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NSR ICE INFORMATION STATE OF THE ART

WP1: DESIGN OF NSR ICE INFORMATION SYSTEM

WP1.1b: Consideration of hydrographic peculiarities on waterways of the Northern Sea Route

Author(s): V.I. Medvedev (SHD),
A.S.Tsvetkov (SHD), S.L. Fedorov (SHD)

DELIVERABLE D1.1b

Consideration of hydrographic peculiarities on waterways of the Northern Sea Route

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PARTNERS:

Kvaerner Masa-Yards	FIN
Royal Wagenborg	NL
Hamburg University of Applied Sciences	D
Tecnomare SpA	I
Merenkulun turvallisuuskoulutuskeskus	FIN
Central Marine Research and Design Institute	RU
Arctic and Antarctic Research Institute	RU
Hamburgische Schiffbau-Versuchsanstalt GmbH	D
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Nansen Environmental and Remote Sensing Centre	NO
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Technical Research Centre of Finland	FIN
Stiftung Alfred-Wegener-Intitut fur Polar und Meeresforschung	D
The Fridtjof Nansen Institute	NO
Lloyds Register	UK
University of Lapland	FIN
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DELIVERABLE SUMMARY SHEET

Short Description
This ARCOP deliverable D1.1b is the report “Consideration of hydrographic peculiarities on waterways of the Northern Sea Route”. It describes the navigational and hydrographic support of shipping on the waterways of the NSR, the hydrographic survey of the Russian Arctic seas and inland waterways suitable for sea navigation, gives information of the maintenance of the aids to navigation, describes the navigational charts and manuals for shipping on the waterways of NSR and updates the information concerning ECDIS, electronic charts, pilotage and TRIS-100. Special sub-chapters regarding the various sea areas both in the western and eastern regions of the Russian Arctica are included Deliverables D1.1a and D1.1b together present the updated information regarding the available information systems consisting the ice information system and the hydrographic information system on the waterways of the NSR. This ARCOP deliverable D1.1a summarises the currently available ice information system for support of Arctic navigation and offshore activities, which is based on a complex approach to the methods and means for collecting information on ice conditions. This involves the combined processing and analysis of non-homogeneous information from satellites, ground-based observations, autonomous drifting buoys and polar stations, icebreakers and ships. Ice mapping is performed using the information on ice regime, historical databases and ice models. The report presents a state-of-art review of the current ice information system on the waterways of the Northern Sea Route (NSR).

Author(s)	
Name	Company
A.I. Tsvetkov, S.L. Fedorov	SHD

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V.I. Medvedev	SHD	Approved	April 2005
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DISCLAIMER

Ministry of Transport of the Russian Federation

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_____V. I. Medvedev

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Final Report

«Consideration of hydrographic peculiarities on waterways of the Northern Sea Route»

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Deputy general director

A.S.Tsvetkov

Deputy head of

Arctic service of navigation equipment

S. L. Fedorov

St. Petersburg

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1 SERVICE OF THE FEDERAL STATE UNITARY HYDROGRAPHIC ENTERPRISE

1.1 The navigational and hydrographic support of shipping on the waterways of the Northern Sea Route (NSR).

The navigational and hydrographic support (NHS) of shipping on the waterways of the Northern Sea Route (NSR) is entrusted in Russia to the federal body of executive power in the field of transport – Ministry of Transport, through the Federal Agency of Marine and River Fleet (FAMRF) and directly through the Federal State Unitary " Hydrographic Department" (SHD). SHD has its subsidiaries in Arctic which provide NHS for the specified areas of NSR in the following seas of Arctic – Barents Sea, Kara Sea, Laptev Sea, Eastern-Siberian Sea and Chukchi Sea, as well as into the north-west part of the Bering Sea (from Franz Josef Land on the west, Novaya Zemlya and Vaygach till Bering Strait and Provideniya Bay on the east)

Areas of responsibility of the arctic branches of the SHD are shown in Figure 1.

A choice of waterways for ships into the NSR depends on the season, ice class of the ship, the port of destination and the real ice conditions at the moment of voyage.

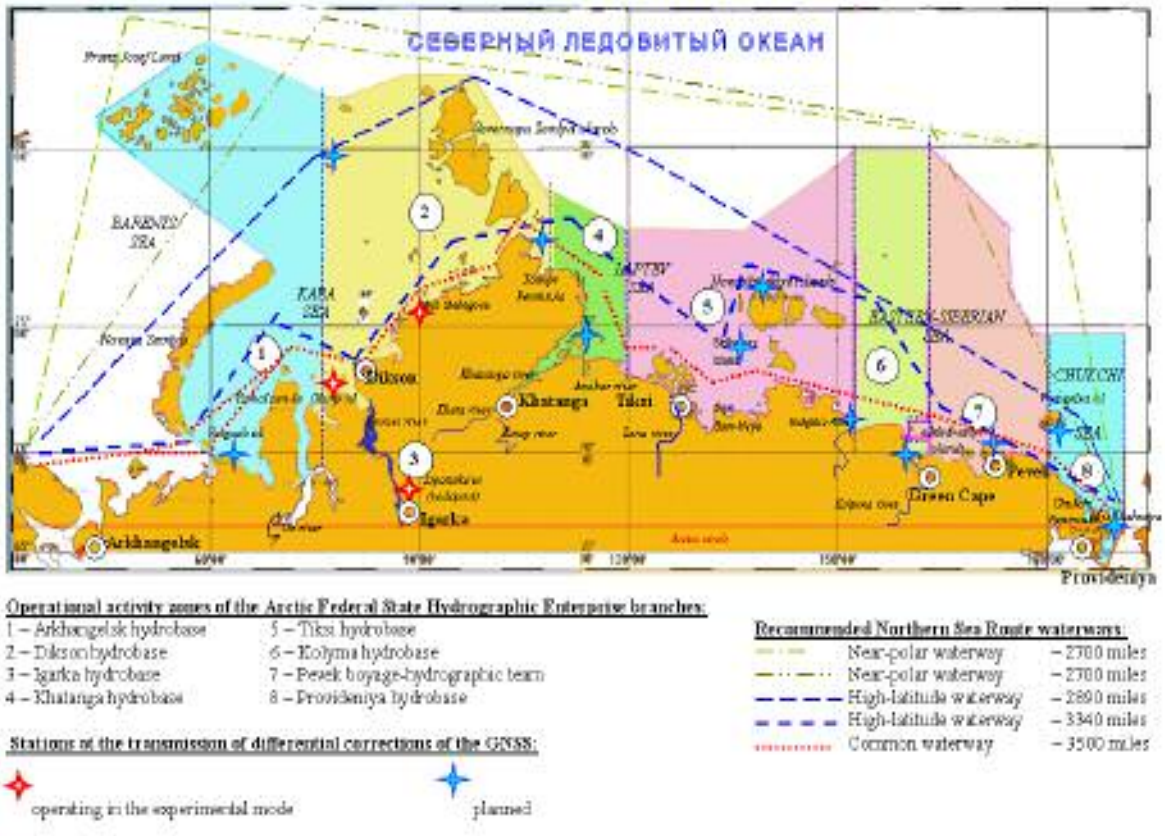

Figure 1.

The Federal State Unitary “Hydrographic Department” owns a biggest in the World fleet of ice-classed hydrographic vessels, including 14 ships built in Finland (the series of vessels “Dmitriy Ofsin”, “Fedor Matisen”, “Aleksey Maryshev”). These ships were destined for expeditions, hydrographic researches for the purposes of mapping of a sea bottom contour, installation and service of navigational aids.

1.2 Hydrographic survey of Russian Arctic sea bottom contour and inland waterways suitable for sea navigation.

One of the main safe navigation conditions is the availability of navigation charts and guides to navigation, which meet the modern requirements. The basis of each navigation chart and manual are date received from hydrographic researches.

At the time being the level of hydrographic knowledge and studies, which were carried out by the Hydrographic Department (today is Federal State Unitary “Hydrographic Enterprise” (SHD)) from 1933 is characterized as follows:

- For the main areas of the arctic shelf, which cover 90% of the traditional navigation routes, a detailed underwater topography is available;
- The costal zones inspection of the Chukchi Sea, the East Siberian Sea, the Kara Sea, the navigable part of the gulf of Ob, the undercurrent Yenisey up to the port of Igarka, the undercurrent of the Khatanga and Kolyma rivers and the Bykovsky waterway on entrance from the sea to the delta of the Lena river is finished;
- The topographical survey was preformed on a number of high-latitude parts of the Arctic sea.

Table 1.Volumetric parameters of the hydrographic researches carried out by hydrographic expeditions during the years 1933-2003.

Type of sounding by periods	1933-1952 linear km	1953-1964 linear km	1965-1983 linear km	1984-2003 linear km	Total in linear km
From ship From launch From ice	291 000 47 000 70 000	901 000 49 000 203 000	2 112 000 86 000 452 000	905 000 63 000 141 000	4 209 000 245 000 866 000
Total	408 000	1 153 000	2 650 000	1 109 000	5 320 000

During the topography survey the expeditions discovered and inspected about 1000 places with dangerous depths for the navigation.

On the basis of the materials received as a result of underwater and coast topography, ***a collection of navigation charts and plans*** of various scales was created. This collection contains ***more than 750 Admiralty charts*** from which 650 were open for global navigation, including 194 units in the English language. During the work of hydrographic expeditions a large quantity of materials was collected, which have formed a basis for creation of manuals and guides to navigation. Maps for approaching the basic offshore discharging points and detailed maps for navigation of seagoing vessels on the rivers Yenisey, Khatanga, Anabar and Kolyma were made. Twenty various manuals to navigation on the Arctic seas were issued.

This level of mapping of the Arctic seas was considered as fully satisfactory prior to the beginning of 80th years when it became clear, that the underwater topography which was realized using linear, parallel beats (boards) spread on defined distance one from another, cannot serve the increased needs to safety of the navigation. It especially concerns to the Arctic seas with their difficult ecological and climatic conditions where in case of an accident of vessels with a nuclear-powered propulsive plant or a large-capacity tanker there can be non-reversible ecological and serious economic consequences.

To except for vessels the risk of collision with unknown underwater obstacles resulted in the necessity to fulfill a hydrographic survey on ways of intensive navigating with technical means permitting to find out all underwater obstacles. In turn it has changed the concept of estimating the hydrographic level of scrutiny at a choice of recommended routes of navigating and hydrographic providing the traditional routes in coastal areas and all Arctic basin as a whole.

In 1992 the underwater topography was suspended because of the financing reduction. Only control measurements were carried out on the fairways to the river Yenisejs and in palaces were the topography couldn't be postponed:

- Place of ground contact of nuclear icebreaker «Yamal» in 1998.
- Bykovsky fairway in 1997.

The increased requirements to the providing of navigation had changed the concept of hydrographic surveys for the purposes of mapping and providing safe vessel navigation, especially in connection with the perspective of export of the hydrocarbon raw extracted from the north of Russia, engaging for these purposes large-capacity tanker (ice class "УЛ" and "УЛА" of the Russian Maritime Register of Shipping).

The modern standards for the hydrographic survey (national Russian "Rules of the hydrographic services No.4", and standards of international Hydrographic agencies) are recommending to use methods and means of survey which assure the detection of all underwater obstacle on the ways of intensive navigation. As a result the map material must be up-dated and in the near future an appreciable work has to be done, namely:

- A detailed survey of the recommended shipping routes, harborages and anchorage places for cargo operations using a instrumental area survey by special hydrographic equipment;
- Regular measurement in areas yet not inspected or inspected with poor accuracy and details;
- Regular measurements in region that are difficult to access because of the ice conditions.

This method will require fixed financial expenses on the NHS in the Arctic basin from all party in extracting and transportation of raw hydrocarbon independent from the direction of transportation West or East (taking onto account the interest of the USA to the supply of liquefy gas).

However the existing material of hydrographic survey and the navigating maps, sailing directions, port rules etc. based on this surveys and the experience gained from the sailing on the NSR allow to make trustworthy descriptions of the hydrographic features of the NSR.

1.3 Maintenance of the aids to navigation. Information.

Main objective of activity of the SHD is the providing of navigational-hydrographic seafaring and safety of shipping industry at delivery of economic cargoes to regions of the Far North by marine

and river vessels, trade, research, special and other vessels, irrespective of their departmental and national belonging. The area of liability of the SHD includes waterways of NSR, area of archipelago Franz Josef Land and mouth sites (bottom current) of the rivers Yenisey, Khatanga, Anabar, Lena and Kolyma accessible to marine shipping industry. The aids to navigation on the waterways of NSR are equipped with equipment which works by use of sources of electrical power, including radioactive nuclide propulsive plants (RNPP) in which are used radiating sources of heat (RSH) on a basis of the radioactive nuclide - Strontium - 90.

Regarding technology of operation RNPP and the control of their condition by means of inspections, during the process of de-installations from operation by dismantling and transportation for the further RSN utilization and burial, the Federal State Unitary "Hydrographic Department" is forced to fulfill special measures on providing radiation safety (RS) and radiation monitoring (RM), on ecological safety in installation sites of products - on the aids to navigation. These measures meet the requirements of international and national agreements and documents, but demand significant material and financial expenses. Recently (since navigation of 2004) on realization of measures on conclusion RNPP from operation and their utilization are outlined (on the basis of inter-governmental agreements) defined means. But the same inter-governmental agreements provide replacement RNPP by alternative power sources so as not to break an acting infrastructure of the system of the aids to navigation. Unfortunately, in 2004 funds for replacement of power sources was not outlined, and in 2005 the minimal volume is scheduled. Such development of events can result in breaking system NGO of Northern marine way and will considerably complicate floating vessels near to shores and on approaches to ports and to point of loadings/unloading on the non-equipped coast.

RNPP are used for providing electric power to unmanned, automatically acting aids to navigation light beacons, shining navigation marks, active RACONs, located in remote areas of the Arctic coast, on islands where usage of other sources of electrical power is impossible or is substantially complicated, especially in the winter period at providing all-the-year-round navigations in Western sector of Arctic regions.

On the 1st of January 2004 were registered 396 RNPP in SHD. During the navigation period of 2004 from Arctic region were taken out on a re-use of wastes of 69 RNPP units. On the 1st of January 2005 remained 327 RNPP on the waterways of the NSR

Works are carried out according to positions bilateral « Agreements between the Russian Federation and the United States of America concerning safe and reliable transportations, storages and destructions of weapon and prevention of distribution of weapon» of the 17th of June 1992

added and extended by the Protocol of the 16-th of June 1999, and «Agreements between Government of the Russian Federation and Government of the United States of America in the field of the account, the control and physical protection of nuclear materials» of the 2nd October 1999.

The Arctic service of aids to navigation and radiation safety

The Federal State Unitary "Hydrographic Department" established according to the Regulation of Board of Ministry of Transport of Russia №7 of 25.06.2002 «About situation with navigation and hydrographic support of shipping on the waterways of the Northern Sea Route ». The Arctic service of aids to navigation and radiating safety is the structural industrial subdivision of SHD to which was entrusted the management and liability for providing work under the rules of an industrial complex of the system of aids to navigation and radiating safety on the waterways of NSR.

Structural subdivisions of the enterprise: Branches of the enterprise - the Arctic hydrographic bases (including those in Arkhangelsk, Dixon, Igarka, Khatanga, Tiksi, Kolymsk, hydrographic bases of Providensk and buoy-hydrographic group of Pevek) are responsible for normal operation of the of aids to navigation in accordance with the appropriate regulations as well as operation of RNPP, including measures of radiation safety.

The results of activity in 2004 allow to plan removing of all RNPP from aids to navigation on the waterways of NSR. The SHD will support this way of development if sufficient financial funds will receive on these measures and the appropriate contracts will be concluded on delivery of alternative sources of electrical power for the aids to navigation (on the basis of Russian or foreign energy-saving technologies). This equipment should pass through rigid control and win the recognition of experts maintaining the aids to navigation in Arctic.

Table 2. Approximate terms of utilization of RNPP

Year	Sets	Year	Sets
2005	49	2009	40
2006	50	2010	40
2007	51	2011	45
2008	52		
Total			327

1.4 Preparation and distribution of information related to safety shipping on the waterways of the NSR. Information.

The Federal State Unitary "Hydrographic Department" (SHD) is responsible for providing maritime safety information (MSI) on the waterways of NSR for seafarers. SHD ensures service for collection, monitoring and transmission of MSI on the waterways of NSR. SHD is also a coordinator that provides preparation and transmission MSI to the waterways of NSR. All requirements of seafarers concerning MSI were fulfilled, taking into account technical means of Inmarsat-C in Arctic area.

SHD receives information about hydrometeorology and ice conditions from Arctic and Antarctic Research Institute. Navigational information receives from subsidiaries of SHD, as well as expeditions, ships and icebreakers that work on the waterways of NSR. Then this information is transmitted to the users. Information about hydrometeorology and ice conditions is transmitted to the users twice a day (06 and 18 UTC) as follows:

- to the West Arctic – all the year round;

- to the East Arctic – during the navigation period of time from July till October.

MSI transmits in frame of International safety network in accordance with Certificate of IMO No. 67 dated 20.05.2000. For this purpose SHD has a special centre, which was granted with the appropriate Certificate. This centre transmits MSI to the Coastal Earth Stations (CES) through Inmarsat by protocol X.25 according to the agreement with the provider "Global-1" (starting from 2002 the name of this provider is ZAO "Ekvant"). SHD cooperates with CES "Nudol" (Russia) and CES "Eik" (Norway). MSI is transmitted in English language.

