_{CC} \quad \text{(kg/day)} \qquad (3)$$

where N_{CC} is the average number of cabotage craft in the port;
R_{CC} is the average daily rate of waste generation: $R_{CC} = 1{,}4$ kg/day per man;
P_{CC} is the average number of seafarers on board a typical cabotage ship: $P_{CC} = 15$ men.

The quantity of food wastes from cargo ships and icebreakers will be

$$q_{cs} = N_{cs} \times R_{cs} \times P_{cs} \times k \quad \text{(kg/day)} \qquad (4)$$

where N_{cs} is the average number of cargo ships in the port;
R_{cs} is the average rate of waste generation: R_{cs} = 1,4 kg/d per man;
P_{cs} is the average number of seafarers on board a typical cargo ship: P_{cs} = 30 men;
k=0.1 is the portion of ships not equipped to burn garbage.

b. Domestic wastes (other than food wastes):

$$D_t = d_{sc} + d_{cc} + d_{cs} \qquad (5)$$

where d_{sc} is the domestic waste quantity from the port service craft;
d_{cc} is the same from the cabotage craft;
d_{cs} is the same from the cargo ships

The individual values are calculated by formulae:

from port service craft

$$D_t = N_{sc} \times R_{sc} \times P_{sc} \times T_{sc} \quad \text{(kg/day)} \qquad (6)$$

where N_{sc} is the number of ships discharging domestic wastes;
R_{sc} is the average daily rate of waste generation: R_{sc} = 0,5 kg/day per man;
P_{sc} is the average number of seafarers on board a port service ship: P_{sc} = 5 men;
T_{sc} is the typical turnaround time of a ship in the port: T_{sc} = 1 day.

from cabotage craft:

$$d_{cc} = N_{cc} \times R_{cc} \times P_{cc} \times T_{cc} \quad \text{(kg/day)} \qquad (7)$$

where N_{cc} is the number of cabotage craft discharging domestic wastes;
R_{cc} is the average daily rate of domestic waste generation: R_{cc} = 0,5 kg/day per man;
P_{cc} is the average number of seafarers on board a cabotage ship: P_{cc} = 15 men;
T_{cc} is the average turnaround time of a ship in the port plus the duration of voyage in areas closed for discharge.

from cargo ships:

$$d_{cs} = N_{cs} \times R_{cs} \times P_{cs} \times T_{cs} \quad \text{(kg/day)} \qquad (8)$$

where N_{cs} is the number of cargo ships discharging domestic wastes;
R_{cs} is the average daily rate of cargo ship-generated domestic wastes: R_{cs} = 1 kg/day per man;
P_{cs} equals 30 men;
T_{cs} is the average duration of voyage in a Special area and/or of staying in the port.

c. Operational wastes (without cargo wastes and cargo residuals) generated on a typical ship will be

$$O = N \times T \times (M_1 \times M_2 \times M_3) \qquad (9)$$

where N is the number of ships in the port;

T is the average duration of voyage in a Special area and/or of staying in the port;

M_1 is the daily waste quantity generated in workshops (metal chip, fillers, lines, etc.):

M_1 = 3 kg/day per hip;

M_2 is the daily waste quality generated through operation of ship mechanisms (soot, deposits, etc.): M_2 = 5 kg/day per ship;

M_3 is the daily waste quantity of weathered paints: M_3 = 3 kg/day per ship.

d. Quantity of sewage waters.

According to the Rules, transport ships going by the NSR should be provided with an installation for sewage treatment. Sewage waters are thus essentially not accumulated on transport ships. The port service ships with the number of seafarers under 10 men can legally discharged their sewage in sea. A major source of the sewage to be discharge are the cabotage craft or ships, on which sewage treatment installations are faulty.

The sewage water quantity is calculated as follows:

$$S = (m_{ts} \times n_{ts} + m_{cc} \times n_{cc}) \times 0{,}15 \quad m^3/day \qquad (10)$$

where m_{ts} is the number of the transport ships not equipped with a sewage treatment unit;

n_{ts} is the number of seafarers on a transport ship;

m_{cc} is the number of cabotage ships;

n_{cc} is the number of seafarers on a cabotage ship;

0,15 of m^3 is the sewage quantity per ship per day per man.

