Maritime Navigation System: Technological Solutions to Ensure The Safety Of Maritime Navigation

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Summary
The article assesses the level of navigation safety, in theoretical terms, defines the complexity of managing navigational risks in practice. The issues of assessing the navigational safety have been studied due to the importance and relevance of the issue in question, however, due to the great complexity of the problem under consideration, the article considers and indicates the directions for the development of the solution of the given direction, where, first of all, it became necessary to analyze the issue of assessing the levels of navigation risks when navigating vessels of various types in difficult navigation conditions.

Key words:
navigational safety, seafaring safety, navigation, sea.

1. Introduction

Throughout human history, the oceans have been very important to people around the world as a means of transportation. Unlike a few decades ago, ships began to transport goods, not people. Since the growth of intercontinental flights, sea travel has begun to be carried out over shorter distances (ferry crossings between the Baltic and North Seas, in the Mediterranean, in Japan and Southeast Asia), in addition, sea cruises are widespread, which have recently undergone the broadest growth and represent a very profitable source of tourist income.

As markets become more globalized, shipping volumes are increasing. Since the 50s. until the recent global economic crisis, the growth rate of intercontinental trade was almost double that of economic activity as a whole. From 2000 to 2008, world trade grew by an average of 5.4% every year, while economic activity, measured by GDP, grew by about 3% per year. Due to the extraordinary growth of trade relative to economic activity, world trade since the 50s. grew almost threefold, reaching a share of 45% in world GDP, while the transportation of goods for the processing industry actually increased almost fourfold.

In terms of the value of these goods, about 23% of world trade takes place between countries with a common border. This share has remained relatively constant in recent decades. However, between continents, this figure differs depending on their level of development. In Europe and North America the share is the highest - from 25 to 35%. This trade is carried out mainly through roads and railways. Freight between countries without a common border is transported mainly by sea, although more and more goods are transported by air.

The growth rate of the air transportation of finished goods has exceeded the sea transportation twice in recent years. How much cargo is transported by each mode of transport depends on the relative costs of transportation and the ratio of price to weight of goods: the higher the cost per unit of weight, the less significant the cost of transportation. Punctuality and reliability are also considered important for valuable goods. Innovations in maritime technology have helped accelerate the growth of maritime shipping. The most significant changes have occurred in the following areas:

Size: The average size of ships has grown significantly. Larger vessels reduce costs per unit of crew, fuel, downtime, insurance, maintenance and repair costs. Port authorities must respond to the increase in ship size by expanding the port infrastructure (berths, transport) and improving access to the port (for example by deepening port canals). Consequently, they have to increase costs. This can lead owners - usually the government - into financial hardship: capital investments are usually publicly funded, but the full cost cannot be passed on to port users.

Speed: The average speed of a merchant ship is about 15 knots (1 knot = 1 nautical mile per hour), or 28 km / h, which is the equivalent of 670 km per day. Newer vessels are capable of speeds up to 25-30 knots (45-55 km / h).

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Marine propulsion has improved significantly since the invention of the propeller, in particular the twin propeller. Development peaked in the 1970s. Achieving higher speeds is difficult and can be very expensive to complete. Experts predict only small improvements in the speeds of conventional commercial vessels.

Design: The design of ships has changed significantly, from wooden ships to steel ships built from aluminum and composite materials. The design innovations were aimed at reducing fuel and ship building costs, while at the same time increasing safety.

Specialization: Specialization in the shipbuilding industry has made significant changes in shipping. Highly specialized vessels are increasingly being built for certain types of cargo:

Tankers for crude oil, petroleum products, chemicals, liquefied gas and juice concentrates;

Bulk carriers for transportation of bulk cargo, for example, ores, coal, grain;

Bulk carriers for large cargo such as cars and iron;

Refrigerated fruit vessels from the Southern Hemisphere;

Vessels for transportation of general cargo;

Container ships, which increasingly perform the tasks of vessels for the transport of gene cargo on long routes;

Ferries as well as Ro-Ro ships. These two types of vessels take on the tasks of vessels for transporting the gene. cargo on short routes.