For providing navigation data for ship-owners, captains of maritime ports and hydrographic bases, SHD transmits of coast warnings about changes in navigation circumstances on the sea. There are two types of coast warnings on the waterways of NSR:

- West coastal warnings (the messages for the areas located to the West of the meridian 125 ° Eastern longitude);
- East coastal warnings (the messages for the areas located to the East of the meridian 125 ° Eastern longitude).

These two types of coastal warnings are usually sent separately in Russian language (normally by teletype) to the Central Administrative Board of Navigation and Oceanography, ports of Murmansk, Arkhangelsk, Vladivostok, Yakutsk and hydrographic bases (subsidiaries of SHD), based in the following ports of NSR – Dixon, Igarka, Khatanga, Tiksi, Zeleny Mys, Pevek and Provideniya. Coastal warnings, sent to shipping companies, then are transmitted to seafarers, working on the waterways of NSR by communication facilities available in the ports for shipping companies. Ships calling the Arctic ports can also receive copies of the valid coastal warnings directly in the hydrographic bases (in Russian language).

Transmission of the navigation warnings by Safety NET was carried out for two rectangular areas, on which the waterways of NSR were divided:

- Coastal warnings WEST: 67N044E16081 (coordinates of SW angle of the rectangle, enlargement to the north 16 degree, enlargement to the east 081 degree);

-Coastal warnings EAST: 63N125E17070 (coordinates of SW angle of the rectangle, enlargement to the north 17 degree, enlargement to the east 070 degree).

All information into Safety NET is transmitted in the agreed format in English language.

Since 1st of January 2004 SHD has been transmitting hydrometeorological and ice information as follows:

- to the west area of NSR – all–the–year-round;
- to the east area of NSR – from July to October.

This information is prepared in English language in accordance with the requirements of “Manual on International Safety Net” (No.9026B) and “Manual for preparation and transmission of information about safety at sea“ (No.9026I).

Monitoring of transmission of MSI into the Inmarsat network in the West area of NSR is provided directly from operator working place in MSI centre by getting information from remote station, installed in 2002. In the East area of NSR, the same job is provided by specialists of radio navigation group in the port of Tiksi. On-line monitoring of transmission of MSI into the Inmarsat network in the East area of NSR (in contrast to the West area of NSR) at present time is only possible during the operation of the NAVTEX station. Due to the fact that CES “Eik” (Norway) confirms number of the transmitted data, day and time of the transmission, receipt number after the transmission of MSI we can think with confidence that the appropriate information are received by seafarers.

There is NAVTEX station in the port of Tiksi for covering the zone of intermittent reception of MSI on section of NSR between 90° and 135° eastern longitude. The centre for preparation, transmission and monitoring of MSI was established in St. Petersburg. The preparation

of MSI in NAVTEX format is provided by a coordinator in St. Petersburg (MSI department of SHD) in accordance with NAVTEX Manuals and approved instructions.

There are the following types of MSI messages:

- Weather forecasts (twice a day by Inmarsat – C only);
- Coastal warnings (as new information becomes available by Inmarsat – C only);
- Ice messages;
- Storm – cone.

The transmission from the station NAVTEX TIKSI was received by m/v "Ivan Kireev" near Wrangel island; this is much more than the international fixed standard of action for stations in 400 miles. If to take into account, that in western direction the range coverage of the station is about the same (or if it even less twice), then the information vacuum, which is taking place between IOR and POR satellites, is completely filled by this station.

Transmission of message on search and salvage was not effected because of absence of the information from the State marine rescue co-ordination centre.

The Russian Federation should support offers of the International Hydrographic Organization and the World Meteorological Organization, which were officially proposed on the 5-th session of Subcommittee on a Radio Communication, Search and Salvage of IMO (document Comsar 5/3/3 about formation of two new NAVAREA areas in the Arctic region of the Russian Federation). There is a probability that IMO will not grant to Russian Federation (to its any organization) the certificate on operation of 5 coast stations NAVTEX on the waterways of NSR if these waterways will not be included in NAVAREA areas as it have been proposed by HSD.

1.5 Navigational charts and guides to shipping on the waterways of NSR.

The area of activity of the SHD is the Arctic Ocean. On the 1st of January 2005 the verified collection of marine navigation charts for this area consisted of 679 charts available for seafarers including: 200 bilingual charts (in Russian and English languages) and more than 210 charts in electronic format. All above-stated charts are immediately corrected in accordance with all notices to mariners, received in the Central administrative board of navigation and oceanography and they keeps up-to-date.

In 2004 the Central administrative board of navigation and oceanography issued 12 navigation charts on the basis of hydrographic researches carried out by the SHD

including: 1 chart M 1:500000, 3 charts M 1:200000, 4 charts M 1 : 100000, 3 charts M 1:50000 and 1 chart M 1:25000. Also were issued "Rules of shipping on the rivers Yenisey and Kolyma" and " Manual for small marine and river boats for shipping in the bottom stream of the river Yenisey".

There are 19 valid manuals for shipping on waterways of NSR, one of them was issued in English. All manuals are corrected in accordance with notices to mariners issued by Central administrative board of navigation and oceanography and they are kept up-to-date.

For the correction of navigation charts and manuals for shipping in the last year there were collected and prepared more than 200 messages about changes of navigation and hydrographic situation and procedure of shipping on the waterways of NSR. These corrections were transmitted in Central administrative board of navigation and oceanography for publication of notices to mariners.

1.6 ECDIS, electronic charts, pilotages, TRIS -100.

Since 1995 the electronic cartographical production of the SHD has been carrying out works on creation of a databank of electronic navigation charts on the waterways of NSR and their update. These works meet the Standard of International Hydrographic Organization S-57, V.3.0 and V.3.1. and they are fulfilled on a firmware complex "CARIS". The database includes 1038 (967 under standard S-57) electronic charts on the basis of 230 navigation charts.

Six firmware complexes "Pilot" on the basis of an electronic-cartographical system with database of electronic charts for area of the rivers Yenisey and Kolyma are used for pilotage. ECDIS "TRIS-100W" is used on the hydrographic vessels and as simulator.

"TRIS-100W" was designed for providing of safety of shipping. It meets "Technical and operational requirements of the Rosrechflot of the Russian Federation for ECDIS" (Type Approval Certificate for ship's equipment No. 4/Э-580-96С, dated 15 August 1996). ECDIS "TRIS-100W" includes a data base of the electronic charts, which was developed by SHD in accordance with the IHO Standard S-57 and X-90. It helps to solve many problems concerning safety of shipping provides, electronic plotting a course, route planning, navigation information processing, etc.

ECDIS "TRIS-100W" and mobile hardware and software unit "Pilot TRIS-100" with the data base of electronic charts, developed by SHD gave a demonstration of the best performance within operating period. As a result "TRIS-100W" was recommended for ships and icebreakers as navigation equipment, which could increase safety of shipping on the waterways of NSR and "Pilot TRIS-100" - for pilot service and lights servicing groups of the hydrographic centers.

2 WEST REGION OF RUSSIAN ARCTIC

The west region of Russian Arctic is situated in the polar zone (completely behind the polar circle) and has typical features common for this region: **polar day and polar night**, the duration of which depends from the latitude and the extreme hydrometeorologic conditions, including the ice condition. The waters of the Arctic Ocean and his marginal seas with the mouth of the rivers, which fall into them, occupy a huge part of the region. The division into the West and East region has it historical reason, which relate to the founding of the Central administration of the NSR and the hydrographic administration of the NSR (1932 year). The boarder between the West and the East region was the meridian 125^0E. In the present report are described the part of the Russian Arctic, in which, according to the valid documents and Russian law, navigation and hydrographic services is provided by the SHD.

2.1 Borders.

Division of the Arctic Ocean basin into sectors in the area of activity of the SHD is shown in Figure 2 with blue dotted lines of some recommended ways of shipping in the west region of the NSR.

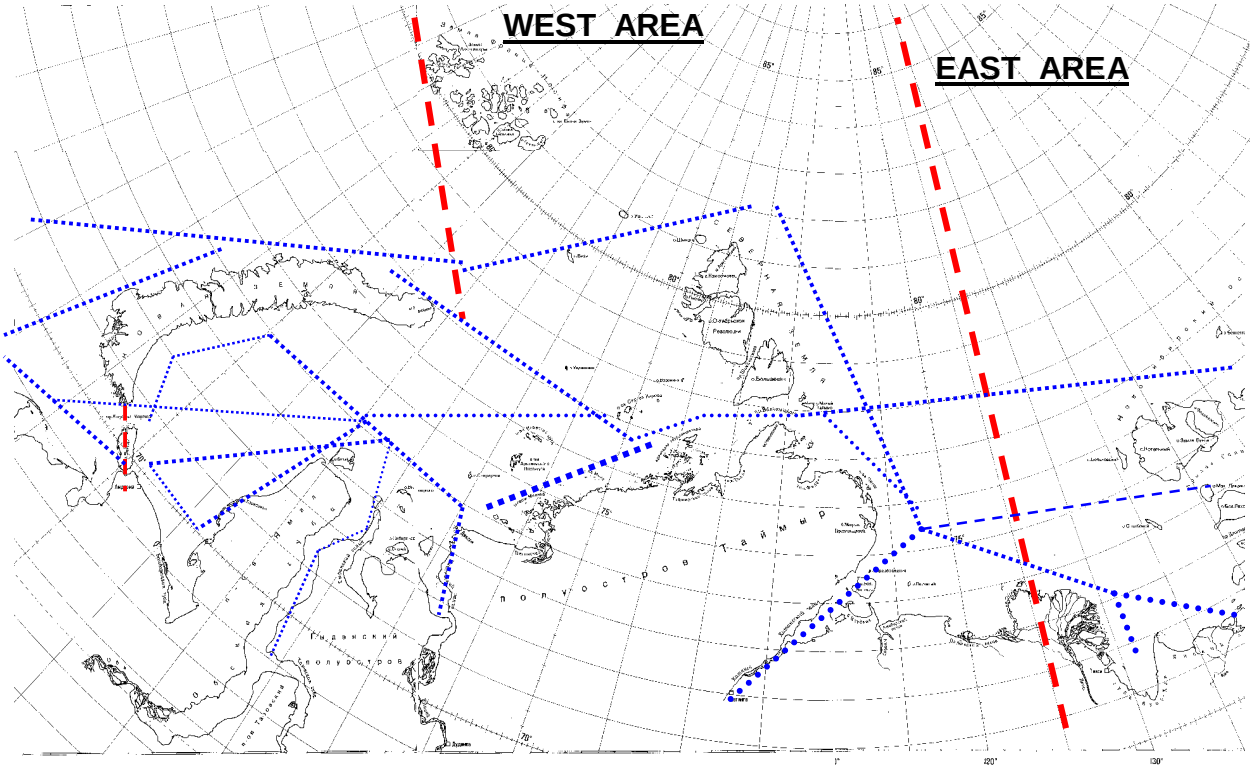

Figure 2.

2.2 Kara Sea

(More detailed information can be found in Sailing directions of Kara Sea, part 1 "Kara Sea with the exception of Ob – Enisey area" and part 2 "Ob – Enisey area").

Kara sea is one of the marginal seas of the Arctic Ocean and occupies the area of 883000 km^2 (including islands - 893000 km^2). The boarders of the sea in the west are considered: the eastern shores of the islands Vaigach and New Land. Also in the west the Kara Sea is connected to the Barents Sea by the straits Yugorski Shar, Kara gates and Matochkin Shar. In northwest Kara Sea spreads up to the Barents Sea and in the north it has a wide exit to the Central Arctic pool. In the east the sea is limited by the coasts of the islands Northern Earth and the peninsula Taimyr, and it is connected to Laptev Sea by the Vilkitski , Shokalski and Red Army straits.

The shipping conditions in Kara sea are extremely hard. The main reasons, which make the shipping there so difficult are: large quantity of underwater threats, frequent fogs, nearly constant presence of ice and little information about the streams there.

The selection of the way in costal area depends on the presence of ice and depths dangerous for shipping. The way in the open sea, in which dangerous depths are absent, depends on the presence and compacting of ice. This generate a need in strict inspections of shipping in the region by the Federal Agency of Marine and River Transport (FAMRT). This agency has the complete information about the character, amount and location of the ice.

When shipping on recommended ways from the straits Yugorski Shar and Kara gates to the port of Dixon and the Vilkitski Strait, it is possible to determine your location by satellite navigation systems, and well as by lighthouses light beacons and dark navigation marks(during the day). There are some radar responder beacons (RACON), and a large number of radar reflectors, usually combined with navigation beacons.

The use of radars for providing shipping near the coast is favorable in regions where stony abrupt cliffs predominate, because they have a good reflectivity. But the coast of the lip of Baydarskai, the west shore of Jamal Peninsula, the islands Belyi, Vilkitski , Sverdrupa, Arctic Institute, Uedineniya, Vise and Sergeya Kirova are displayed only at close range, and if some drifting ice is present, there low lying spots are completely unrecognizable. Eastern shores of the islands Novaja Zemlya, northwest coast of Taimyr peninsula from port Dickson up to cape Pronchisheva with adjoining islands, and also western shores of islands Severnaja Zemlya mostly are well displayed on the screen of the radars. Separate sites of the coast of the Taimyr Peninsula with low shores, for example at peninsula Mikhailova, at island Lishny (on the approach to the Vilkitski Strait), at an island of Samoylovich and places in archipelago Sedova, are identified badly.

Small islands, especially when they are covered with snow, look on the radar's display like a ice-field or accumulation of ice with small height above sea level. It is a rather dificult to find out on the radar's display small flat islands inside of drifting ice or hummocked fast ice from a distance of 3 – 6 miles; the low sandy-rebble spits are displayed even worse.

There were some incidents, when navigators did not discern on the radar's display picture of drinded ice from picture of small islands and approached to such islands without the necessary caution. Such mistakes can lead to casualties.

Depths, bottom contour and bottom. Kara Sea lies within the borders of the continental terrace and has a depth of 400 meters in general. The continental slope begins to the north of the line, which connects the islands of Franz Josef Land with the islands Severnaja Zemlya.

The deepest area of the sea is the western part of it. There, between the island Wojgach and the islands Novaya Zemlya, is situated the cavity of Novasemelskaj, the depth of this area is 200-400 meters and more. The average width of the cavity is around 40 miles. It is crossed by thresholds in two places. One of this thresholds with depths under 170 m stretchs to the east from the mys Spornyj Navolok, the second with depths under 200 m – to the northeast from the most north point of the island Wajgach.

The wide gutter of St.Anna with depths around 200-400 m penetrate into Kara Sea from the north along the eastern coasts of the islands Zemlja Franza-Yosifa to the cape of Desire, where it, after crossing elevations with depths of 80-200 m (it is the underwater prolongation of the northeast extremity of the islands Novaja Semla) it turns into the cavity of Novasemelskaj. To the east of this deep area so along the meridian 80° E to the parallel 81° N lies the Central Kara underwater elevation with flat shallow-water parts(depths 8-50 m). From the depths of 40 -50 m the gradient of the elevation is rising sharply, especially in the west in the direction of the gutter of St.Anna. The eastern slope of the elevation is less steep. It is directed to the gutter of Voronin,which lies between Central Kara underwater elevation and the islands Novaja Zemla. The Central Kara underwater elevation is crossed by wide narrows with depths of 150-180 m in some places; in general they are directed to northeast.

The gutter of Voronin is worse shown then the cavity of Novosemelskaja. Depths about 200 m, in the gutter lie to the north of the latitude 78°40'. They reach places, which lie at a distance of 180 miles to the continent.

In the south part of Kara sea, including the wide(in some places about 200 miles) band, which is adjoining to the Ob-Yenisey region and to the coast of Hariton Laptev, the depth is less then 50-60 m, because of the sediments of the rivers Ob and Yenisej.

The islands, which lie in the open part of the Kara sea, are surrounded by sea banks (Sverdrupa island, island of the Arctic Institute, Sergey Kirov island, islands if Uedineniya and Vise). Underwater dangers can mainly be found in the region of island Sverdrup, islands of News of the CEC, islands Sergei Kirov and island Voronin. Especially there is a irregular bottom in the area between the islands of News of the CEC and the islands Sergei Kirov, there are many sandy sea banks.

Straits of Yugorsky Shar and Kara Gates, which connect Kara Sea with Barents Sea and Straint of Vilkitski , which connects Kara Sea with Laptev Sea are most important from navigation point of view.

Strait of Yugorsky Shar separates island of Vaigach from the mainland. The light beacons installed there and the strait is convenient for shipping in spite of presence of some banks.

Strait of Kara Gates is situated between island of Vaigatch and the south part of Novaya Zemlya. The strait has indented coastline and there are some rocky reefs. Vilkitski Strait is situates between island of Bolshevik and Taimyr peninsula; dominant depths of water are 120 – 180 m there.

There are some straits between many islands of Kara Sea, which also a rather important for shipping, for example: Malygina Strait, which separates island of Beliy from the peninsula Yamal (ships with draft less than 4 meters could sail there); Vega and Preven straits to the port of Dixon; Kalinina and Belucha straits between islands of Izvestiy CIK (depths of water are 10—20 m there).

There a cavity with the depths of water more than 200 m into the Vilkitski Strait from Laptev Sea.

Shoaling water of Kara Sea with rugged topography of the ground inside of depth curve of 50 m between Pyasin and Taimyr bays are most dangerous for shipping.

If ship sails to the port of Dixon from NW a depth of water is increasing to 30 m and more starting from 15 miles form island of Dixon and near the island a depth of water is about 40 – 45 m. Waterways to the port of Dixon from N have a depth of water 32 – 38 m. Do not sail to the areas with the depths of water less than 30 m if no confidence in the ship’s location; do not sail eastwards as well.