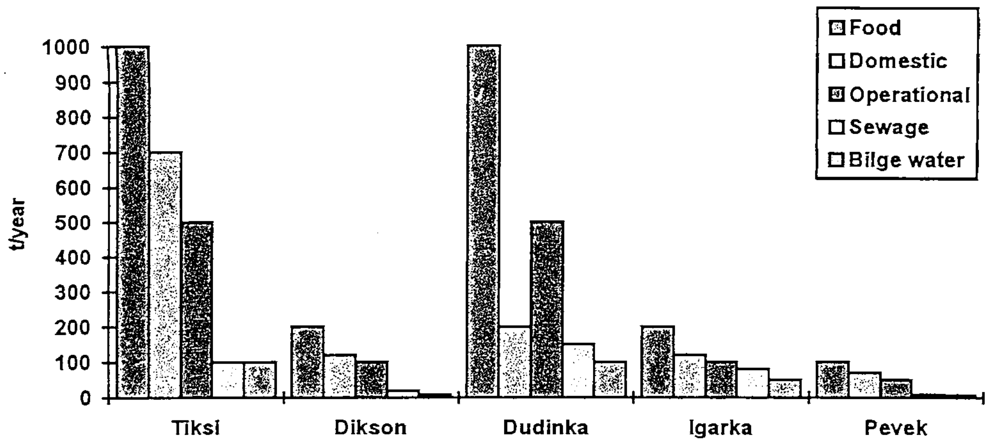
e. Quantity of oil residuals.

The oil waste quantity from separation of fuels and lubricants, which is discharged in a port, is estimated to be 0,1-0,2 m^3/day in average for a cabotage ship or a port service ship.

f. Bilge water quantity to be discharged in ports.

The main quantity to be discharged in ports are the bilge waters accumulated on transport ships when staying in port, as waste waters with oil content over 0,3 ppm are prohibited to be discharged in ports and should be collected in settling tanks. Another source is from the port service craft and from the cabotage ships. The bilge water quantity discharged to the shore is determined from Fig.1 in The report on Project II.6.I of 1993.

Fig.2 is a summary of data on waste quantities to be discharged in the NSR ports, if referred to the expected annual turnover of 4,000,000 t in the NSR.



Note: 1. Bilge water in 10^3 m^3
2. River ships not accounted for.

Fig.2. Quantities of wastes discharged in the NSR ports, (t/year).

4.3. Requirements to the technology and equipment for waste treatment in the Arctic ports.

The requirements to the technology and equipment are as follows:

1. It must be appropriate to operate in Arctic conditions.
2. Should be ensured its periodical operation (during navigation).
3. Should be of adequate capacity to manage the respective quantities and types of wastes.
4. Should comply with ecological standards for effluent quality (oil content in effluent <0.3 PPM; Coil index < 1000; BO = 50).
5. Operation of the equipment must be profitable to the owner and the charges for waste discharge should be reasonable for seafarers (much less than penalties for contravention of the rules).
6. The shore treatment facilities should be licensed to perform the waste disposal operations.

Conclusions and proposals.

1. A waste management scheme is proposed for the NSR ports.
2. Requirements have been developed to apply to the facilities for reception and treatment of ship- and port-generated wastes.
3. A review has been made of the available equipment and technologies for discharge, treatment and final disposal of wastes.
4. In the NSR it will be most expedient to collect and to decontaminate wastes, while their treatment and disposal are to be done at central reception sites in the ports of Murmansk, Archangel, Providenje and Nahodka.
5. Authorities of the shipping companies planning to operate the NSR are recommended to equip their ships with installations as that will minimize as far as possible the waste quantities to be discharged to the shore reception facilities.

Appendix A

Comments on Project II.6.3: Requirements to NSR Shore Reception Facilities

Review and Comment
on INSROP Report: August 1994

II.6.3. Shore Reception Facilities

Authors:	Dr. G. Semanov	CNIIMF (supervisor)
	Dr. V. Molchanov	Macarov State Marine Academy
	Dr. S. Lotukhov	Macarov State Marine Academy
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The authors are to be congratulated for their efforts to try to map the present situation concerning shore reception facilities. They appear to have worked out quite a comprehensive questionnaire, which was sent to all ports along the NSR. The ports, however, did not all respond according to the questionnaire and consequently it is very difficult for the reader to form any kind of opinion about the present situation. In order to make the report easier to understand a few amendments are suggested:

- Table 1 would benefit from also having the freight volumes included.
- Chapter 2 should include a table trying to summarize the rather scattered data obtained from the ports.
- Some effort should be put into trying to find out the maximum capacities of the reception facilities; in the report merely the treated amounts are mentioned.

The name of the report has changed from that in the INSROP PROJECT CATALOGUE 1993. The requirements of shore reception facilities are not addressed at all.

Reviewer:
Kimmo Juurma

Appendix B

Comments on Project II.6.3: Requirements to NSR Shore Reception Facilities, Part I and Part II.

Review and Comment
on INSROP Report: April 1996

II.6.3: Requirements to NSR Shore Reception Facilities, Part I and Part II.