By increasing the speed of cargo handling, specialization has reduced the cost per unit of goods transported.

Automation: Various automation technologies have been used in shipbuilding and shipping, including self-unloading systems, computerized navigation, and GPS. Automation has significantly reduced the number of crew members required on a ship while increasing safety. According to IHS Fairplay, total ship losses (due to accidents or incidents) have dropped from 200 in the mid-90s to 150 today - a significant improvement in safety when the increase in ship numbers is taken into account. Shipping has grown rapidly over the years. The volume of cargo transported by sea exceeded 8 billion tons for the first time in 2007. World shipping has thus doubled since 1990 (with an average annual growth of over 4%). The carrying capacity of ships also almost doubled over the same period to 33 trillion. ton-miles.

World recession in 2018-2019 led to a huge drop in world trade and, accordingly, in shipping. Following a slight increase of 3% in 2018, trade fell 14% in 2019. Freight rates have dropped to historic lows in many markets. At the beginning of 2019, about 9% of dry-cargo vessels were not used, stood in ports, this mass of ships returns to the market very slowly due to a slight recovery in 2020.

The basis for planning the upcoming transition is the voyage plan, which includes the necessary instructions explaining and specifying the conditions for the upcoming flight.

Preparation of the navigator's unit for the voyage is divided into two stages:

1) preliminary preparation;

2) final preparation.

At the first stage of preparation for the voyage, it is established: the availability of navigational charts and transition allowances, the availability of Convention documents, the availability of the latest correction materials for updating the maps and manuals, the serviceability of technical navigation equipment (if necessary, they are repaired with the involvement of coastal specialists), the staffing of the "Emergency folders ”and the presence of the“ Schedule for alarms ”with the completed correction (when changing the crew), the terms of re-examination of life rafts, fire extinguishers, foam concentrate, breathing apparatus, staffing of emergency equipment, serviceability of ship equipment and systems that ensure the seaworthiness and survivability of the ship, validity of ship documents and crew qualification certificates, etc.

At the second stage, the navigation areas are studied, a preliminary laying is drawn on the maps, and the progress of the implementation of the activities planned at the first stage of preparation for the voyage is analyzed. Resolution A.893 (21) IMO, when choosing and working out the route, indicates that it is necessary to perform a preliminary laying on the general map and make a preliminary calculation of the flight. The work on choosing the route of the flight ends with drawing up a graphic plan and calculations for the flight on the general map. The study of the navigation area is carried out according to selected and corrected maps, guidelines and manuals for at least three days, taking into account the requirements of good maritime practice. The length of the part of the route learned at a time should be reasonably limited. When studying the sailing area, the captain marks the route on the general map, which he assigns to transfer to the route and private maps to one of the assistants (usually this is the duty of the navigational assistant).

After the approval of the graphic plan, preliminary laying on the route maps is performed and the preliminary calculations for the Flight are specified.

In accordance with the preliminary laying on the general map, the maps and navigation guides necessary for the voyage are selected according to the "Catalog of maps and books". When selecting maps and guidelines, take into account the possibility of re-routing, entering ports and points not provided for in the plan, shelter from a storm or forced entry for troubleshooting and other factors that may affect the performance of the voyage. Careful implementation of preliminary laying in many cases determines the quality of constant monitoring of the current position of the vessel at the transition.

Modern seagoing vessels can navigate in rather difficult weather conditions. Nevertheless, captains are sometimes

forced to change course, ship speed, bypass the danger zone or drift to ensure the safety of navigation and safe transportation of cargo. When choosing the route of passage, the captain must remember that the route should be the shortest in time, and not in distance. The efficiency of navigation of ships largely depends on the choice of a route with favorable hydrometeorological conditions. Most often, the minimum duration of the voyage, which ensures the safety of navigation, is chosen as the determining indicator of efficiency. In this case, sailing is carried out along the so-called most advantageous route.

In navigation, two main methods are used for choosing the optimal path:

1) the use of special hydrometeorological manuals, in which the seasonal recommended routes are given;

2) determination of the sailing route by the captain on the basis of hydrometeorological information supplied to the ship. When determining the optimal route, it is necessary to choose the route to follow based on the hydrometeorological information transmitted to the ship.