Underwater topography of Kara Sea has not been fully investigated, but systematic sounding was arranged for the main recommended waterways.

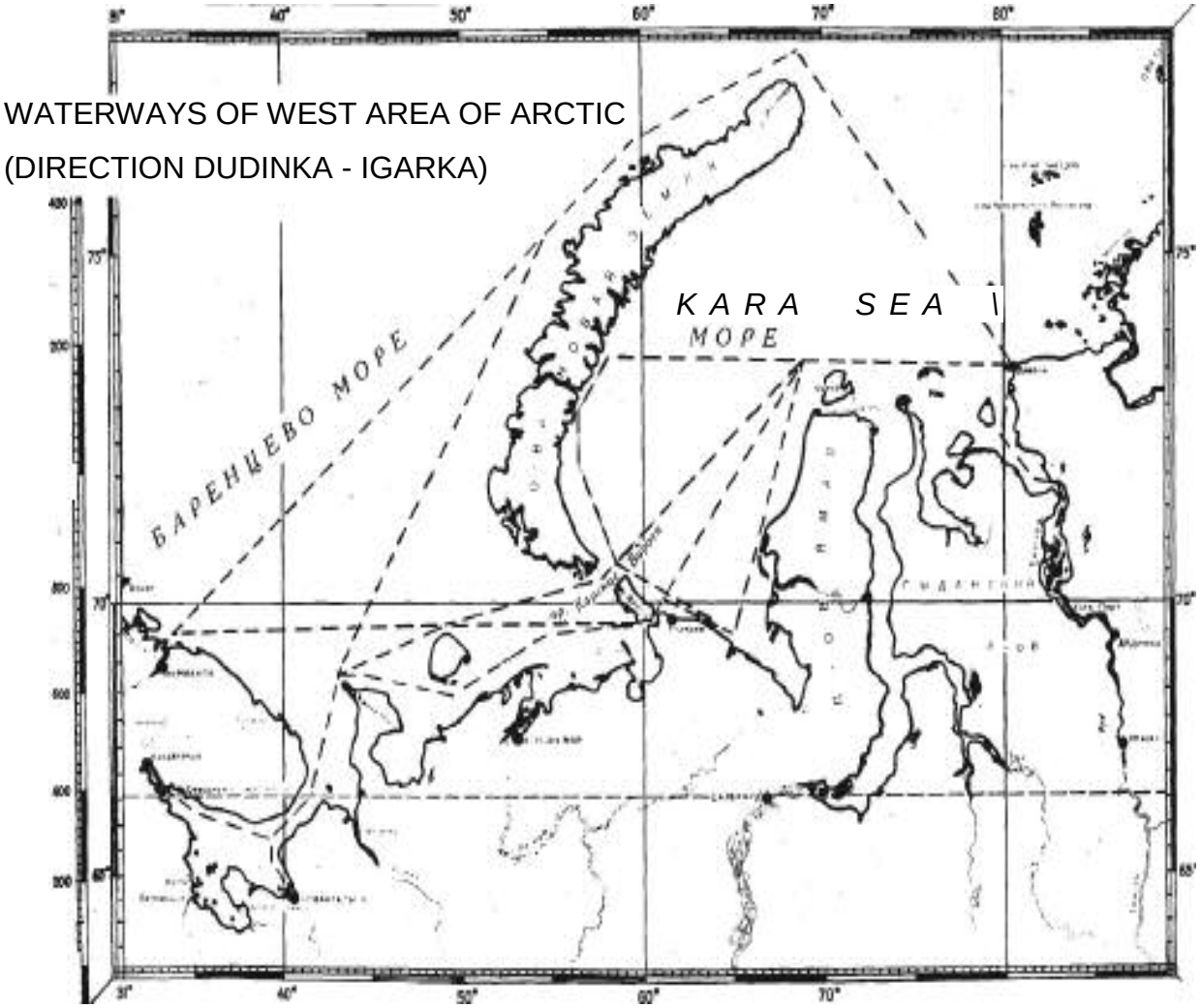

Figure 3 Waterways of the west area of Arctic

Piloting ships through the ice in the period of navigation is organized and is realized by **FAMRT**. Vilkitski Strait and approaches to it are the habitual regions of icebreaker assistance. In the starting and ending period of navigation the southwest part of the sea (from the strait of Yugorsky Shar and Kara Gates till the port Dickson) is also the area of icebreaker assistance. The voyage of transport ships to the island lying in the north part of the sea: Ushakova, Vise, Sredniy – is also assisted by icebreakers.

The shipping conditions and the reachability of this or that islands in the open part of Kara Sea is defined mainly by the location of the North Kara and Northland ice tracts and by the direction of the dominating winds. The shipping conditions near the coast completely depend on the weather in the southwest part of Kara Sea and on the location of the Novozemelskogo ice tract. The ice is an obstacle for shipping only when it closes the coast up. As an example see below Figure 4.

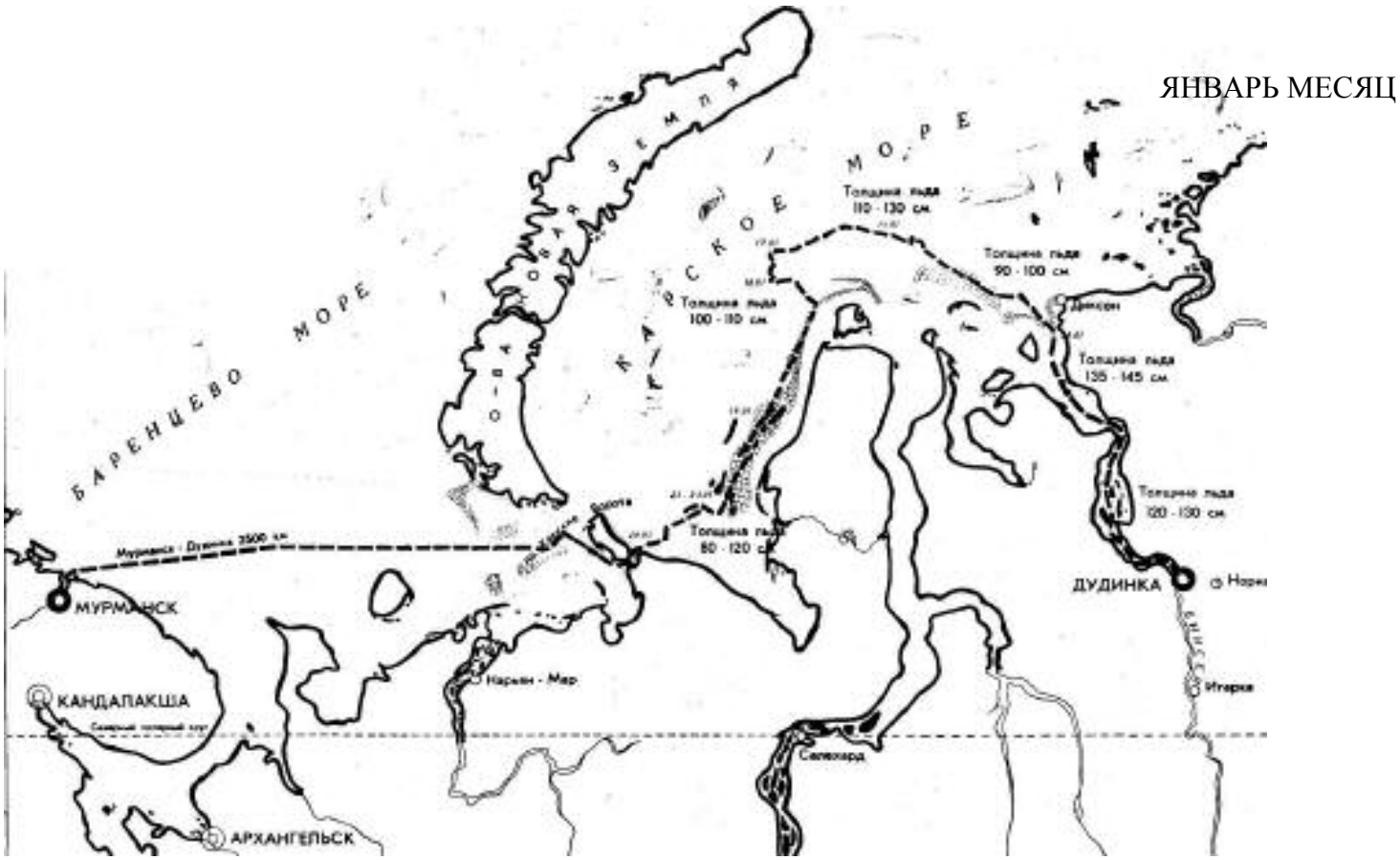

Fig. 4 Icebreaker a assistance to a convoy of ships in the southwest sector of Kara Sea (in January. Last years., from the reports of Administration of NSR)

Ice schedule in the Gulf of Ob

In the north part of the gulf the formation of ice covers starts from the first ten days of October. In the central part of the gulf the ice generating and ice drift continues another three-four decades. The ice hummocking is 3-4 numbers here.

Area	Ice formation	Fast ice formation
Kamenny (cape)	11.10	27.10
New port (bay)	7.10	16.10
Seyakha (village)	10.10	28.10
Tagebyayarha, (vil.)	17.10	28.10
Tambay (village)	17.10	28.10

The above stated results are based on ten years observations.

The average ice period vary from 262 to 298 days. The time of ice and fast ice formation is very unstable in the north part of the gulf.

In the south part of the gulf the thickness of ice is similar near the coast and on the waterways. In the north part of the gulf the thickness of ice is decreasing from the coast to the waterways.

On the results of the SHD expeditions in the spring-winter period of 1976-1986 (by sounding from ice) the average thickness of ice was 1,5 m. The strongest ice (2,3 m) was observed in 1978 to the north from the cape of Khonarasalya. According to the results of a long-term observation the strongest ice in the area around the polar station Tadebjaha was 249 cm; the average was 175 cm.

The distribution of thickness of the ice in the gulf of Obsk (because of it's big extension) is irregular and the difference in some areas was 60 – 70 cm (during the end of May - the beginning of June).

2.3 Ob - Yenisey area

This area is situated in the south part of Kara Sea, in the south of the islands Bely, Vilkitski and Dixon. This region involves the bays of Ob and Gydansk, gulf of Yenisej and also the part of the river Yenisey, which is navigable from the mouth to the port of Igarka.

The shipping conditions for sea vessels in the Ob-Yenisey area are rather complicated because of the shallows of the gulfs and bays and sandbanks. The selection of the route depends on the location of ice. For shipping in the gulfs, bays and on the river Yenisey the navigator has to choice the route, which is given in the sailing directions or in the instructions for shipping. The possibility to realize the safe shipping way in the described region in the light, as well as in the dark part of the day by visual aids are minimally sufficiently.

The hydrographic level of investigation of different parts of this region is irregular; less investigated region is the Tasovskaya bay, especially the south part of it, and the bay of Ob.

The largest navigable waterways – Ob and Yenisey. There are many big and small rivers ending in the water areas of Kara Sea in the Ob-Yenisey area.

The river Ob, which flows into the bay of Ob, is navigable by river vessels along the length of 3500 km. It has many shipping inflows, the largest from them is the river Irtysh.

The river Yenissey, which flows into the gulf of Yenisey **is navigable by sea** vessels along the length of 370 miles, from the mouth till the port of Igarka. Upstream there is a high developed river

shipping to the cities of Krasnoyarsk and Irkutsk (on the river Angara up to the lake Baikal). The draft of sea vessels while shipping on the river Yenisey is limited by the depths of the sandbanks of the river in the gulf of Yenisej and rifts of Turushinsk (to 10m) and Lipatnikov (to 7m).

There are two navigable channels in the Ob- Yenisey area - Western and Eastern channels in the gulf of Enisey. The channel of Gydansk, which separate the island of Shokalskogo and the Yavaj peninsula, is shallow and is navigable only by small vessels.

The Western channel (including the channel of Ovzin) is situated in the western part of the gulf of Yenisey and it is used by sea vessels very seldom, only if it is required by the ice conditions. The depth of water in this channel and on the approach to it from NW (from the island of Vilkitski) is 10-19.8 m.

The Eastern channel, is situated between the island of Sibirjakov and the western coast of the Taimyr peninsula. It is deeper than the western channel and is used by sea vessels as a waterway to the river Yenisej. The depths of water in this channel is more than 20 m.

The islands of Neupokoev and Oleny are lying on the Big sandbank, which seperates the gulf of Yenisej from the bay of Gydansk. The channels between the islands Oleny, Neupokoev and Vilkitski are shallow. From the island of Sibirjakov, which is lying in the center of the gulf of Yenisej, to the N stretches the North Siberyakov sandbank.

Farther to the SW from the island of Siberakov is the South Siberakov sandbank, which is a very dangerous, because it is near the Bolshoy Korabelny waterway.

The detailed sounding of the underwater topography and ground sounding were executed in bay of Ob from the mouth of the river Ob to the New Port and in Tasovskaya bay such a sounding was arranged in its west part untill latitude 76° E. As a result of the works, which were carried out by the expeditions of the SHD for more than 10 years, were received a lot of data for producing excellent navigation charts. At present for the bay of Ob were published charts with a scale 1:100 000, for approaches to the ports Jamburg and New Port were published charts with scale 1:10 000. The results of the work carried out in 1979-1988 made it clear that the depths of water in bay of Ob, including bar parts, had not changed in the comparison with the results of the previous years. The present level of hydrographic investigation of the bay of Ob allows to create charts with scales 1:25 000 and 1:10 000. The data of the hydrographic soundings can be used for pilot analysis about a necessity of dredging operations.

So at present time it can be guaranteed the following safety waterways for ships:

- with the draft less than 9 m into the depth curve 10 m;
- to the anchorage buoy of the port of Jamburg with drafts less than 7 m;
- to the anchorage buoy of the New Port with drafts less then 6 m.

At the same time it should be reminded that this safety passage drafts can be guaranteed only in case of good arranged observations and good timed notice to the ship about the level of water, because the total fluctuation of the sea level in the bay of Ob can be reached more than 2 m.

Aids to navigation in the bay of Ob are mainly luminescent bacons.

Depths, bottom contour and bottom. The Ob-Yenisey area — is the most shallow part of Kara Sea. The bottom there is even. It is caused by the rivers Ob and Yenisey, which carry out sand and silt.

Bay of Ob

The bay of Ob is the biggest bay of Kara Sea. Its length is about 400 miles and breadth (in some locations) is more than 40 miles. Tasovskaya bay (length is more 165 miles) juts out into middle part of the bay of Ob. East coast of the bay of Ob is higher than west coast and mostly abrupt. The coasts of the bay are mostly covered by alluvial soil. South coast of the bay (till latitude 67°30 N) is covered by forest-tundra vegetation, north of is tundra. There are some villages (New Port, Tambay, Seyakha, Yaptiksalya, Kamenny) on the west coast. Polar station Tadebyakha and villages Napalkovo, Nyda, Yamburg are situated on the east coast. A ground of bay of Ob is a rather even. The depths of water are decreasing to the south without sudden variations. There is a sand-bar (a depth of water is about 10-13 m) in the north part of the bay. Further to the south the depths of water are increasing to 20 - 25 m and then they are decreasing. Minimum distance from the coast to the depth curve of 10 m is 0,7 miles (near a mouth of the river Yarengsedeyakha). Tasovskaya bay is a rather shallow.

Grounds in the bay of Ob are mostly sandy silt, sometimes – miry silt. Near shoals – oozy sand and sand.

There are following depths of water:

- From the bay entrance to cape of Drovyanoy – more than 20 m;
- From cape of Drovyanoy to cape of Shtormovoy – 11 – 17 m;
- Into the narrow gutter south of cape of Khonarasalya – up to 27 m;
- Into the middle part of the bay – mostly 12 – 15 m;
- South of latitude 68° N - less than 10 m;
- South of Nakhodka bay – less than 5 m;
- There are a lot of shoals near west coast of the bay; near east coast of the bay, which is higher than west coast a number of shoals are less;
- Ships with the draft less than 6 meters sailed till New port bay.

The north part of the bay of Gydansk is a rather deep-water and navigable for sea ships. A convergent to the south gutter with depths of water 10 – 16 m extends to south – east till the bay bending. There is a rather narrow field of depths of the water 5 – 6 m further inside the bay. Notrh part of the bay is confined from the east by shallow water of the Big sandbank. There are some risks in the bay of Gydansk: sandbanks, underwater spits, etc. Grounds in the bay of Gydansk are mostly sandy silt, on the sandbanks – a sand.

The soundings and investigations of the fluctuations of the water level into the bay of Ob and Tasovskaya bay were carried out by the Arctic Hydrographic Expedition of SHD during 1979 – 1989. The fluctuations of the water level in the bay of Ob are caused mostly by nonperiodic variations (negative – positive setup). A nature of the high and low tide into the bay of Ob is a regular (12 hours). The fluctuations of level (negative-positive setup) are to be observed during active cyclonic disturbance. The positive setups are to be observed in case of winds from north directions, negative setup – from south directions. The maximum value of summary fluctuations of the sea level in the bay of Ob is 3,1 m (near Drovyanoy cape). In summer a middle value of the water level is higher than in winter.

Gulf of Yenisej.

There are some stone banks near east coast of the gulf of Yenisej. The most dangerous are: Taimyr bank (to NNW from Isachenko cape), underwater rock Vaigach (near cape of Efremov Kamen), Bolten bank, banks near the Korsakovskie islands and Krestovsky island. The smallest depths of water in the gulf of Yenisej are on the Big sandbank and on the banks north of and south – east of the island of Sibiryakov.