The authors have provided a thorough and extensive analysis of the needs for NSR waste facilities. The strategy proposed seems plausible and based on solid reasoning and practical application.

The survey questionnaire was comprehensive, but the results could be presented in a more clear manner by use of diagrams and tables showing the data.

The report does not discuss the (IMO) Special Area discharge limits (15PPM) adopted in the NSR. More importantly though, there is extensive reference to the in-port allowed discharges (not greater than 3PPM), and the means of treatment.

The authors are to be congratulated for the clear, informative and detailed study on NSR shore facilities needs.

Reviewer:
V.M. Santos-Pedro

Appendix C

Comments on INSROP's Reviewers
II.6.3. Requirements to NSR Shore Reception Facilities, Part I and Part II

The authors thank the reviewers for comments on INSROP Reports II.6.3 Requirements to NSR Shore Reception Facilities.

The report was revised according to the comments and it contains the following amendments:

1. The chapter 2 (Part I) is supplemented by the table which summarizes the data obtained from the ports and contains the maximum capacities of the reception facilities.
2. The report doesn't contain the freight volumes, as this information is included in Subprogramme III projects.
3. The report 1994 (Part I) was the first part of the project II.6.3 and did not include the requirements of shore reception facilities as they were presented in the final report on the project II.6.3.
4. Some information is now presented as tables and diagrams.

Supervisor
G.Semanov

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Project II.6.3. Requirements to NSR Shore Reception Facilities, Part I and Part II

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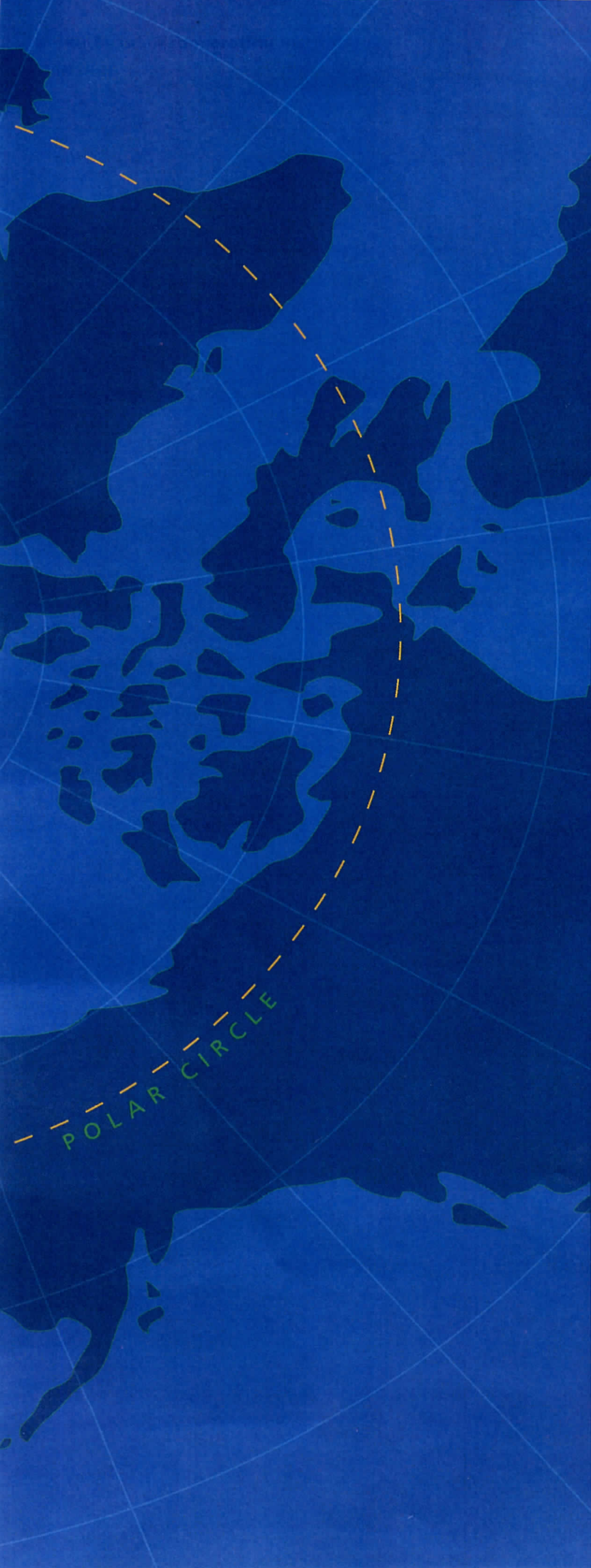

The three main cooperating institutions of INSROP

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 multidisciplinary approach, entailing extensive cooperation with other research institutions both at home and abroad. The INSROP Secretariat is located at FNI.