When choosing the optimal route, the captain has to consider two most typical cases:

1) the ship is sailing along the recommended seasonal route. In this case, the route will be with an extension of the path, on which the most favorable weather conditions are observed;

2) in a generally favorable hydrometeorological situation, the ship follows the shortest path along an arc of a great circle.

The navigation of the vessel along the optimal path according to the recommendations of the Forecasting Centers is widely used by some companies.

2. Theoretical Consideration

To ensure the safety of navigation, each vessel must always have the necessary charts and navigation guides, the mandatory list of which for the vessel is determined by the shipping service of the shipowner (base), taking into account the type of vessel, the transportation plan, the anchoring of the vessel on a particular shipping line, as well as possible options for changing the navigation areas. The captain has the right to supplement this stock at his own discretion. Maps and sailing guides covering a specific geographic area are called a kit. Such kits facilitate the procedure for ordering charts and manuals by radio, during correspondence, and also speed up the process of selecting them for the upcoming voyage and simplify the ordering of their proofreading. Sets of charts and sailing guides included by the maritime service in the list of mandatory for this vessel constitute the so-called ship's collection.

- navigational nautical charts;
- auxiliary (VC);
- maps of hydrometeorological elements for information on currents, waves, tides, ice, winds, fogs, dangerous hydrometeorological phenomena, etc .;
- boat charts intended for supplying lifeboats of vessels of the first and second categories;
- maps for laying an arc of a great circle;
- gnomonic projection;
- sailing guides and aids: sailing directions, descriptions of lights and signs, descriptions, schedules of transmission of navigational and hydrometeorological messages for mariners, schedule of facsimile radio transmissions of hydrometeorological information (if facsimile equipment is available);
- swimming rules;
- hydrometeorological atlases and tables;
- various reference publications - Oceanic ways of the world. International Regulations for Preventing Collisions at Sea (COLREGs - 72), International Code of Signals (ISS), Tables of distances. Marine Astronomical Yearbook (MAE), MT-75, Heights and azimuths of the stars (BAS-58), (TVA) and others.

For timely notification of mariners about all changes in the navigation situation, special navigation aids are used - information representing the so-called correction documents, according to which an immediate correction of all navigation aids, primarily catalogs of maps and books, is mandatory.

Keeping and keeping records of charts and sailing guides. There is no standard way to arrange charts and navigational guides when stored on board a ship and is usually done on a per-ship (or series) basis.

The use of maps and guides is allowed only to persons directly related to these documents, without being removed from specially designated office premises.

The ship's collection maps should be kept in the navigator's table boxes, or on specially adapted racks, or in pencil cases; swimming guides - in cabinets or on special shelves. The navigator's cabin (or other room in which maps and navigation guides are stored) is a service room, the order of access to which is determined by the ship's master.

By the same document, keeping records of the ship's collection, its preservation and maintenance at the modern level, day-to-day control over the state of proofreading is assigned to the second mate.

All charts and sailing guides are kept on board in catalogs of charts and books. When replacing one or another catalog of charts and books, all data of accounting for charts and sailing manuals should be transferred to the new catalog.

Writing off charts and sailing guides.

Periodically, the IM announces the numbers of outdated sailing charts and guides, which are to be withdrawn from use. As a rule, such announcements are made after

the release of new maps and sailing guides for the same areas. Upon receipt of the announcement of the release of new charts and sailing manuals, the second mate is obliged to immediately inform the master of the ship and, with his permission, apply for these publications.
Swimming guides that have become unusable are also subject to retirement. The minimum service life of the card, after which it is considered to have become unusable as a result of continuous operation of the vessel in any area, six months from the date of receipt. The terms of use on ships of navigation guides and aids (sailing directions, descriptions of lights and signs, catalogs, etc.) are determined by their reprinting ..
Charts and sailing manuals to be discarded are destroyed only after new maps and sailing manuals have been received on board to replace the destroyed ones.