There is an external sand-bar of the river Yenisej with maximum water depths of 10,2 m near Shaitansky cape throughout the gulf of Yenisej. The depth curve of 10m is situated approximately 5 miles from a hidden line, which passes along south – west coast of the gulf of Yenisej till meridian of the Korsakovskie island.

South of the latitude of Shaitansky cape is situated external sand-bar of the river Yenisej with water depths less than 10 m. South of Shaitansky cape the waterway, concerging little by little, becomes a narrow gutter with water depths of 11-14 m. This gutter passes along the east coast to the mouth of the river Yenisej. There is a fairway equipped by lines and spar buoys. Ships with a big draft normally sails through this fairway. Ships with draft less than 7 m sails straight from Korsakovskie islands to the mouth of the river Yenisej.

There are following grounds in this area:

- Into the central deep – sea areas of the Eastern channel and Ovtsyna channel – clayed silt, closer to the coasts – sandy silt;
- Into the north part of the Western channel — silty sand;
- North of island of Sibiryakov – sand;
- Near east coast of the gulf - some pebble and gravel;
- On the banks - usually a stone.

Korsakovskie islands and Krestovsky island, which are situated near the east coast of the gulf of Yenisej, are stony. They can be found by a radar from the distance of 8 -10 miles. There are some dangerous stony banks near these islands.

There are waterways with water depth of 20 – 35 m into Krestovsky strait and Moscow strait.

Hydrometeorology conditions.

There are difficult hydrometeorology conditions for shipping into the Ob-Yenisej Area of the Kara Sea. **The main reason of it is ice; there are no ice in this area in October and September only.**

Icing up of ships, which could be here all over the year, is a rather dangerous for shipping. The ships with a big draft also could find some difficulties because of fluctuations of the water level caused by negative-positive setups.

The value of these negative- positive setups are usually more than the tidal oscillations there, especially in the south part of the bay of Ob and the gulf of Yenisej. This value is depends on the speed and direction of wind in the Ob- Yenisej area as well as distribution of wind under the a rather big part of the Kara Sea. The biggest value of the negative-positive setups are found during passages of cyclones.

There are two waterways from the Gulf of Yenisej to the river of Yenisej:

- By Bolshoy Korabelny fairway, which passes through the Eastern channel between island of Sibiryakov and west coast of Taimyr;
- By the Western channel, which separates island of Sibiryakov from the Big sandbank and then by Ovtsyna channel Bolshoy Korabelny fairway (line of cape of Leskina – Krestovsky cape);
- Besides, ships with big drafts, for example powerful ice-breakers during piloting of the ships, are allowed to sail by the recommended west coastal way to the south part of the gulf till latitude 72°17' N.

- Usually marine ships sails through the Bolshoy Korabelny fairway east of island of Sibiryakova, but sometimes (especially in the beginning or at the turn of the navigation period) ice conditions could be better in the Western channel.

Sea currents. The main current from the rover Yenisej goes from south to the north along the east coast of the gulf of Yenisej; the middle speed of the current is 0,2-0,3 knots. During the ebb a speed of the current is increasing (here and there, including Krestovsky channel and Moscow channel) up to 1 kn and more. During the flow current is stopping or its direction is changing to southward. In case of a long – drawn south wind and decreasing of the water level after positive setup a speed of the summary current, which goes northward along the east coast of the gulf, is increasing up to 2 kn. In case of a long – drawn north wind a speed of this current is decreasing and the direction is changing, for example there was found SW current in the west mouth of

Ovtsyna channel.

There are strong rise and abatement of the water level in the bay of Ob because of a wind forcing as well as strong positive and negative setup. These currents are stronger than permanent and tidal currents if strength of wind is more than 10 m/s. Long –drawn north winds results positive setup currents, southward – directed, and long – drawn south winds – negative setup currents, northward – directed. West and east wind have practically no impact on the currents, only near the south part of the bay of Ob these winds gives rise to negative set up.

NORDENSHELD ARCHIPELAGO.

Nordensheld archipelago, which consists of more then 70 islands, is situated near the coast of the Tajmyr peninsula, between the 94°E and the 98°E meridians and stretches to the north around 65 miles. The two major channels - Matisen and Lenin – are separate the archipelago in three groups of islands: the southern, the middle and the northern. The islands: Bonevi, Nansen, Tajmyr, Pilot Alexeev Pilot Mahotkin with surrounding them small islands form the northern group. They are separated from the continent by the channels Fram, Sara and Taimyr. The middle group consists of the islands: Vilkitski, Zivolki and Pahtusov. The borders of this group are: Matisen Strait (in the south), Lenin channel (in the north and east).

The southern group consists of the biggest island of the archipelago - Russkiy, as well as the Litke Island and Vostochnye islands. Most of the islands of the archipelago are elevated and stony; there average height is 50—70m. They are like cupolas of granite, covered by 0,5-1 m of earth. The stony character of the islands is defined by the presents of stones near there coasts, as well as reefs and stony banks in the channels. The coastline of a big part of islands and of the continent near the

archipelago is serpentine; there are many bays the majority of which is accessible by ships with big draft.

Near the archipelago there are many places where ship can stay by anchor. The Bay of Nord is normally the refuge for ships, which are waiting for better ice conditions. The bay is closed up by the western coast of the Tyrtov island and by the channels of Palander and Fram.

In the archipelago there are good radar use conditions.

The depth of the majority of channels in the archipelago is 20—70 m; the channels are accessible by ships with dig draft. The shipping in the recommended waterways, especially when the ice is absent, is easy. Most of the channels and bays of the archipelago are investigated by systematic sounding from ice and partly by sounding from a ship or a boat.

There are many underwater dangers in Nordensheld archipelago, and despite the fact that the recommended shipping ways lead through areas with big depth, it is absolutely necessary that the echo-sounder works all the time.

Approaching to the archipelago from west it is necessary to beware of the Sadko bank with depths of 4,6 m, which is lying in 2,8 miles to the W from the island of Makarov. Approaching from east— banks with depths of 4,6 and 4,8 m, which are lying in 4,5 and 3 miles to the E from the island Nord. On approach to the archipelago from NE it is necessary to beware of a bank with depth of 12,4 m, which is lying in 12,3 miles to the NE from the island Russkiy.

The streams into the Nordensheld archipelago are playing an important role in the distribution of the drifting ice.

Ice condition. In the period of navigation the channels of the archipelago play an important role, because they are often free of ice, while the parts of the open sea, which surround the archipelago, are full of strong ice. Normally the ships use the Matisen Strait, because it is better equipped by means of aid of navigation.

If the ice condition or any other reasons prohibit the usage of the Matisen Strait, the ships can pass through the Padseevsky or Lenin channels.

In the winter the waters in the archipelago are completely covered by stationary ice, the borders of which are a bit more northern then the island Russkiy. The ice is mainly flat.

The formation of young ice in the archipelago happens between the 26 of August and the 26 of October. Normally it happens around the 4—6 of October.

The stationary ice is formed very quickly after the show up of young ice, especially in narrow channels.

The strongest ice appears in the end of May—beginning of June, when the average thickness is 185—210 cm, and the smallest is 145 cm.

MATISENA STRAIT crosses the Nordensheld archipelago from the west to the east and it is the main waterway for ships, which sail through the archipelago to the Vilkitski Strait. A relief of the islands, which bound the strait, are a rather monotonous; the islands, which are situated south of Matisena Strait are higher than the islands located north of the strait. A middle height of the island is 20-40 m and only the Taimyr Island is 235 m height and a north part of Chabak island – 108 m.
There are a lot of small bays, covered from wind and heavy sea into the big islands. But they can be used for ships' staying not always because of ice conditions. Practically all islands are good visible by radars.

Seabed of the strait (on the recommended courses) is even. The water depths near the west entrance of the strait are 40 – 55 m. East of a meridian of the Pravdy Island the water depths are increasing till 60—70 m and remain the same up to the way out of the strait to the east. Mezhlauk and Nord banks are most dangerous into the strait. The Nizkiy Island with a low coast is a rather dangerous as well.

RUSSKIY ISLAND (77°02′N, 96°05′E) is one of the north and biggest of the islands of the Nordsheld archipelago. A height of the island is about 40 m. Its surface is a plain with very small hills. The island is covered by a sparse flora with some boulders. There are some navigation marks along the north-west coast of the island. They are visible (in case of a good weather conditions) from 3 – 5 miles. The observation' s tower of 8 m height, which is situated 5 miles north – east of the Russkiy Zapadniy Cape, is most visible. The coasts of the Russkiy Island are a rather difficult to find out by a radar. The north-west cost is visible from 6 – 8 miles, but its view is discontinuous and this coast is very difficult to find out in case of ice near the coast. A location of a place of the ship is possible from 4 – 5 miles by a matching of views of the abrupt parts of the coast with a map. Internal parts of the island are very difficult to find out on the screen even from a small distance from the coast.

TAIMYR BAY

The Taimyr Bay is a large water field, bonded from north – west by the Nordsheld archipelago and from east – by mainland, which is south – west of Oskara Peninsula. The north boarder of the Taimyr Bay is a hidden line from the Maliy Island on the west to the Oskara Cape (76°30′N, 98°58′E) on the east. The coast of mainland into the area of Taimyr Bay is a rather high, sometimes abrupt and there a lot of bays and gulfs there.
The bay is not important for shipping because it is situated outside of the recommended waterways to the Vilkitski Strait. Ships, which supply some fisheries situated here, are main visitors of the bay.

Conditions of orientation are good into the bay. The relief elements are normally used for orientation.

Orientation by radar is difficult only in the mouth of the bay. But after a determination on the screen the views of the Pilota Makhotkina and Rastorgueva islands and the precipices north of the Medvegiy Yar Cape the waterway into the bay is good supported by navigation marks.

The Taimyr Bay is fully accessible for ships with big drafts. The seabed is a rather flat here; navigation hazards are a rather seldom; there are only some banks with water depths less than 10 m in the south – west part of the bay.

2.4 Vilkitski Straight.

The Vilkitski Strait, which lies between the Taimyr Peninsula and the Severnaya Zemlya islands, is the most important part of the NSR, connecting the Kara and the Laptev Sea. The western border of the Vilkitski Strait ranges from the Cape of Poluostrovoi (77°20′N, 102°06′E) to the Cape of Neupokoeva (south-west part of the Bolshevik Island) and the eastern border from the Cape of Pronchishev (77°33′N, 105°56′E) to the Evgenova Cape (south-east part of the Bolshevik Island). From the west the Geiberg Islands are covering the entrance to the Vilkitski Strait from the east – the Firnleya Islands.

The coasts are covered with tundra vegetation and stony scattering. On the north and the south they are raised above the sea level, but the northern coast is mainly higher then the south. The rivers, which are flowing into the Strait, became shallow to the beginning of the navigation and aren't significant.

The navigation on approaching and on the Vilkitski Strait itself is provided by global positioning and navigation systems. As landmarks for the navigation could be used the islands located: on approaching of the Vilkitski Strait from south-west, on entering from the west side and near the southern coast. The mountains on the inland from south and north and some Capes are advisable reference points to.

The inhabited locality is the village called the Cape of Tchelyuskin located in the bay of Spartak (77°43′N, 104°12E).

The Strait bottom is relatively flat. The exceptions are the areas of the Geiberg Islands and especially the approaches from the south-west. The dominated depth is 100- 200 m but if approaching the Strait from the west side they are a little lower. The bottom is primarily brown or sandy silt and near the coast gravel, pebble and clay could be found. Underwater obstacles in the Vilkitski Strait are located near the costs, mainly in the western part: near the Cape of Pronchishev

and located 6,7 and 1, 5 miles to NNW from him the Lockwood islands and the Farm Island. Very dangerous are the islands of Lishniy and Moristiy; only a little part of them is above the sea level.

When using the ships radar, the navigator must be notice that the coasts of the Vilkitski Strait are looking on the display like interrupting reflections of medium strange with 4-6 miles and on some places 10-12 miles. Hills and mountains are distant 7-10 miles from the coast and are displayed indistinct. Radar reflectors which are mounted on navigation marks are detected before 10-14 miles and the radar responder beacons before 10-20 miles.

Ice conditions. The navigation on the Vilkitski Strait primarily depends on the ice conditions, not in the Strait itself, but on approaching from west and east.

From the beginning of the year until August the navigation from east is realized through the fast ice in the water area near the Taimyr Peninsula and the Bolshevik Island. The fast ice thickness of 160-239 cm (in average severe winter 180-190 cm) in the Vilkitski Strait is reached in the second half of May. From these days the fast ice slowly breaks up. The navigation until the ice break up is only possible with help of powerful ice-breakers.

During the navigation period the ice conditions in the Vilkitski Strait sometimes changes very fast, even during 24 hours. The ice concentration in the Strait is usually different on the southern and northern coasts and his contraction dangerous for ships with week hulls.

The concentrated drift-ice is not the only difficulty for the navigation in the Vilkitski Strait. Other adverse conditions like strong sea current and poor visibility are very problematic for the navigation. The course choice for navigating through the Vilkitski Strait depends on the ice conditions. On basis of the experience of many years it was shown that ship (with help of ice-breakers or without it) navigating from the Kara to the Laptev Sea were following the southern coast using the prevail direction of the ice drifting and the following sea course. This way is well arranged for navigating under weather condition. By good vision the position of the ship could be defined by lighting beacons and landmarks and under poor vision conditions using the ships radar and the global positioning and navigation systems.

For navigation from the Laptev to the Kara Sea the ships are using not only the southern way near the coast but the centre of the Strait and the way along the northern coast (with the following western sea course) to.

2.5 Western part of the Laptev Sea

Western part of the Laptev sea - one of the seas of the Arctic ocean - is situated between the Kara Sea and the meridian 125^0E. Western border of this area is east coast of the islands of the Severnaya Zemlya: a coast of island of Komsomoletz, a coast of island of October Revolution from the Gvardeitzev cape up to the Anuchina cape and coast of the Bolshevik island a from Peschany cape up to cape of Evgenov. From the south this area of the sea is separated by the coast of continent from the Pronchisheva cape up to delta of the river Lena.

Navigating conditions in the Laptev sea are a rather difficult. Southern coast of the sea is shallow, therefore marine vessels sail here mostly outside of visibility of the coast. Ships with small draft as well as river vessels usually sail through a shallow coastal strip, free from heavy ice, in order to go by sea between mouths of the rivers.

Ice conditions, especially in the western part of the sea (Taimyr ice pack), create difficulties for following ships by recommended ways and frequently force to go far in the sea or, on the contrary, to sail near the coast, where the small depths limit an opportunity of manoeuvrability of marine vessels.

The ice in the Laptev sea is observed all over the year, however in summer the significant part of the sea is released from it. In winter the most part of the sea is covered by drifting ice, the coastal part becomes covered by motionless ice – fast ice.

There are mostly one-year ice, local origin, and only in the northern part of the sea meets two-years ice and long-term ice.

Icebergs and their fragments can be found mainly near east the coast of Severnaya Zemlya islands and coasts of Taimyr Peninsula. As a rule, icebergs are a rather small: length up to 200 m, height above water no more than 30 m.

The Laptev Sea can be divided by distribution of the ice into two large areas. Each area has its own ice conditions. The first are is the area of the sea from the Vilkitski Straight up to the meridian 125° E (west part of the sea by the area 249 thousand km^2). The heavy ice of the Taimyr ice pack is located here. The second area covers area of the sea from the meridian 125° E up to Novosibirsk islands (east part of the sea by the area 287 thousand km^2). The ice of the Yansk ice pack is located here.

There are two periods in the Laptev sea by a status of an ice cover: October - May, when ice is forming, and June - September, when ice is destructing.

There are a lot of a rather big areas of the motionless ice – fast ice- in the Laptev sea.

A point of time when a thickness of young ice becomes 15-20 cm is considered as the beginning of the fast ice formation. Its formation, as a rule, occurs by freezing of drifting ice because of its compression. Into the closed bays and on shallow sites of the sea the fast ice is formed by natural increase of the ice and this process is usually over within 10 days after the ice began its formation.
The stable border of distribution of the fast ice in the sea approximately coincides with a depth curves 15-20 m and it is changed very little within the winter. The Hatanskiy gulf is fully covered by fast ice. The biggest total area of fast ice is observed in April and May.

Ice conditions for shipping in the Laptev Sea. In the western part of the sea ice conditions depend on the arrangement of the Taimyr ice pack and conditions of drifting ice.
The basic waterways pass along the coast of the Taimyr peninsula, or from Cheluskin cape in the direction of the mouth of the river Lena up to meridian 125° east longitude and further to the port of Tiksi, or north of in the direction of Novosibirsk islands (if ship sails to the east part of the sea without visits any intermediate ports.

A regular navigation is carried out only since June till October. The most favorable waterway from Kara sea to the east during this period passes through the Villisca Strait . This waterway is better than the northern waterway, which passes around Severnaya Zemlya Islands, even there are difficult ice conditions into the straight.
The northern waterway is used during the cold period (October - May) because of high monthly repeatability of Western (48-62 %) and East (31-89 %) ice-holes of Severnaya Zemlya.

In the west part of the sea during some years the Timyr ice pack blocks east approaches to the Vilkitski Strait. In this case it is recommended to cross the pack through its narrowest part, using areas of breaks and more thin ice. In the most cases shortest and easiest (on the basis of ice conditions) way to the mouth of the river Khatanga and to the port of Tiksi passes on a coastal track.
Taimyr and Anabaro-Lenskaia ice-holes are very important during a cold period of time.