Proofreading.
The discrepancy between the content of maps and navigation guides to the actual situation on the ground not only complicates the solution of navigation problems, but can lead to gross miscalculations and errors; and sometimes - to ship accidents. Thus, the safety of navigation essentially depends on the timeliness and quality of keeping charts and navigation guides up to date. Systematic correction and addition of information on charts and sailing manuals with the aim of constantly keeping them up to date, that is, bringing them in line with the actual situation at sea '(on the ground), is called proofreading.
Proofreading consists of a wide range of special work, which starts with recording changes in the terrain and ends with the application of information changes to charts and sailing guides.
Changes to charts and sailing manuals content are collected on an ongoing basis. The source of such information is special observations of hydrographic bodies, official reports of bodies of other departments, reports of captains, pilots, etc. The information obtained in this way is generalized, verified and taken into account.
All the variety of work on the implementation of the proofreading of charts and sailing manuals can be divided into two main stages - reprinting and current proofreading.
Re-publishing of maps and sailing guides is a cycle of work, starting from corrections of the published originals to the publication of corrected materials or additions and inserts (inserts) to them.
Ongoing proofreading is proofreading, pasting, and handwriting.
Re-issue sailing guides when corrections reach 15% of the total guide. When reprinted sailing manuals go out of print, the previous edition is no longer suitable for navigation purposes.
Reissue of maps, depending on the nature and volume of corrections, is divided into three types - new edition, minor proofreading and inserts.
The new edition of the map is printed in cases where the corrections are so significant that they cannot be applied otherwise than by making new publishing originals of the maps. Corrections related to changes in the geodetic base (displacement of the cartographic grids) also necessitate a new edition of the map.
On maps issued by a new edition, the inscription "New edition (date)" is placed under the lower frame. The date of the new edition indicates the time when the card was reissued and the date of the last registered IM issue. Upon the release of a new, republished map, its previous editions are unsuitable for navigational purposes, which is announced in IM.
With minor proofreading, cards are printed as the previous editions are used up and the need to replenish them. When cards with low proofreading are released, the previous editions of these cards remain usable, provided they are manually corrected.
Inserts are published on maps in cases where certain parts of the map have undergone such changes that cannot be announced in the MI and at the same time do not cause the need to reissue the map. Up to three inserts of no more than 15X25 cm each can be printed on one card. If necessary, corrections on the area of the map exceeding the area of three inserts, the map is republished.
Current updating of charts and sailing guides is carried out on the basis of printed correction documents and special radio navigation notices.
As the proofs accumulate, the so-called consolidated proofs to the sailing manuals are published annually, including all the information that is announced in the IM for this manual after its publication. Each subsequent consolidated update includes all the data from the previous consolidated update that has not expired. The information in the consolidated proofreading shall be announced in the form in which it was published in the IM. If the proofreading has undergone changes, then it is given in its final form. Canceled IMs are not included in the consolidated update. In addition to summary corrections, which are published, as a rule, annually, so-called supplements to the directions are periodically published. The text in the supplements, as a rule, is printed on one side of the sheet, which makes it possible to make clippings for correcting the text of the directions by pasting.
For updating the alphabetical indexes of sailing manuals, a list of abolished, changed and new geographical names and nomenclature terms is placed at the end of the Supplement.
The publication of additions and summary corrections is announced in the IM. Navigation manuals for summary

corrections and additions to the ERNC are not corrected, they are included in the manuals issued to ships.
With the receipt of charts and guides for navigation on the ship, their further current updating is continued on the ship, regularly receiving printed correction documents and special radio navigation notices.
Printed and proofreading documents
The main printed proofreading documents are IM, including numbers and alphabetical indexes to them, as well as the summary proofs and additions to swimming manuals described above.