Straits and islands. Marine ships sail to the gulf of Khatanga through Northern and Eastern straights, which separate the Large Bigechev island from the coast of continent. Through Northern Straight and further on SW by the gulf of Khatanga the vessels with large drafts can sail up to a parallel of Kulcha cape. The ships, which goes to the gulf of Khatanga from the east (from the port of Tiksi) as well as ships, which goes along the coast (between rivers Khatanga and Anabar) sail mainly through Eastern straight. Western part of Eastern strait is mainly shallow.

Depths, bottom contour and ground. The depths in the most parts of the Laptev Sea are a rather small and only on a continental slope near northern borders of the sea they rise sharply up to oceanic depths of the Central Arctic.

In the south part of the sea up to depths curve 100 m the bottom of the sea is underwater plain with low ridges. Down gradients of the bottom are very small here. The plain is crossed by several superficial troughs in meridian directions and being underwater continuation of valleys of the Khatanga, Anabar, Olenek, Lena and Yana rivers. The underwater valleys in the Laptev sea are well traced only on depths exceeding 20 m, as the wide strip sea base between a coast and the depth curve of 20 m is exposed to intensive smoothing accumulation of the rivers, and also ice and roughness.

A border of the continental sandbank, where the depths rises sharply to the ocean from 100 up to 1000 m and more, passes along coast of Severnaya Zemlya islands up to a parallel of the Maly Timyr island, then – to the east up to crossing a parallel 77,5° N and meridian 125° E.

The ground in the Laptev sea basically consists of oozy and sandy sediments. Pure silt and sand are rather seldom here, more often can find their mixes with prevalence one or another.

The aids to navigation in the Laptev sea are installed irregularly. Light beacons are available not on all sites of the coast, and now are transferred into category of not light up. There are many visual aids to navigation on the south coast of the sea. They provide a location of ships in a coastal area of the sea, and in the Khatanga and Anabar rivers.

The floating barrier is exposed in the top of Khatanga gulf, on the river Khatanga. There are alignments of light and not light beacons for providing shipping into the Khatanga and Anabar rivers.

A shoal of the coast of the Laptev sea, often bad conditions of visibility, and also heavy ice conditions quite often compel even coasting vessels to follow outside of visibility of the aids to navigation. Therefore major importance gets the use of satellite radio navigation systems of location of ships.

The port of Khatanga, situated on the river Khatanga, is accessible to ships depending on a level of water on a bar of the river Khatanga and on river rifts.

Once again about the Laptev Sea:

Sailing by the basic recommended waterways in the Laptev Sea, it is necessary to take into account the following:

- During sailing from west to east or in the opposite direction the ships usually have appreciable, up to 5-8 miles per day, drift to north;
- Location of the place of a ship with the help of satellite radio navigation systems is basic;

- The anchor places are available only directly near coasts;
- The approach of marine ships to the shallow water of the southern coast of the sea is a rather complicated; here it is possible to find only temporary shelter from southern winds, but not from ice, drifting from north.

Sailing from the Vilkitski Strait to the east in order to bypass of the Novosibirsk islands from the north

Ships, sailing from the Vilkitski Strait to the east (with large draft) can under the appropriate ice conditions go around of Novosibirsk islands from north by the big depths. From a point 77°45 ' N, 105°00 ' E the course of 94° conducts to the point 77°15 ' N, 138°00 ' E. Distance between these points are 460 miles.

During sailing between the above mentioned points by great circle ship can meet with heavy ice with a high probability.

The location of the place of ship at sailing on this recommended way is possible only by satellite navigation systems. The waterway for sailing from the Vilkitski Strait to the Novosibirsk islands, passes on depths from 60-100 up to 1500- 2000 m. Near the point 77°20 ' N, 138°00 ' E the course 94° lays on the depths of 30-40 m.

At course band to the south because of bad ice conditions, the ships with big drafts, approaching to a meridian of the Anisyi cape, should be afraid the banks with depth 14,2 м, laying in 45 miles to N from the cape, and especially the bank with depth 9,2 м, which is situated in 22 miles to NNW from this cape.

Further the ships usually sail between New Siberia (75°00 ' N, 148°00 ' E) and Bennetta (76°41 ' N, 148°55 ' E) islands by depths about 30-35 m.

Sailing from the Vilkitski Strait to the gulf of Khatanga.

Some years the sailing from the Vilkitski Strait along the east coast of a Taimyr peninsula through the ice-hole (behind the fast ice) is possible during the end of July - beginning of August. The sailing is carried out in 3-5 miles from the coast according to depths and draft. A width of the ice-hole is 1-2 miles or it can be as a chain of patches of ice-free water.

During the end of July – first half of August the Taimyr ice pack usually consists of one-years, and sometimes two-years hummocky ice-fields and their fragments. During compression speeding up of these ice – fields by icebreaker, as a rule, unsuccessfully. If the Taimyr ice pack is near the coasts, the sailing through this ice-hole could lead to a clutch of the ship by ice at changing winds from southern and western directions to northern and eastern.

3. THE EASTERN REGION OF RUSSIAN ARCTICA

The eastern region of Russian Arctic is situated in the polar zone (completely behind the polar circle) and has typical features common for this region: **polar day and polar night**, the duration of which depends from the latitude and the extreme hydrometeorologic conditions, including the ice condition. The waters of the Arctic Ocean and his marginal seas with the mouth of the rivers. The division into the West and East region has it historical reason, which relate to the founding of the Central administration of the NSR and the hydrographic administration of the NSR (1932 year). The boarder between the West and the East region was the meridian 125^0E. In the present report are described the part of the Russian Arctic, in which , according to the valid documents and Russian law, navigation and hydrographic services is provided by the SHD.

3.1 Borders

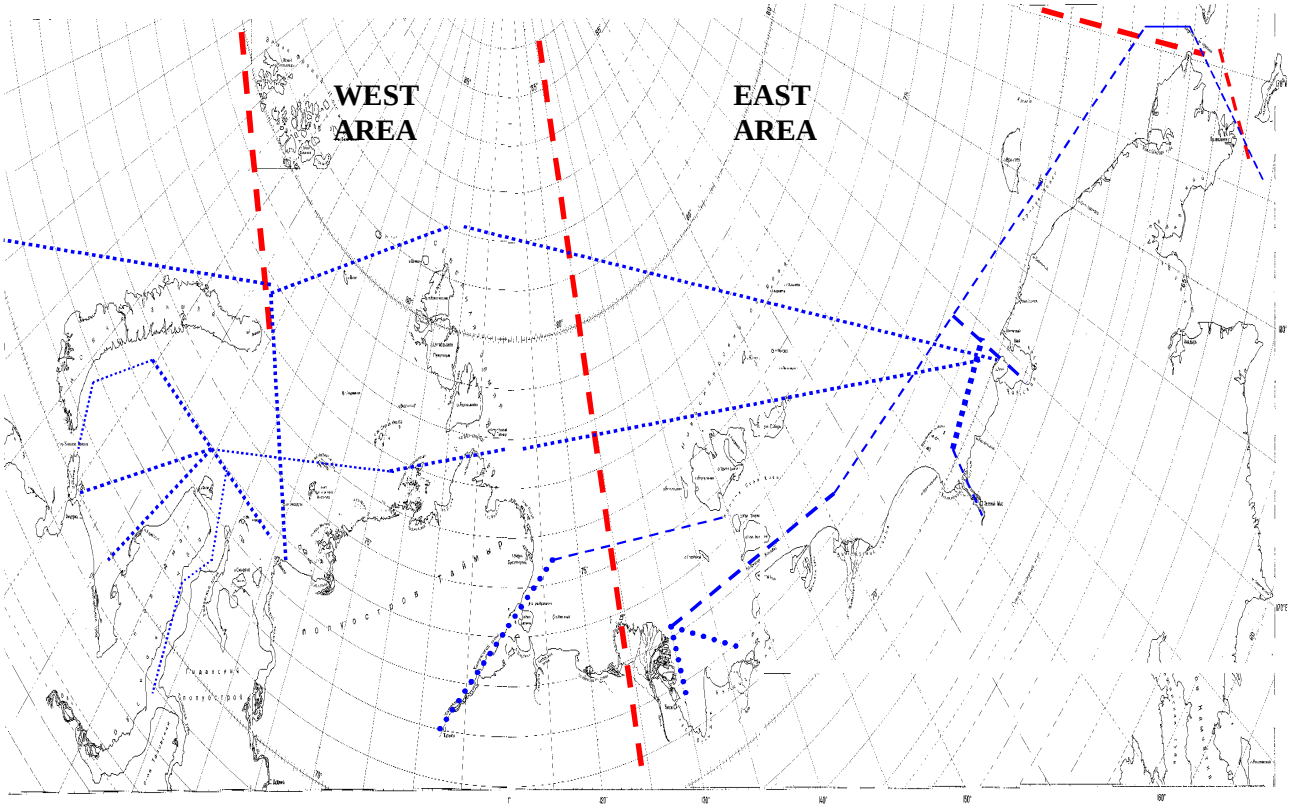

Figure. 5. The division of the basin of the Arctic Ocean into areas within the borders of the area of activity of the SHD

3.2 Western part of the Laptev Sea

According to the ice distribution the Laptev Sea can be divided in two parts, the ice condition in which has its particular features. The first region is the area of water, which lies between the Vilkitski Strait and the meridian 125° E; there is the heavy ice of the Taimyr ice field. The second region is the area of water, which lies between the meridian 125° E and islands of Novosibirsk, there is the ice of the Yansk ice field.

During the year the ice cover is changing all the time. According to the conditions of the ice cover in the Laptev Sea is divided two periods: October — May (the formation of new ice) and June — September (the destruction of ice). By the end of September the western part of the sea is cleared from ice by 50 %, the eastern part—75 %.

The ice fields of Taimyr and Yansk are most difficult for shipping in summer.

The Taimyr ice field is one of the biggest in the NSR. In the middle of July it covers nearly 70 % of the western part of the sea, in the end of September — nearly 25%. Southern part of the field is usually formatted by one-year-old ice, while the northern part consists of ice of different ages. The shipping conditions in the western part of the sea mainly depend of the square and location of the Taimyr ice field. There are three locations: western, central and southern. In the western location the Taimyr ice field is situated the whole summer near the eastern coasts of the Taimyr Peninsula and complicates the shipping between the Vilkitski Strait and the ports of Laptev Sea. In the central location the ice field is situated in the center of the western part of the sea; this location of the field is the most favorable for shipping. In the southern location the Taimyr ice field is situated in the southwest of the sea and it is quite often divided in two parts.

Thus shipping to Katanga Bay and to coast of Taimyr Peninsula for long-term time is blocked by a close ice whereas a steady break is between two parts of the ice field to sea direction.

The Yansk ice field is formatted from thick one-year-old ice, which was broken by fast ice. This ice field is situated between the mouth of the river Lena and the islands of Novosibirsk. The field is separated from the Taimyr ice field by a broad area of open ice or clear water, which appears instead of winter ice – hole. The ice of the Yansk ice field according to its characteristics differs from the ice of the Taimyr ice field. Usually, the first one is less hummocked and better capability of destruction, what makes the shipping easier. In the second half of August the Yansk ice field usually disappears, because of the thawing. Some years in the period of navigation the ice of this field can remain till the end of summer and so complicate the shipping to the mouth of the river Yana and to the straits in the area of the islands of Novosibirsk.

Shipping on the waterways from the mouth of the river Katanga till the port of Tiksi is fulfilled near the coast. In August the probability of meeting close ice is nearly 0 %. Ships, which are shipping from Kara Sea to the east, often use this waterway, because the Taimyr ice field occupies a center of the western part of the sea.

In June and July near the approach to the port of Tiksi is still the fast ice, the average thickness of which is 180—220 cm, the hummocking 1—2 marks and extension of which is 120—130 miles. Shipping in such a fast ice, especially when the depth of the strait is less then 10 m, is not available.

The shallows, which are often met in the eastern part of Laptev Sea, in the straits of Savikov and of Dmitry Laptev and on approaches to them from east and west, determine the ice conditions for shipping in the areas of: port of Tiksi — straits — mouth of the river Kolyma and port of Tiksi — river Yana. Mainly this leads to a large area of fast ice on the waterways and to increased thickness of ice in the autumn. In this region in the winter is observed the thickest one-year-old ice (till 240 cm) of natural growth on the whole NSR, a large number of ground hummocks on coastal areas of the waterway.

The choice of the best shipping route depends on the session, on the draft of the icebreakers and the ships, and on the assignment of the cargo.

For transit traffic from Kara sea to the east, without entering the ports of Laptev Sea, can be used the waterway, which is enveloping the island of Novosibirsk to the north.

FROM KHATANGA GULF TILL TIKSI BAY.

This is the region in which the big shipping rivers Anabar, Olenek and Lena flow into the sea.

In the mouths of the rivers Anabar and Olenek are situated some low lying islands. The delta of the river Lena occupies a big area between the gulf of Olenek and the Tiksi bay. The mountains here are at a distance of 90 miles from the coast and can be seen only on near approaches to the Tiksi bay.

The mouth part of the river Anabar can be used by sea ships on the length of 20 miles. The rivers Olenek, as well as canals Olenekaya and Bykovskaya of the river Lena are completely shippable. Other canals of the delta of the river Lena are not used by ships, which are going to the sea, despite the fact that their depth reaches 13-15 m, but their sandbars are carried far in the sea.

The coast is very indented. The sea part of the delta of the river Lena has many shallow bays and big shipping bays -Anabarsky and Oleninsky.

There are few populated places near the coast, some settlements and hunting huts.

The difficult for shipping in this area is mainly determined by the absence of visual reference objects on the low lying coasts; distant flat flanks of hills are bad seen even by good weather. Just same capes are good discernible. That is why the ships, while shipping near the coast, have to navigate by lighting and dark beacons.

The location of the ship by radar (for ships, which a shipping along the coast) is only acceptable in the western part of Laptev Sea.

In the eastern part by the delta of the river Lena is it nearly impossible to determine routinely the location of the ship by radar, because of the little depths the shipping there happens far from the coasts. The bad screen of some hills can not been recognized. The approach of ships with big draft on recommended coast waterways in the northeast and in the northwest side of the delta of the river Lena is very difficult.

Depths. The bottom of the sea in this area is flat and regular; this allows to detect the dangers in time by echo – sounder. Along the whole coast there are sandbanks, especially in the gulf of Olenek and in the delta of the river Lena. Depths less than 20 m are at a distance of: 18 miles from the coast of the gulf of Anabar, 40 miles to the N from the Peshany island and 90 miles to the NW from the delta of the river Lena. To the north of the gulf of Olenek there is a narrow line with depths above 20 m which extends to the south till the meridian 73°50' N. A depth curve of 20 m is 20 miles away from the eastern coast of the delta of the river Lena. Between this depth curve and the coast on a large shallow area there are many separated places with depths under 10 m.

Bykovsky fairway leads from the mouth of the river Lena, from the channel of Ispolatov to the port of Tiksi on the channel of Orto-Yuese, then along the western and eastern coasts of the Bykovsky peninsula. The fairway's depth is mainly above 4 m, and only opposite the Mamonts cape is a bank with depths of 3,7–3,8 m, which limits the shipping in low water.

The fairway is accessible by ships with draft of 2,5–3 m even when the water level is low (by set-down), when there is the average navigation water level ships with drafts under 3,5 m can pass. Ships, which draft is near to (under) 4 m have to wait for high water level (by run-up or by flood in July) to use the fairway. In the beginning of navigation period, while there is a high water level in the river Lena, the Bykovsky fairway is mainly used for entering the river by sea ships of the Arctic shipping company.

Aids to navigation. The fairway is equipped with rows of lighting beacons. On the coast of the Bykovsky peninsula there are also lighting beacons. On the fairway lighting buoy are set up.

In the mouth part of the river Lena for shipping is used the Bykovsky channel. In the spring period the river is not used by ships, because the ice breaking happens there very intensively, the water level in the time of the ice blocking reaches up to 29 m. After the flood for early cargo

delivering on the ice - hole from the river Lena into the river Anabar (with the help of icebreakers) can be used the Tymatskaya channel.

FROM THE TIKSI BAY TO THE DMITRIY LAPTEV STRAIT

The coast between the Tiksi Bay and the Dmitry Laptev Strait is located in the south-eastern part of the Laptev Sea. The length of the recommended navigating route from the Tiksi Bay to the Dmitry Laptev Strait is about 230 miles. The coastline of the south-eastern part of the Laptev Sea could be described as very meandering and its relief as very variable. A mountain-ridge with a length of 65 miles and a height of 300-400 m (on some places 600-800 m) is passing along the coast from the Tiksi Bay to the top of the Buor-Haya Bay. Often the mountainsides are high, cliffy and ranging up to the water, which makes this part of the coast good visible. From the top of the Buor-Haya Bay and further to the east the coastline abruptly became much lower and turn into a hilly tundra. Also the coastline has a large number of rivers, the main of them are Omoloy (71°14'N, 132°00'E) and Yana River. Such coast characteristic remains nearly without changes up to the Dmitry Laptev Strait. Only a little part which is bordering with the Svyatoy Nos Cape (72°52'N, 40°43'E) is mountainous and good visible. The mountain height reaches 341 m.

Moderate gulfs and bays in this region are: the Buor-Haya Bay, the Yanskiy Gulf, the Selyahsksya Gulf (71°48'N, 139°19'E), the Vankina Gulf (72°07'N, 139°39'E) and the Ebelyahskaya Gulf which juts into the coast to the south of the Svyatoy Nos Cape.