Notices to mariners. IM are collections of information on changes, on detected navigational hazards, on important announcements and warnings, including changes in sailing regimes, as well as information on the publication of new charts and sailing guides, on the withdrawal of certain charts and sailing guides from use and updates. those that remain in effect. They are published with the aim of informing mariners of information about changes in the navigation situation and the regime of navigation on the seas and oceans and the production of proofreading of maps and navigation guides in coastal correction units and directly on board ships.
IM publishes information about changes in the navigation situation on the seas and oceans.
Each MI is assigned a serial number for a given year, and they are published in weekly issues (on Saturdays), which contain several independent MI numbers.
Title page of the issue, which indicates: issue number and date; numbers published in the issue of MI, general provisions of a reference nature (units of measurement of depths, distances, heights, directions, etc.), necessary for the correct use of the information in the issue. At the bottom of the title page are usually notices of particular importance to mariners.

Contents, which is a listing of the chapters in this issue.
List of charts, sailing guides and aids to be revised for this issue. In such a list, in ascending order, the Admiralty numbers of those cards are given, which are subject to proofreading for this issue. Moreover, next to each card number, the MI numbers are indicated, according to which this card must be corrected.
For all sailing manuals, next to their admiralty number, the year of publication of the book and the IM number, according to which this manual should be corrected, are indicated.
Numbers printed in italics refer to temporary and provisional.
The sequence of the location of the MI for this issue is a list of geographic areas (oceans, seas, their areas, etc.); opposite their names are the pages of the issue on which the IMs related to this geographical area are placed. If there is no IM for a given region in the issue, then a dash is placed instead of the page number.
Section II - "Map Proofreading" - the main document for the NMC proofreading. It contains data grouped by seas and oceans, which are brought to the attention of mariners and are used directly in the current updating of charts. The presentation of the IM text is standardized as much as possible, shortened: the headings of notifications, links to manuals and swimming aids are omitted; instructions for performing proofreading are given in standard words - apply, abolish, correct, rearrange, etc.; instead of nomenclature terms, conventional signs used in the NMC may be used. The coordinates of objects are given with an accuracy corresponding to the accuracy of the map of the largest scale on which this object is plotted. Before the text of each MI, the numbers of the cards are placed on which the announced proofreading should be applied. The first is the number of the map of the largest scale. The rest of the maps are shown in decreasing order of scale.
At the end of the section there is a special section “Information received during the publication of the issue”.
Section III - "Proofreading of Swimming Guides and Aids" - is printed on one side of the sheet only and can be used as inserts into the corresponding sheets of books.
After the text of each IM, the names, admiralty numbers and the year of publication of sailing manuals are given, to which the announced revision must be made. The information is grouped by types of guides: the page is indicated for the directions; to describe aids to navigation - number; to describe RTSNO - page and number; for others, a page.
By their nature, MI are subdivided into permanent, temporary and preliminary.
Permanent MI contain navigational information that is not subject to frequent changes: notifications about changes in aids to navigation, hydraulic engineering and coastal structures; notifications on detection of navigational hazards; notifications about the mine situation and about areas with a special navigation regime, etc.
Temporary MIs contain information about short-term changes in the navigation situation: information about changes or violations in the standard aids to navigation, notifications about the setting of non-standard aids to navigation, notifications about areas with a special navigation regime and their fencing.
At the serial number of the temporary, they put a sign. If the term of its validity is indicated in the text of the notice, then it cannot be canceled, since it automatically loses its validity upon the expiration of the period specified in it. If the term of its validity is not indicated in the text of the temporary, then if it loses its meaning,

it must be canceled by a permanent notice.
Number books are published in order to facilitate the selection of updating maps and sailing manuals, as well as to simplify control over the corrections already performed; they are published in separate brochures twice a year - for the first half of the year and for the year.
In the numbered lists, in ascending order of the admiralty numbers, maps and navigation guides are given and the MI numbers are indicated by which they must be corrected. Numbers include all MI numbers, regardless of their nature, except for canceled ones. After publication, supplements to swimming guidelines include only those IM numbers that are published after the date indicated in the supplement.
The list of charts and sailing guides, subject to proofreading for the first half of the year, is summarized and published in a separate brochure - the number for the first half of the year. In the same way, at the end of the year, a number book for the past year is issued.
At the end of each number-book, there is a list of publications announced in half a year or a year.
Swimming manual supplements and summary proofs are also official printed proofs.
The material in the Supplements is located in the form of amendments and inserts to the pages of the manual, printed on one side of the sheet for easy adhesion to the corrected page of the manual. To facilitate updating of sailing manuals, the Supplements indicate the page and line to which the correction applies. Sometimes in; manuals may require replacement of an entire book sheet. In this case, the corresponding Appendix sheet is printed on both sides; such a Supplement sheet is glued on the corresponding page of the revised manual.
The Appendix does not include data on changes in the type and heights of structures of lighthouses and luminous signs, as well as the heights of lights. New information, as well as information that changes or cancels the text of the previous Supplement, are enclosed in square brackets.
To facilitate the work of finding the necessary corrections, a table of contents is placed at the beginning of the Appendix.
Consolidated updates to sailing manuals include information that was announced in the IM for this manual after its publication or after the last Supplement to it was issued. Each subsequent Consolidated Correction includes all the data of the previous one that has not become invalid. Several IMs, supplementing or changing each other, are combined into a single final proof text for a given object; temporary and preliminary MI do not fit into summary corrections. If this manual was regularly revised according to MI, then the Consolidated revision is used only to control the completed revision. Consolidated revisions to sailing manuals are usually published annually.
English IM (Admiralty Notices to Mariners) are published by the British Admiralty in the form of weekly general and private Admiralty IM (AIM). In addition, after the release of the next Supplements to the English sailing directions, annual collections of notices (Annual Code of DIM) are issued.
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At the end of the issue, there is a form and instructions for drawing up reports on detected hazards and changes in the navigational environment. To carry out extensive proofreading, the short text of the AIM is accompanied by a picture from the map of the largest scale, which shows all the proofreading. At the beginning of each year, in a separate brochure (with a red cover), the Annual Summary of Admiralty Notices to Mariners is published. Private AIM (Weekly Home Edition) also publish weekly; they are intended only for updating the

nautical charts and sailing manuals issued by the British Admiralty for British territorial waters; they are included in the general AIM Weekly Edition.
Capital letters "P" or "T" after the number of some AIMs indicate that the AIM is Preliminary or Temporary.
The order and form of presentation of materials in Notices to Mariners of other countries are approximately the same as in Soviet and British ones.
Recently, in connection with the rapid development of digital technologies and the increase in the speed of digital data transmission, the updates received on the ship via satellite e-mail have become widespread in the world fleet. On a personal computer specially allocated for this purpose, a program is installed on the ship to process the received data. Most of the leading hydrographic services in the world send IMs by e-mail to the vessel on a weekly basis, but containing only the updates related to the charts and manuals on the vessel. The assistant responsible for the proofreading prints tracings on the tracing paper for the proofreading of the maps (they contain a part of the grid for establishing tracing on the map and the objects to be corrected and the type of proofreading, which speeds up the process itself and minimizes errors due to errors of measuring instruments), and on paper of the appropriate standard, proofreading of manuals and manuals. Also, hydrographic services provide a part of the manuals, such as guides to lighthouses in electronic form, the updating of which is done automatically after downloading the files containing the update to the computer, and the sailing directions are delivered to the ship along with disks containing the same information as the printed publication. Drawings, diagrams and maps, which cannot be sent to the ship due to their large size in the electronic port, are sent to the ship in the port on disks along with new editions of maps and manuals.
This system has a number of advantages: the proofreading is performed weekly, which does not lead to stagnation of the proofreading process on ships with long transitions, and the process is much faster and easier due to the lack of proofreading in the MI for charts and manuals not contained on the ship.