The coasts in the described region are usually uniform; there are only a few noticeable places. The ship’s radar displays only the south-western coast of the Buor-Haya Bay and Cape and the coast in the region around the Svyatoy Nos Cape well. The location conditions of the ship’s position are unfavorable in other areas because of the lower coast level.

Two ports are available in the described region. The port Tiksi and the inland water port called Nizhneyansk (71°27'N, 136°09'E).

The river Omoloy isn’t nearly used as a traffic waterway. The Yana River is used as a connection between the settlements situated directly on the river up to the town Verhoyansk.

There are a few settlements along the coasts. The biggest one is a village Tiksi. Small settlements are located in the Haraulahoyskoy Bay, the mouth of the Yana River, Selyahsksya Gulf.

Depths and sea bottom. The south-eastern region of the Laptev Sea is shallow and with an uneven bottom. On approaching this region from north the shallow waters with depth about 12-18 m are on the south. On some places the sandbanks are reducing the depth to 0,8-10 m.

From the north-eastern border of the mouth of the Lena River to the island Stolbovoy (74°05'N, 135°51'E) there are two lines with depth of 20-28 m available separated by a line with

depths of 12-15m. These lines are stretched to the south and have a width of 10-30 miles. In the area of the Stolbovoy Island the depths rises up to 40 m. To the south from these line the depths reduces. To the north there is a large area of shallow waters with depth 12-16 m and 2,5-10,2 m on sandbanks. These sandbanks generate breakers.

The coasts are sandbank like almost along the whole way from the port Tiksi to the Dmitry Laptev Strait. The greatest of them are near the peninsula Buor-Haya and in the gulfs of Selyahsksya and Vankina.

THE TIKSI BAY is situated in the southeastern part of Laptev Sea.

This bay is not very deep: 8—10 m to the east of the island of Brusnev and 6—7 m to the west of this island. The depth in the Bulunkan and Sogo bays is less then 6 m. The shallowest part of the bay lies between the island of Brusnev and the Kolychev isthmus, where in some places extends drying up underwater spit. The bottom of the bay consists of clayed silt and somewhere of pebble.

YANA BAY is situated in the southeastern part of Laptev sea, between the Buor-Haya and Shirokostan peninsulas. The southern border of the bay is the line, which connects the Buor-Haya and Datygan capes (72°15'N, 139°09'E). In the central part of the coast of the bay is situated the mouth of the Yana river.

The coast of the bay is low-lying and the western part of it is less indented. The coast is mostly full of sandbanks; they mainly consist of some sorts of clay with a layer of fossilized ice. Also the coast of the western part of the bay is an alternation of earth abrupt or taluses with plots, which gently leads to the water.

The shipping in the Yana River goes through the channel Main riverbed. A sandbank with depth of 1,5—1,7 m hinder sea ships from reaching the port of Nizhneyansk. That’s why offshore cargo handling of ships is carried out here.

The localization of the ship in the Yana bay by radar, by limited visibility, is mainly difficult, because of the low-lying coasts. Starting from the center of the bay the approach to the coasts with the radar is safe, because of the gradual decrease of depth, although it is necessary to sound the depth. To define the distance to the coast from more then 15 miles is favorable only near the island Makar and in an area to the west of the delta of the Yana river, there extends a low abrupt.

The depth in the bay is mainly little, but on approach to the bay the depth reaches 17 m. To the coast it gradual decreases. The irregularities of the bottom (outside of the depths curve of 10 m) are situated only on approach from N to the northeastern part of the bay.

Sailing from Vilkitski strait to Sannikov strait

Depths in western and middle parts of this area are 40-80 m. Approximately on a meridian 132 ° E to the north from shallow water Semenovsky the depths are sharply reduced down to 13-20 m. At the left remains a bank with depth of 9,2 m, which is situated 67 miles to SW from cape Northern. The breadth of the area of shallow water on this waterway is about 50 miles. To the east from the specified shallow water the depths increase up to 30 m. Then they gradually decrease in the direction of the entrance to Sannikov strait.

The entrance to the Sannikov strait is well identified by the lighting beacon of Sannikov and by the constructions of the polar station Sannikov strait, and by radar on a range scale 15 miles - by southwest coast of Kotelny island.

Sailing from Vilkitski strait to Dmitri Laptev strait

Ship can sail to Dmitry Laptev strait Depending on the ice conditions in middle and eastern parts of Laptev sea ship can sail to Dmitry Laptev strait by two ways: leaving Stolbovoy island either to south or to north.

The first way is recommended waterway for sailing to Sannikov strait.

The second way is the waterway recommended for sailing to the Tiksi bay. In this case ships should not sail to the south in order to keep clear of Ostantsovaya bank and shallow water West (73°10'N, 133°02'E).

Location of ship is carry out by radar by the mountains raising near capes Kigilyah and Svyatoy Nos. These mountains can be found by radar by a range scale of 30 miles and more (in case of no noise).

WESTERN COAST OF NOVOSIBIRSK ISLANDS

The Novosibirsk islands, consisting of several groups, lay on the border between Laptev Sea and Eastern - Siberian Sea. The islands of Big Lyakhovsky, Small Lyakhovsky and Kotelny bound the Laptev Sea from the east. The islands of Stolbovoy (74°00'N, 136°00'E) and Belkovsky (75°34'N, 135°46'E), which is also part of the Novosibirsk islands, completely lay in eastern part of Laptev Sea. Other of the Novosibirsk islands, which are situated in the Eastern - Siberian Sea, and coasts of the islands of Big Lyakhovsky, Small Lyakhovsky and Kotelny (except their western parts) as well as Dmitry Laptev and Sannikov straits, are described in the Sailing directions of Eastern - Siberian Sea (№ 1119).

Coasts of the islands Stolbovoy, Belkovsky and western shores of the Lyakhovsky islands are not indented coastlines.

Western coasts of Kotelny island is more indented; there are bays, small gulfs and lagoons

here. Some of them are suitable for anchorage, in particular Stakhanovtsev of Arctic gulf (75°47'N, 137°29'E). A lot of small rivers, which are flowing down from western coasts of Lyakhovsky islands, Kotelny island and Stolbovoy and Belkovsky islands, are a rather shallow also not navigable.

There are some polar, fishing and hunting stations on the west coast of the Novosibirsk islands. There are also some log huts where hunters and fishermen live all-the-year-round.

Conditions of sailing at sea on approaches to the Novosibirsk islands from the west are a rather favorable in case of using satellite navigation systems. A regular and in time sounding of depths can notify about approaching a vessel to hazards.

Depths and a bottom contour. The depths in the Laptev Sea near Novosibirsk islands are irregular. There is a big shallow water with banks of 0,8 – 11 m. This shallow water bounded by the depths curve of 20 m and located between meridians 132 ° and 135 ° E and parallels 72°20 ', 75°50 ' N.

The centre of this shallow water is Semenovskoe shallow water (74°10'N, 133°40'E) where Vasilevskay and Semenovskaya banks depths 0,8 -1,0 m are situated.

The eastern boarder of the shallow water is from 6 to 14 miles from Stolbovoy island, and from 27 to 50 miles – from Belkovsky island. Into the area between Stolbovoy Island and Sannikov strait among depths of 15-18 m is very narrow gutter with depths more than 20 m.

In the middle part of Zarya channel between Belkovsky and Kotelny islands and Boiler the depths are more than 20 m.

To the north of the western part of Novosibirsk islands the depths slowly increase up to a parallel 79 ° N. Then they sharply increase, which is usually for a continental slope.

3.3 Straits.

3.3.1 Dmitry Laptev Strait.

The Dmitry Laptev Strait is separating the Bolshoy Ljahovshiy Island from the mainland. The west border of the strait is a line connecting the capes Svyatoy Nos (72°52′N, 140°43′E) and Kigilyah (73°21′N, 139°52′E), and the east border: a line connecting the mouth of the Kondratev river (72°40′N, 143°45′E) and the Shalaurova Cape (73°13′N , 143°37′E).

The coasts are raised above the sea level, abrupt and indented with ravines. On some places they are border with sandy-argillaceous or pebbly beaches. The mountains on the capes Svyatoy

Nos, Kigilyah and on the southern coast of the Bolshoy Ljahovshiy Island are very useful landmarks in the strait.

Covered anchorage palaces are missing.

If approaching the Dmitry Laptev Strait from east and during the navigation through the strait it is necessary to use the recommended navigating routes and systematically to locate the position of the ship using the global positioning systems.

Depths and sea bottom. The depths in the Dmitry Laptev Strait are uniform, usually 12-15m on the centre line of the strait, which are 14-18 miles width. On some palaces the depths are up to 16-17m and 6.6-7.8m on sandbanks.

A vast area with depths below than 10 m is located on approaching of the Dmitry Laptev Strait from east (between the meridian 146° and 148° E). The shallow water near the mainland (east from the Merkushina Strelka Peninsula) joins with the shallow water which extends from the Bolshoy Ljahovshiy Island far to the east. As a result we have now a bridge between these shallow waters with depth under 10m and width about 30-40 miles. The width centre is located near the meridian 73° N.

The *sea stream* in the Dmitry Laptev Strait is usually flowing along the centre line and is mainly depending from the winds in the adjoining areas. If the wind over a long period of time blows from south or east, the sea stream is directed to the west, otherwise to the east. The flowing speed is varies from 0,2 to 1,3 knots. The flowing direction changes fast after the wind direction change.

The SOUTH COAST OF THE DMITRY LAPTEV STRAIT ranges from the Svyatoy Nos Cape to the mouth from the Kondratev river and is called Ojogosskiy Yar. Nearly over the whole length this coast is abrupt and border with sandy-argillaceous and on some places with pebbly beaches. The coast altitude behind the beaches is 10-30 m. Through this indented with ravines coasts, a lot of rivers and streamlets had found their way into the strait. The gentle hills are located on the inland, stretches along the coasts and became smaller to the east. Here and there hunting huts and “floating” objects could be faced on the coast.

The Svyatoy Nos Cape is the entrance to the Dmitry Laptev Strait from south-west. It was formed by abrupt mountainsides which peaks are located to the south-east from him. Under good weather conditions the mountains could be seen before 55 miles from the Dmitry Laptev Strait and on the radar display before 50 miles.

The Svyatoy Nos lightning beacon is places 1,2 miles to the east form the Svyatoy Nos Cape and could bee seen only from the north-west direction and from the Dmitry Laptev Strait.

The NORTHER COAST OF THE DMITRY LAPTEV STRAIT is the southern coast of the Bolshoy Ljahovshiy Island, which is abrupt over its full length. In the region of the Kigilyah Peninsula the mountain peaks are flat and the mountainsides have a great number of large kekurs. The coasts are cliffy, abrupt and vertical. Further to the east up to the mouth of the Dimnaya river (73°14,5′N, 142°21,0′E) the sandy-argillaceous coast are breaking-up, abrupt and with fossilized ice coming out.

The approaching to the coasts is allowed by boat only and only in the mouth's of rivers because of the often avalanches in this area. From the Dimnaya river to the Shalaurova Cape the coast became stonier with fewer abruptions. The mountainsides are covered with tundra vegetation and coming up right to the water (more often than before). The sandy and pebbly beaches are just a little above the sea level where "floating" objects could be found. The coasts are sandbank like. But boats with a draught up to 1,2 m could approach closely the coast near the rivers and streamlets mouths.

The Kigilyah Cape (73°21′N, 139°52′E) is the south-western end of the raised above the sea level Kigilyah Peninsula, which itself is standing out from the Bolshoy Ljahovshiy Island. It is also the north-west cape on the entrance to the Dmitry Laptev Strait and good visible because of the mountain Malakatin-Chokur. On the radar this mountain is displayed from a distance of 27-30 miles if approaching from south-west.

SAILING ALONG THE DMITRY LAPTEV STRAIT.

The Dmitry Laptev Strait is navigable for ships with a draught up to 9 m by an average sea level. The possibility to locate the position of the ship with usual navigation methods is limited.

The *conditions of orientation and using of the ship's radar* in the Dmitry Laptev Strait are satisfactory. On the northern coast they are better than on the southern. If approaching the strait from the west the mountains in the area near the Svyatoy Nos Cape are displayed on the ship's radar from 50-55 miles. From 27-30 miles the mountains on the Kigilyah Peninsula are displayed.

3.3.2 The Sannikov Strait

The Sannikov Strait is separating the Ljahovshiy Islands from the Andgu Island.

The western border of this strait is a line connecting the capes Vaigach (Maliy Lyakhovsky Island) and Medvezhy (Kotelny Island). The eastern border is a line between the capes Shalaurova (Bolshoy Lyakhovsky Island) and Nadezdy (74°44′N, 149°46′E).

The coasts of the Sannikov Strait are low and badly visible. Only the coasts of the islands Maliy Ljahovshiy and Kotelny are visible from the middle of the strait in the west. Because of the restricted visibility in the strait, it is necessary to use the ship's radar more often.

If approaching the Sannikov Strait from east and during the navigation through the strait it is necessary to use the recommended navigating routes and systematically to locate the position of the ship using the global positioning systems.

Because of the bad ice conditions it occurs quite often that the ships have to use a navigating route different from the recommended and as a result to navigate on the minor depth. I this case it is more dangerous to choose the northern side for navigation because of a great number of sandbanks. Therefore if navigating on the Sannikov Strait in both directions it is absolutely necessary to undertake all safety measures.

Some hunting huts could be found along the coast.

Depths and sea bottom. The depths in the western part of the Sannikov Strait reach 33 m. To the east they are getting gradually lower up to 11-15m. There leads a passage with a width of 16-18 miles and a depth more than 13 m along the Sannikov Strait. On the outside of this passage (to the coasts) there are sandbanks with depth of 4-10 m available. In the eastern part of the strait, to the north of the passage and along his centre line there is a vast sandbank. The length of this sandbank is 45 miles and the depth 8-9.8 m. A great number of sandbanks could be found near the southern coast of the Novaya Sibir Island. These banks are situated ridge like in an area with a length of 15 miles. A large sandbank with a length up to 35 miles and depth less than 6 m exists to the east from the Bolshoy Ljahovshiy Island. Depths of around 13-15 m are near the eastern exit of the Sannikov Strait. The bottom in the strait is silt or sandy-silt.

THE SOUTHERN COAST OF THE SANNIKOV STRAIT. From south the strait is bordered by the islands Bolshoy Lyakhovsky and Maliy Lyakhovsky, which are separated by the Eterikan Strait. The coast of the Maliy Lyakhovsky island from the Vereshagina Cape to his south-eastern end (74°00′N, 141°00′E) is hilly tundra smoothly rising to the centre part. The coast is also indented with ravines from which small rivers are flowing into the strait. In the river mouth's and on low situated places floating objects could be found. The islands coasts are sandbank like. The biggest banks are located in front of the entrance to the Eterikan Strait (when approaching from east) and between the capes of Beregovoy and Shalaurova (Bolshoy Ljahovshiy Island).

THE NORTHERN COAST OF THE SANNIKOV STRAIT. From north the strait is bordered by the islands Kotelny, Zemlya Bungre, Faddeevskiy and Novaya Sibir. The coasts of the Kotelny Island are raised above the sea level and good visible. The height of the mountains in the south of this island is more then 200 m. The coasts of other islands, especially of the Zemlya Bungre Island,

are low. These coasts are located far to the south not visible from the navigating channel through the Sannikov Strait.

. The coasts of the islands Zemlya Bungre, Faddeevskiy and Novaya Sibir are sandbank like and have a great number of risks. Approaching to these coasts is only possible on some places and up to a distance of 1-2 miles and sometimes 3-5 miles. In this case the crew should make conform of the ships draught.

3.4 Eastern-Siberian Sea

General information. Eastern-Siberian Sea is one of the seas of Arctic Ocean. It washes against eastern part of the Russian Arctic coast. In the west the sea is limited to Novosibirsk islands; Dmitry Laptev strait and Sannikov strait connect it with Laptev Sea. In the north Eastern-Siberian sea adjoins to the central polar pool of Arctic Ocean. In the east the sea is limited to Wrangel island and connected with western part of Chuckchee Sea through the Long strait.

Northern border passes on margin of a continental shelf from point 79°N, 139°E up to point 76°N, 180°E.

Eastern border goes from the parallel 76 ° N on the meridian 180 ° up to Wrangel island, bending around it from the west and further through Long strait to cape Yakan.

For the first time materials on the Sailing directions of the Siberian sea (so was called then East Siberian sea together with Laptev sea) have been published in the Sailing directions of a northwest part of Eastern (Pacific) ocean, part IV, edition of 1909. Then in additions to this sailing directions materials of works of hydrographic expedition of Arctic ocean (on ships "Taimyr" and "Vaigach") positioned: for 01.01.1912 - from cape Yakan up to mouth of the river Kolyma and for 01.01.1914 up to Dmitry Laptev strait. The first Sailing directions of East Siberian Sea has been made by I. A. Kireev and published in 1939. Further she was supplemented and reprinted in 1946, 1953, 1959, 1964, 1970, 1978 and 1990. Last edition is the ninth.

Conditions of sailing in Eastern-Siberian Sea for ships are complicated due to shallow water, a weak level of scrutiny (except for a coastal area), often mists in the summer period and almost constant presence of a close ice.

The choice of a route in a near-shore area is determined by presence of ice and depths dangerous for sailing, and in areas of the open sea depends on unity of ice and presence of the depths dangerous for sailing.

The choice of route in depends of ice conditions, determining of an opportunity of

independent navigation, organization of icebreaker assistance (alone or in group) and aviation ice reconnaissance, the surveillance of supplying to ships with necessary ice, hydro meteorological and navigational data is performed FAMRT. The detailed statement of organization and all kinds of providing of marine operations, no less than features of sailing in ice, is resulted in the Guidelines for ships sailing through the Northern marine route (№ 4151).

The location of the ship in Eastern-Siberian Sea is possible by using the satellite navigation system. Landfalls for implementing offshore cargo operations in points of temporary loading-unloading of ships can be supplied in necessary cases with special navigating tools (equipment) by SHD under the contract.

Conditions for location with the help of the radar station in East Siberian Sea are rather various. In Dmitry Laptev strait conditions of a radar-tracking location are satisfactory, especially at its northern shore. In Sannikov Strait the radar station can give the common alignment only in western narrow part of the strait. At sailing from Dmitry Laptev strait up to mouth of the river Kolyma, performed far from low shores to take advantage of the radar station it is possible only near the Bear islands. For a reliable location of a vessel by the radar station it is possible to use almost all shore to the east of a river mouth Kolyma up to Ayon island, a part of shores of Chaun bay and, behind some exception, mountainous coast from port Pevek up to cape Yakan. Here the Bear islands, and from Novosibirsk islands - an island New Siberia and, in particular, De-Long islands are most suitable for a location with the help of the radar station.

On the majority of marks fixed radio-locating passive reflectors, which depending on a relief of ambient district and other conditions (a construction of a reflector, heights of installation) are find out from 8-16 miles.

On some marks fixed recons-respondents which are find out from 15-22 miles.

Depths, bottom contour and bottom. Eastern-Siberian sea is shallow, as is located within the limits of the Siberian continental shelf. The bottom contour it is possible to share into two parts: western - shallow-water and eastern - deepwater. The bottom of Eastern-Siberian sea is evenness equal and also has a smooth down gradient to north-east. However the different sea areas have some dangerous.

The isobathic line 10 m in western part of the sea passes in 10-45 miles from a shore of continent. In eastern part of the sea this isobathic line comes nearer to the coast on 1-2 miles, and only at Ayon island , cape Aachim, mouth of the river Pegtimel and cape of Billings it leaves on 3-7 miles from a shore.

The isobathic line 20 m in western part of the sea passes between islands of Anjou and De-Long islands. To the east of Novosibirsk islands it considerably leaves from a shore of continent in

a direction of Ayon island. In eastern part of the sea the isobathic line 20 m passes in 2-8 miles from a shore. From the depth curse of 20 m to the open sea a depth of the water gradually increase up to 100 m and at northern border of the sea the continental slope begins.

Buttom in Eastern-Siberian sea is mainly the silt. In a near-shore area approximately within the limits of an isobathic line 10 m almost everywhere a bottom is the sand. The rocky bottom is spread north-eastern of islands Genriett and Ayon, and also at shores of Pevek strait and in area of capes Big Rams and Shelagsky. To north-east from island Ayon there is places with gravel bottom.

At sailing in areas where the detailed regular measurement is not effected, or there where on maps uncertain isobathic lines are shown, it is possible to meet depths less shown on maps, therefore here it is necessary to be careful.

Aids to navigation (AN) in Eastern-Siberian Sea are located irregularly. The basic kind of visual AN, ensuring sailing along shores, is lighting beacons. It is least supplied with visual AN sea bar area from Novosibirsk up to the Bear islands where routinely the ships pass outside of visibility of a shore. Here is present some lighting and dark beacons. In the Sannikov Strait the lighting beacons are established only in his narrow western part. At sailing in the middle of Dmitry Laptev strait ships go outside of visibility of the lighting beacons. In the area of the Bear islands the visual AN ensure sailing of the ships both to the north of them, and on the Melechova and the Kolyma straits. There are enough visual AN on the approach to the mouth of the Kolyma river. From the mouth of the Kolyma river up to port of Zelenomyssky sailing is ensured by row of lighting beacons and buoyant prevention marks exposed on system MAMS (region A).

From a Kolyma river mouth up to port Pevek sailing near to the shore is ensured by lighting and dark beacons. Visibility of lighting beacons is about 10-15 miles here. The approach to the port of Pevek is ensured with lighting beacons and row of lighting beacons. There are enough lighting beacons on the coast from Shelagsky cape up to Yakan cape.

Because in the Eastern - Siberian sea during one third of navigation period the restricted visibility (a mist, rain, snow) predominates, which excluding usage of visual **AN**, as well as because of the shallow water is near the western coast of the sea, the satellite navigation system have major importance.

All navigation equipment in Eastern - Siberian Sea operates only during a navigation period. Information about their putting into operation and stoppage pf the operation are given by Navigation Warning Service of East. The full data of navigational equipment are located in Guidelines « Lights and marks of Northern marine route » (№ 2111), « Radio technical means of navigational equipment of Northern marine route » (№ 3111).

Ports and anchor berths. Port of Pevek (69°42′N, l70°l5′E) is on the coast of Eastern - Siberian sea. It is located in Pevek strait before entrance to Chaun bay. There are some berths with water depths up to 9 m in the port. The harbor area is not fully protected from drifting ice, but due to Big Routan island it is protected from heavy waves. The anchoring berth in the port of Pevek is uncomfortable for use because of ice, which appears sometimes, and local wind “southern” blowing quite often with storm force.

On the river Kolyma is the main delivery point of cargoes for domestic areas of the Magadan area – Zelenomyssky maritime port (68°48′N, l6l°22′E).

There are protected form ice anchor berths near island Chetirechstolbovoy (the Bear islands) and island Shalaurov (before the entrance into the Aachim bay.

In other places of Eastern-Siberian sea anchor berths are completely opened also anchoring on them is restless, especially because of ice. At strong winds it is possible to be defended only at lee coasts. Anchoring between Novosibirsk and Bear islands where shallow waters do not allow to go out even on their visibility is especially unfavorable. Here it is necessary to become on an anchor in the open sea on shallow depths. Anchorage of marine ships is possible at mouth of the river Indigirka only out of coast visibility.

Pilotage service. The pilotage duty of sea-going vessels is performed on the river Kolyma from a mouth up to settlement Chersky by pilots of the Kolyma hydrographic base.

In port of Pevek port’s pilots provide assistance for sea-going vessels.

Hydro meteorological conditions. Eastern-Siberian Sea is one of the most shallow-water Arctic seas of the Arctic Ocean. There are difficult hydro meteorological conditions for shipping in the sea like in all other Arctic seas. The basic obstacle for sailing is ice. Ice conditions during navigation period are stipulated mainly by the location and sizes of Ayons ice file.

Sailing is complicated also with the big repeatability of a cloudy sky and often mists.

Under favorable ice conditions threat for sailing ships their ice accretion presents, the most intensive in the second half of September and the beginning of October.

In shallow-water areas danger to ships is presented with significant fluctuations of depths because of strong positive and negative setup of water level. First of all it concerns to Sannikov strait and Dmitry Laptev strait, and also to bar sites of the rivers Indigirka and Kolyma.

Fluctuations of water level and tides. Fluctuations of water level in Eastern- Siberian sea are assembled basically from tides and positive and negative setups. In the greater part of the sea predominate fluctuations of water level caused by positive and negative setups.

The tides are caused by a tidal wave from the Central Arctic pool and a tidal wave going from Chuckchee Sea through the Long strait. The tides in the Eastern - Siberian Sea are semi-diurnal.

The mean value of a spring tide in the navigation period in the greater part of the sea does not exceed 0,3 m, at coast of continent it makes 0,1-0,2 m. In area of Long strait and at Wrangel island a mean value of a spring tide of 0,6-0,8 m, and at northern shore of an island New Siberia of 1,6 m.

The mean value of a neap tide in 2-2,5 times is less than spring range.

Positive and negative setups are a rather big in the Eastern - Siberian Sea. The size of them achieves 2-4 m. In the rivers these setups are spread to the big distances upwards on the river. For example, in the river Kolyma they are watched after Michailovsky channel, 40 miles above a mouth.

Currents. Summary currents in this area are assembled from constant, wind and tidal currents.

The maximal velocity of summary currents in the open sea 1-1,5 knots, in a near-shore area 1,5-2 knots. In Eastern-Siberian Sea and his straits in the navigating period (August - September) at determined meteorological conditions currents which velocity in 1,5-2 times is more than the velocities above mentioned can be marked.

From Sannikov strait and Dmitry Laptev strait up to the Bear islands when floating on the basic recommended route is impossible, it is necessary to go on depths of 9-10 m between Novosibirsk islands and a Kolyma river mouth, being held from a shore in 25-55 miles. Ships with draft up to 4-5 m at sailing from the port of Tiksi to the river Kolyma routinely follow from Dmitry Laptev strait up to the Kolyma strait on a coastal shallow water in 6-10 miles from a shore, adhering to depths of 6-7 m and being guided on navigation marks and radar reflectors. There are less stranded hummocks in the western part of Eastern - Siberian Sea than in eastern. Because the Novosibirsk ice file is usually consists of one-year-old poorly hummocky ice, which freely drifting on any depths down to depths of 2-3 m, it is impossible to find out sharp changes of depths by the appearance of ice.

From the Bear islands up to the Kolyma river mouth in conditions when the close ice pressing to north-east shores of the Bear islands, is routinely kept an opportunity of sailing through Melechov strait and Kolyma strait on the basic recommended routes specified in the table.

In the Kolyma strait the ice it does not happen usually even within with unfavorable ice circumstances.

Passing on straits between the Bear islands, it is convenient to be guided on precise displays of islands on the screen of the radar station.

From the Bear islands up to cape Shelagsky within with unfavorable ice circumstances sailing on the basic recommended routes becomes impossible. For the ships going without call in the river Kolyma, it is necessary to follow from the Bear islands in a direction on cape of Letyatkin or Big Baranov. If on these courses ice nevertheless will meet, it needs to be left to the north and the east, evading aside shores as far as depths will allow.

Routes along a coast of the continent to the east from a mouth of the river Kolyma lay, being conformed to ice circumstances and draft of the ship. The coasts near capes here are deepened, but near the mouths of the rivers and at low sandy shores can find small sandy silt or pebbly banks which are recommended to be bypassed always from sea side.

The sea bar that is deviate from the northern shores of Ayon island, is most removed from a shore on all route between the Kolyma river mouth and cape Shelagsky. To bypass it follows in 7-8 miles from a shore on depths of 10-20 m; it is frequently blocked by a heavy ice, and sailing here becomes possible only with the help of the icebreaker.

To locate a vessel on a site from the Kolyma river mouth up to cape Shelagsky at good visibility it is possible on marks and natural reference points which on this coast it is a lot of. In a restricted visibility at sailing in area of banks between mouths of the rivers Small Baranicha and Rauchua it is recommended, if there is no confidence of an observation on the radar station, to depart further from the shore or to suspend traffic before improvement of circumstances. At sailing to the east of Rauchura river it is necessary to remember, that in 16 miles to north-east from her mouth among depths of 11-13 m there are some raises of a bottom with rather complex relief; depths on them up to 9,8 m.

From cape Shelagsky up to cape Yakan. Conditions of sailing on coastal ice holes here more difficult, than to the west of cape Shelagsky. No-bottoms between cape Shelagsky and Shalaurov island at strong northern winds promote gathering of a heavy ice at the shore. Occurrence the big (on extent) coastal ice holes within years with strong ice infrequently here. At some rarefaction of an ice holes are superimposed by fragments of an almost impassable hummocked ice, and their overcoming needs the help of icebreakers.

To the east of Shalaurov island the condition for formation of coastal ice holes are more favorable, but a shallow water in area of cape Aachim and against delta of Pegtimel river strongly complicates sailing. It is recommended to bypass this shallow water on depths more than 15 m on distance not less than 4 miles from a shore. In the same offshore distance on depths about 15 m it is necessary to bypass the banks in area of cape of Billings as no dangers were found further from sea side.

To the east of cape of Billings a bottom more regular and a shore less deepened, that promotes gathering along him patches stranded hummock and to rise significant on extent of coastal ice holes. Observations near to this shore are supplied with sufficient figure of navigation marks with radar reflectors.

The low shore between capes Enmytagyn and Yakan is mapped on the screen of the radar station only from close distance. Coastal elevations though give strong echoes on the screen, but are identified hardly.

Navigation to Wrangel Island. In some years the ice circumstances in the Eastern-Siberian and Chuckchee seas are sum up so, that it is necessary to direct ships for an exit to Bering strait around of Wrangel island from the north or from the south. Rare visual reference points do not allow to determine constantly a place of the ship. Sailing around of Wrangel Island begins usually from area of cape Shelagsky. Wrangel island is bypassed from the west and the north on depths of 20-30 m in 10-15 miles from a shore.

At sailing in area of cape Florens (71°13′N, 178°54′E) it is necessary to be careful for bank with the depth of 4,1 m located in 8,6 miles to the north from this cape.

In especially heavy in the ice attitude years when coastal ice holes at continent almost do not happen, are sometimes formed big patches of ice-free water at southern coast of Wrangel island. In this case the ships from Eastern - Siberian Sea to Chuckchee Sea sail from cape of Billings or from cape Yakan to cape Blossom (Wrangel island). Approximately in 5 miles to the south from cape Blossom on depths about 20 m the ships turn to the east and, adhering to an isobathic line of 20 m, go to the Chuckchee Sea.

3.5 Western part of the Chuckchee Sea, Bering Sea and Bering Strait.

General information. The following review contains information about the western part of the Chuckchee Sea from the Yakan to the Unikin Cape including the islands of Wrangel and Gerald,

the Bering Strait with its islands and the western coast of the Bering Sea from the Kriguigun to the Stoletiya Cape.

The Chuckchee Sea is a bordering sea of the Arctic Ocean and completely located on the continental terrace to the north Asia and America, bordering the coasts of Russia and USA. This sea is shallow. The prevalent depth is about 40-50 m in the Long Strait and only in the north part they are reaching 200 m. Because of the fast ice and the floating ice, the ships usually have no choice of the navigating route.

The sailing directions for the Chuckchee Sea and the Bering Strait where first made in the Hydrographic department called Glavsevmorput and publicized by the Hydrographic department of the Russian Naval Forces in 1938. Sailing directions were also publicized in 1943, 1950, 1957, 1964, 1970 and 1980. In 1993 sailing directions for the south-western part of the Chuckchee Sea, Bering Strait and the north-western part of the Bering Sea were published and in 1994 for the north-western part of the Chuckchee Sea. The last publication is the ninth one.

Coasts. The south-western coast of the Chuckchee Sea is formed from the branches of the Chuckchee or Anadyr mountain ridges. The height of the central mountain ridge which is located 80-100 miles away from the coast reaches up to 2000 m. The mountains near the coast are from 300 to 700 m high.

Over a length of about 300 miles, between the Yakan and the Heart-Stone Cape, the northern branches are 10-30 miles away from the coast. This coast is belonging to the lowlands of Valkarkaisk and Vankaremsk. Nearly continuous a chain of lagoons is passing long the coast, separated from the water by low pebble-sandy lines. All lagoons are shallow. The entrance to some of them is not possible by boats with a draught under 1 m.

The capes of Otto Smith, Onman, Dgenretlen and Heart-Stone and also some mountain peaks which are stepping forward in the sea are visible from 5-10 miles. But when moving away from the coast they disappear on the background of much higher mountains on the inland. These mountains have smooth, uncharacteristic shapes.

The western coasts of the Bering Strait from the Unikin Cape on the north up to the Kriguigun Cape on the south are preferred hilly and abrupt except the low-lying regions near the lagoons Inchoun and Uelen. To the south of the Uelen lagoon there is a valley separating the mountain range in the area of the Dezhnev Cape from mountains located westerly. Because of this valley the mountain range near the Dezhnev Cape is visible from far away, and from north and south they are looking like a high island.

The north-western coast of the Bering Sea from the Bering Strait to the Provedeniya Bay is hilly and usually abrupt. The mountain ridges are coming forward to the sea and forming single

array of rocks, which are separated by narrow valleys of mountain rivers. In a region located to the south of the Mechigmensk Bay the mountains 13-16 miles away from the coast. This place is filled by lowland with two lagoons. Besides of some mountain peaks the north-western coast of the Bering Sea some other locations are well visible. These locations are the capes of Kriguigun, Martens, Chuckchee, Lysaya Golova, Lesovskoy and Stoletiya.

Straits and Islands. The greatest straits in the described region are the straits of: Long, Bering and Senyavin. The Long Strait is located between the mainland and the Wrangel island. The Bering Strait is separating Asia and North America. The Senyavin Strait is located between the south-eastern coast of the Chuckchee peninsula and the islands Arakamchechen and Ittigran. These straits are navigable by ship without any draught limits.

Islands in the Chuckchee Sea are very rare. The biggest of them is the Wrangel island, located near the west border of the Chuckchee Sea. The rocky Gerald Island is located to the east of them. The islands Kolyuchin, Karkarpko and Idlidlya are located near the northern coast of the Chuckchee Sea. The Kolyuchin island is the biggest of them.

In the centre of the narrow part of the Bering Strait a group of rocky islands called Diomida are located. Near the north-western coast of the Bering Sea there are two big and four small islands situated. The big are the islands Arakamchechen and Ittigran, and the small the islands: Nuneangan, Achinkinkan, Merkinkan and Kinkay.

Depths and sea bottom. The Chuckchee Sea is located in the area of continental terraces with little inclination to the north. The central part has depth about 40-50 m. To the north the depths increases up to 200 m.

Approximately along the meridian 175° W the continental terrace is crossing an underwater valley which extends from north to south until the parallel 70° N. The depth in the south part of this valley are about 60 m, and to the north of the parallel 72°30′ N they are more then 100 m.