NAVIGATION RADIO WARNINGS

Data on changes in the navigation situation, which must be urgently brought to the attention of mariners before they receive printed information messages, are transmitted by radio.
Subsequently, this information is duplicated in printed MI, if by the time of the release of the latest changes there were no changes.
By their nature and timing of transmission, navigational warnings are categorized into emergency alerts of hazards to navigation and scheduled transmissions.
Emergency announcements and scheduled transmissions are carried out by radio under the World Radio Navigational Alert Service (WNEWS), which is designed to coordinate such transmissions.
Worldwide Radio Navigation Warning Service. The structure and main functions of the VSRNP. There are three types of navigational warnings that are transmitted within the WSRNP - regional, coastal and local.
1. To coordinate the radio transmission of district warnings, the entire oceans are divided into 16 geographic regions. The demarcation of regions has nothing to do with the borders between states and should not call them into question. Where necessary, the term NAVAREA is used to abbreviate the designation of an area followed by a Roman numeral indicating the area number, for example, NAVAPEA-I, HABAPEA-IV, HABAPEA-XIII, etc.
In each of the districts, a district coordinator is allocated - a body whose responsibilities include the selection of information, announcement of warnings and bulletins (a list of numbers of previously announced and valid warnings) for its district. Thus, the district coordinator is the country that collects, analyzes and transmits by radio navigation information related to the area in the form of NAVAREA district warnings. NAVAREA area warnings are long-range radio navigation warnings issued by an area coordinator to his area and transmitted through a powerful radio station (or multiple radio stations) that provides alerts in his area and in adjacent parts of neighboring areas.
In all cases, reception of transmissions from a regional radio station must be provided outside the entire area at a distance that a fast vessel can travel in a day (about 700 miles). In this regard, the power of radio stations transmitting regional NAVAREA warnings should ensure their reliable reception at any point in the area and at a distance of up to 700 miles outside of it.
LOCAL WARNINGS — Warnings issued by the NARC for an area within the jurisdiction of the port authorities. Such warnings do not require their transmission outside the area of operation. NAVAREA warnings. They serve as information that is necessary to ensure the safety of navigation on long-distance (ocean) crossings. They include information regarding damage to important aids to navigation, as well as information that may require a change in the planned crossing route. Below is a list of information that allows you to determine the general principle of its selection for NAVAREA, but far from being exhaustive of all that can be contained in NAVAREA: malfunction of lights, fog signals and buoys that ensure navigation along the main shipping routes;
• the presence of dangerous wrecks on or in the immediate vicinity of major shipping lanes and, if any, their fencing;
• installation of new important navigational equipment or

significant changes to the existing one, if such installation or changes may affect the safety of navigation;
• the presence of large tug caravans in areas of restricted navigation;
• drifting mines, etc.
These messages should be repeated as necessary until the action is completed.
The schedule of transmissions of each region of the NSRNP is drawn up so that the time of NAVAREA transmissions to this region does not coincide with the time of similar transmissions of neighboring regions.
If navigational warnings remain in effect since their last radio transmission, the information contained therein is communicated to mariners around the world. In this regard, the District Coordinator is taking all necessary steps to ensure that those messages that require radio announcements in other districts are sent to the other fifteen District Coordinators.
Although the organization established for district coordinators provides for the possibility of ships using warning devices operating in the area, nevertheless, on the approaches to the area or when entering it, in exceptional cases, ships should be able, upon request, to receive the texts of the current warnings, but not included in the current programs established by the schedule.
If the area coordinator considers that he is the first recipient of information relating to another area, he should forward it to the appropriate area coordinator as quickly as possible. This is also mandatory for sub-district and regional coordinators.
In order to prevent the vessels from repeatedly receiving the same warnings and unnecessary waiting, coastal radio stations transmit their NAVAREA in the reverse order of their receipt by the radio station (i.e. from the end). All NAVAREA remain in effect as long as they will not be canceled by the district coordinator. The duration of the warning, if known, is given in the warning text.
PRIP warnings. These warnings apply to coastal waters. Where there is a need for such warnings, their reception should be possible at a distance of 100-200 miles from the coast. May contain the same information as NAVAREA, however, they should not be limited to information on the main shipping routes. Some areas (and subareas) are broken down into regions based on the number of riparian countries. Thus, a region is part of an area or sub-area in which one State has assumed responsibility for the transmission of coastal warnings. Such a State is declared the National Coordinator - the body responsible for the selection and announcement of coastal warnings through the network of national coastal radio stations, as well as the immediate transmission of all relevant information to the area coordinator or the coordinator of its subarea, if any. In this regard, the coordinator of a subarea that includes more than one national region should serve as the focal point of contact for national coordinators and is also required to relay navigational warnings to its area coordinator. Each radio station broadcasts PRIs related only to its sub-region. The radio stations of the sub-regions repeat the PRIP of other sub-regions only at the direction of the national coordinator.
The numbering of the PRIP is different in each sub-region (region) - continuous throughout the calendar year.
The most important PRIPs are selected for subsequent transmission in the form of NAVAREA.