There are only few risks for navigation in the Chuckchee Sea. There is a sandbank about 185 miles away to the north-west from the Vankerem Cape. This bank is called Gerald Bank and has a depth of 11,4-18,8 m. Near the coast of the Wrangel Island are banks with depth 1,4-4,1 m available.

The Bering Strait has a depth of 40-50 m. The sea bottom increase near the northern border of the strait up to 23-25 m. The depth near the Asian coast of the strait is deeper then near the American.

The navigator could meet up depth less then they were shown on the chart. This could happen in navigating areas: if a systematical detailed bottom survey wasn’t made, the depths are

inauthentic, or if the isobaths (depth curve) are breaking or insufficiently surveyed. In these cases the navigator must be cautious.

Special physiographic effects. To the Special physiographic effects in the Chuckchee Sea belongs the polar day and night which are determined by its geographical location (to the north of the polar circle). The duration of the polar day and night are 42 and 40 days on the latitude 68° N, and 97 and 91 days on the latitude 74° N.

Aids to navigation. There are enough visual aids to navigation in Chuckchee Sea, Bering Strait and northwest part the Bering Sea.

Aids to navigation here are lighthouses with a visibility of lights from 14 - 20 miles and lighting beacons with visibility of lights mainly 8 - 14 miles and in some cases - from 2 to 7 miles. This equipment is installed in rather regular intervals on the coast of continent and they provide navigation during dark time along the coast from Yakan cape up to the port of Provideniya. There are a row of lighting beacons in order to provide entrance into the port of Provideniya.

There is no floating boom in the Chuckchee Sea, and in the Laverty gulf and Tkachey and Provideniya bays are installed some lighting buoys and marks.

The following radio means of aids to navigation are here: passive radar reflectors and recons, installed on navigation marks.

The passive radar reflectors are installed on navigation marks into the areas where radar-tracking display of a low shore does not allow to identify a place reliably.

Conditions of a radar operation for fixing ship's location near coast of Wrangel island are favorable as a whole, except the northern coast. A navigator can evaluate a distance to the island approximately by a reflection of the tops of the high mountains.

The using of radars for fixing a ship's position during the sailing along the coast of Chuckchee Sea from Yakan cape up to Heart-Stone cape is complicated with presence of the big numbers of low coasts, which can be found by radar only from a close distance. To the east from the Heart – Stone cape up to Bering strait and further to the south up to Provideniya bay the conditions of orientation by radar are more favorable. High and abrupt coasts give here the precise view which is well corresponds with their outline on a chart.

Ports and anchor berths. There is a port of Mys Schmidt in the Chuckchee Sea and at the northwest coast of Bering Sea a port of Provideniya is situated.

Into the Chuckchee Sea and Bering Strait ship can anchor along all coastlines, except places where rookeries of marine animals are located.

At Wrangel Island anchor berths are located near the entrance into Rogers bay, into Dragi bay and Krasin bay.

Settlements are available along all coasts. Usually the settlements consist of 50-80 small constructions. There are some bungalows and service constructions of polar stations among them. The settlements of Uelen, Lorino, Lavrentiya and urban village Provideniya are biggest from them.

Polar stations are situated at Otto Schmidt cape Otto in Rogers bay (Wrangel island), in Vankarem and Netten capes, in the settlement of Uelen, on Ratmanov island and in the settlement of Ureliki (Provideniya bay).

Asiatic coasts of Chuckchee Sea and Bering Sea are part of Chuckchee autonomous region. The administrative centre of the region is the city of Anadyr, which is situated on the coast of Anadyr gulf the Bering Sea.

Eastern coast of the Bering Strait and Krusenstern Island belong to the United States of America (state Alaska).

ICE CONDITIONS

There are difficult meteorological conditions for shipping in Chuckchee Sea. The basic problem is ice. The sea is covered with ice the most part of the year. The ice conditions during navigation period depend on location and the sizes of Chuckchee, Northern and Wrangel ice files, and also spot of ice Kolyuchinsky.

During the navigation period (July - October) shipping is complicated with a cloudy sky, low massive clouds and often mists.

In case of favorable ice conditions icing of ship is a threat for shipping; it is most intensively in the second half of September and in October; and in Bering Strait it is also in November.

In September (when the ice condition is the best) a danger of heavy sea is increased.

In coastal shallow water areas the big changes depths because of strong negative and positive setups are very danger for shipping, especially for deep-draft ships. First of all it concerns to the areas of Otto Schmidt, Vankarem and Netten capes and Kolyuchin island.

4 CONCLUSIONS

Effectiveness of the beacons' network. ***Among the reasons of accidents in the coastal waters there are a lot of reasons caused by the insufficient effectiveness of the beacons' network.***

- ***The analysis of accidents made it clear that, despite of introduction of the newest aids to navigation, the share of the accidents linked to errors of ships' locations, remained the same. So for the period 1926 - 1930 the share of such accidents was 35,4 % from total, and for the period 1970 - 1996 - 33,3%.***
- ***Thus, has come to light, that for coastal operations and especially on approaches to ports traditional lighting aids to navigation remain and will always remain irreplaceable means for safety shipping.***
- ***For this purpose they should have high reliability and to be friendly in the relation to a navigator.*** *(INFORMATION. Bulletin N of 152, 1999, CNIIMF).*

Condition of aids to navigation of SHD.

Marine waterways to Arctic regions are in conducting by branches of SHD - hydrographic bases and the Arctic direction-finding group. Ships in NSR should sail by the recommended waterways:

1. A circumpolar line №1 - length of 2700 miles.
2. A circumpolar line №2 - length of 2700 miles.
3. A high-altitude line №1- length of 2890 miles.
4. A high-altitude line №2 - length of 3340 miles.
5. A traditional line (coastal) - length of 3500 miles.

There are rather difficult sailing conditions on many waterways (especially in the lower reach of the Siberian rivers) because of shallow depths, small breadth and sharp bends of the waterways. These waterways are equipped by buoyant safety signs and coastal aids to navigation (marks, ranges, radar reflectors and active radar responder beacons). There are following lengths of the waterways in the lower reach of the Siberian rivers:

1. Bay of Ob - 500 km.
2. The river Yenisej - 855 km.
3. The river Katanga with tributaries - 886 km.

4. River Anabar - 90 km.
5. Bykovsky fairway (river Lena) – 65 km.
6. The river Kolyma - 133 km.

The ideology of a development of navigation and hydrographic support (NHS) and a system of aids to navigation (SAN) on the waterways of NSR, especially on the parts of the rivers (Yenisej, Katanga, Anabar and Kolyma) with limiting maneuvering of ships, should be based on quality of NSR and, in particular, SAN. This system should be available and friendly to users, taking into account the limitations linked to weather conditions and climatic factors according to requirements of the international agreements and recommendations:

7. IMO. Resolution A.529 (13) 17/11-1983. Standards of accuracy of navigation.
8. IMO. Resolution A.815 (19) 23/11-1995. The world radio-navigation system.
9. IALA AIDS TO NAVIGATION GUIDE (NAVGUIDE.) Pub. By the IALA, Paris., etc.

NHS is based and it should be based on authentic items of information about condition of a fairway, locations of dangers, dimensions of artificial object of a water way. On the basis of the results of the hydrographic works the decisions can be taken about arrangement and types of the aids to navigation for safety shipping. Therefore it is necessary to observe and fulfill rules and requirements of the valid documents and international agreements which regulate frequency and details of hydrographic researches (sounding works) in the mouth sites of the rivers where shipping is carried out according to marine rules. The place of standing and orientation of the coastal aids to navigation should be corrected annually by the results of control measurements. The fix of ship's position in the narrow water shipping conditions is usually carried out at deficiency of time, basically by visual methods by coastal navigating leading beacons (during day and night time).

Quality and accuracy of navigation is closely related to quality, a saturation and efficiency of SAN. However a part of SAN did not work on the waterways of NSR during last years. As a result there were some problems at night - navigators could not find light beacons for ship's location.

It is necessary to take into account that not all vessels are now supplied with the receiving devices of GSNS in accordance with IMO resolutions about aid to navigation of vessels, including rules of Chapter 5 SOLAS-74, the edition of 2002). Therefore a visual (coastal and buoyant) and radar aids to navigation are basic types for SAN in Arctic regions, especially on marine fairways of the Siberian rivers. Use of the system of differential stations GLONASS/GPS does not result in

abolition of visual and radar aids to navigation. According to the IMO resolutions alternative means of ships' location are necessary in the narrow water conditions of shipping.

A working network of SAN in Arctic regions not always can satisfy all inquiries of navigators and pilots on availability, opportunities of fix a location with necessary accuracy and 95% probability in accordance with international agreements for areas with intensive shipping and limited opportunities maneuver. There is not enough information for fixing a ship's location on some recommended waterways, as it is required by IMO Resolution A. 529 (13), Standards of accuracy of navigation (items 3.1, 3.2). It is required a significant experience of shipping and knowledge of local conditions form navigators.

The Ministry of Transport of the Russian Federation is now assigns not more than 10 % of financial resources which is necessary for maintenance **of SAN** and providing of its normal work. SAN on the waterways of NSR and in particular on such important sites as the fairway in the channels of Yugorski Shar and the Yenisej fairway (the areas of navigation all over the year) is unreliable. This SAN can not work under the fixed rules and can not guarantee safety of shipping , even at presence a pilot onboard ship.

There are the following weaknesses of NHS on the waterways of NSR:

1. Hydrographic researches of the mouth sites of Siberian rivers are carried out in great volume with sufficient details and are used for drawing up of navigation charts. But, taking into account intensity of rearrangements of river – beds there are no up – to – date materials for chart correction. As a result the use of the present charts for shipping does not warrant safety. No precision navigation systems will provide safety if ship sails on sites with unknown or incorrect depths. The assistance of pilot is also not effective in such a case. If you do not know real depths on the fairway the opportunities for true arrangements of SAN and a choice of a direction of running sites of the river stations are sharply limited. Aids to navigation should be placed only by results of duly control measurements on limiting sites of the waterway.
2. Areas are not supplied with theoretically proved quantity of the aids to navigation which can provide safety shipping.
3. The sizes (heights) more than 30 % of beacons do not meet to modern requirements. Information availability of aids to navigation is limited on time. A wide experience is required for shipping on sites equipped with these aids to navigation.
4. A practice of transformation of some aids to navigation to not lighting status limits the period of supporting of the safe shipping only to day time.

5. Practically there are no radar responder beacons, the system of passive radar reflectors is not perfect, though navigators pay our attention that application of the radar responder beacons in the narrow waters is most preferable on reliability and does not depend on conditions of weather and time of the day.
6. Inspection of recommended ways and fairways according to resolution IMO A.699 (16) dated 19/10-89 and the Standard of International hydrographic organization on a hydrographic survey (item 1.A.5.1) by multi-beam echo-sounder was not carried out.
7. More than 20 % of coastal navigation marks demand major overhaul. About 200 marks were destroyed because of old age and the natural phenomena; their recovery is necessary.
8. Because of the lack of financing some lighting beacons on islands and along waterways of NSR were transformed to the category of dark beacons. The lighting beacons remain on the waterways with narrow water conditions, for example, a channel Yugorski Shar, the river Yenisej, the river Kolyma and Bykovsky fairway. The lighting beacons which receive power from radioactive nuclide propulsive plants are also working. The area serviced by Katanga hydro base, is completely transformed to dark (not lighting) mode, including buoys.

   For providing twelve – month navigation on area Kara straits - port of Dudinka in the winter period should be maintained the following aids to navigation:

- Lighting - 120 units;
- Radar-tracking - 77 units, including 11 - PMO;

Work package for improving of the navigation and hydrographic support on NSR. Realization of modern highly effective and competitive system of marine transport in Arctic regions is not possible without improving of the navigation and hydrographic support (NHS) on the waterways of NSR.

SHD should realize (in case of appropriate financing) integrated system of NHS for safety shipping on the waterways of NSR on the following basic directions:

- Investigation of an underwater relief of the Arctic seas and internal waterways in order to issue of navigation charts (including electronic charts) and manuals for shipping.
- Equipment of waterways by the aids to navigation and providing of their work under the appropriate rules.
- Information of seafarers about changes of navigation conditions, supply with navigation charts and manuals, transfer of hydro meteorological data about ice conditions.
- Realization of pilotage duties on the rivers Yenisej, Katanga, Anabar and Kolyma (total extension about 680 miles).

- Execution of works for pollution prevention of Arctic seas by oil products from ships.

During the last few years because of some reasons (mostly financial problems) the integrated system of NHS has undergone serious negative changes. As a result the question about necessity of NHS development (including possible opening waterways of NSR for international shipping) is sharply raised.

Necessity of introduction of new technologies for safety shipping on the waterways of NSR became last years obvious on a background destructive for an environment of accidents with sea-going vessels (for example, catastrophe with supertanker near coast of Alaska). The realities of modern Arctic shipping such as: super ships, tankers, icebreakers, including with nuclear propulsive plants, heavy ice, transportation of dangerous goods (oil and oil products) and besides intensive shipping of river and river – sea vessels. These realities overtake the opportunities of the existing traditional navigation systems for safety shipping and environmental protection.

The important program " Improving of NSH system of a national Arctic transport way of Russia - Northern Sea Routes" was included as a priority project into a subprogram 8 " Transport communications of Russia in World ocean" of the Federal target program "World ocean". It was planed to realize the program of improving NHS till 2000. But because of the financial and economic crisis of August, 1998 the necessary financial funds were not received.
Despite of difficult situation with financing SHD continued the works started within the framework of the above mentioned program for improving of NSH system on the following basic directions:

1. Introduction into service, test and commissioning of a network of 14 differential stations of the global navigation satellite systems (GNSS) stipulated by" The interdepartmental integrated subprogram on creation in the Russian Federation marine differential subsystem GLONAA/GPS ", authorized by Ministry of Transport of the Russian Federation. .
Introduction into service is planed to realize in four steps. At the first step two stations of GLONASS were set in operation in the western area of Arctic region.

2. Creation of a databank of electronic navigation charts (ENC) for waterways of NSR which meet the requirements of the Standard of International Hydrographic Organization S-57, systems of proof-reading of ENC and electronic charts service.

Modern users of transport, fishing and special fleets and management of the national economy require significant improvement of the present system of mapping and descriptive information about regions of World Ocean (including waterways of NSR). These improvements should be directed to

increasing of information capacity, processing speed, speed of the analysis and data delivery to the users.

In order to solve this problem it is necessary to maintain up-to – date the basic fund of mapping information about NSR and mouths of the rivers, its conversion to a digital form, development of modern system of ENC and their proof-readings, development of marine geo-informative systems (GIS).

3. Development of electronic cartographical navigation intelligence systems (ECNIS) for Arctic regions, which meet the requirements of IMO and working with created data bank of ENC (ECNIS for icebreakers, cargo ships, hydrographic, prospecting and other special ships and for pilotage services on the navigable Arctic rivers).

Creation of ENC data bank and modern system of electronic charts service on the waterways of NSR and at the same time equipping with these systems of icebreakers, cargo ships and special vessels will allow to increase efficiency of the decision of many important economic and state tasks, including:

- Improvement of safety of shipping and efficiency of operation of icebreakers, cargo ships, special vessels, etc. due to automation of works of ship's stuff;
- The automated display of navigation conditions into sea areas on a cartographical background and operative decision-making by different control systems;
- Planning of usage of natural marine resources within the limits of an exclusive economic zone of the Russian Federation in Arctic;
- An estimation of conditions and management of forces and means for preventions and eliminations of accidents at sea.

4. It was realized a set of geodetic observations for fixing of the positions of aerials D GPS according to requirements in co-ordinates WGS-84 with a margin error no more than $\pm$10 cm. For achievement of such an accuracy it was used the phase differential method of a satellite geodesy with calculation of vectors of reference lines between stations of constant monitoring and transfer of coordinates from them to the base station on Oleny island.

5. On the hydrographic vessel "Sergey Kravkov" was carried out some works concerning efficiency and measurement of signals' level from basic stations Oleny and Lipatnikovo on the waterways of NSR from a port of Dudinka on the river Yenisej up to a channel Kara Gates.

6. By 2000 It were carried out some sounding works in Laptev Sea to the east from Bykovsky peninsula on the fairway having extremely important value for delivery of cargoes in Republic Saha (Yakutia) by the river Lena. A necessity of the hydrographic researches was caused by the changes of a bottom contour because of intensive carrying away from delta of the river Lena of sedimentary rocks in 1998. For example, there was found the water depth of 1,7 m among depths of 4-4,5 m on the Mamont range. Because of such a small water depth a part of fairway was practically closed for replenishment ships. Only by usage of mobile differential station for co-ordination of sounding of a bottom contour it was possible to perform these works (in hard conditions). It was found some distinctive depths which had been not shown on valid navigation charts and necessary advisories for shipping by Bykovsky fairway were given.

Final conclusions

There is no any difference between hydrographic characteristic of the area on depths in comparison with other regions. The Arctic seas are marginal seas and at the same time – shelf seas. Shipping through these seas is possible. In order to sail by the waterways of NSR it is absolutely necessary to have:

- Up-to-date full set of information about depths, locations of hazards, navigation conditions.
- A continuous information field about the actual hydro meteorological conditions.
- Full information about the ice conditions.
- Short-term and periodic meteorological forecasts and forecasts of ice conditions.
- Information about quantity and quality of ships in the Arctic region as well as information about the tasks which are carried out by these ships.
- A ship (fleet) of the appropriate Register class for sailing independently or with the assistance of icebreakers; ship crew (crews) specially prepared for sailing into the given Arctic regions.
- Financial resources for maintain up-to-date level of navigation and hydrographic support.
- Insurance for compensation of operation losses in case of the accident.