Important meteorological information. Experience has shown that weather warnings affecting the safety of navigation are more effective when transmitted with navigational warnings and on the same frequencies. In this regard, individual District Coordinators are already transmitting weather warnings at the same time as NAVAREA. For the avoidance of misunderstanding, such (meteorological) warnings may be preceded by the symbol “METEO”.

NAVIGATION SAFETY ASSESSMENT

Navigational safety of navigation is ensured by dead reckoning and periodic observations only taking into account their accuracy, which is traditionally estimated by the mean square error RMS (M), the probability of which is P = 63%.
However, the IMO "Navigation Accuracy Standards" for assessing the accuracy of the current (countable) position of the vessel is assumed to be the probability P = 95%. This requirement is practically met by a circle with a radius of R = 2 M.
Requirements for the accuracy of navigation when navigating in any zone (restricted navigation, coastal zone, open sea zone), permissible time of dead reckoning, values of the RMS of measurements of navigational parameters possible at the transition, as well as formulas for calculating the RMS of the reckoning (Mst), RMS of the reckoning position (Msch). It is necessary to be guided by their data when conducting the executive laying.

ORGANIZATION OF THE STURMAN SERVICE WHEN NAVIGATION IN CONFIRMED CONDITIONS

When swimming in cramped conditions, the following should be performed:
- the personal presence of the captain on the bridge and his management of all the actions of the watch duty (and if necessary, the captain can leave the chief mate for himself);

- a clear arrangement of the watch and crew members called to strengthen it, the distribution of specific duties between skippers in order to detect and correct mistakes made in a timely manner; if there is any doubt about the correctness of the location,

In critical situations, the positive development of events, the prevention of serious consequences, largely depends on the initial actions of the officer in charge of the watch, which he will take before the captain arrives on the bridge. Lists of possible actions in typical situations are given in the corresponding section of these Recommendations. It should be noted that these checklists do not limit the officer in charge of the navigational watch in taking whatever actions he deems appropriate in the particular circumstances of intensive shipping.

The tightness of the conditions depends, therefore, on the dimensions and speed of the vessel, as well as on external factors. When sailing in areas with cramped conditions, surveillance is enhanced, including with the help of the ship's radar, regardless of visibility conditions. Along with observations, methods are used that make it possible to practically continuously monitor the position of the vessel (traverse distances, enclosing isolines, etc.), sea level fluctuations and the required water supply under the keel of the vessel are taken into account, depths and trends of their change are monitored.

Near the coast, the appearance of small vessels (pleasure, fishing, yachts, speedboats) is possible, following courses that differ from the recommended ones. In such areas, it is possible to install non-standard buoys and milestones that have a special purpose and are not mentioned in navigation sources.

Shielding by high capes of other vessels following the fairway bend is possible.

When preparing to sail in cramped conditions, the officer in charge of the watch should study (and remember the most important data):

- course on each section of the route;
- the distance and sailing time at each site and between aids to navigation;
- landmarks for control of turns and swimming in each section and other characteristics;
- the presence of natural sections;
- values of fencing bearings and distances, other navigation parameters;
- permissible deviation from the fairway axis in case of divergence with other vessels;
- confined areas where divergence by course change is difficult;
- places of possible anchoring.

It should be borne in mind that the actual direction of the current can be determined by the breaker of floating aids to navigation.

In critical situations, a positive development of events, the initial actions of the officer in charge of the navigational watch, which will be taken by him before the arrival of the captain on the bridge.

Lists of possible actions in typical situations are given in the corresponding section of these Recommendations. It should be noted that these checklists do not restrict the officer in charge of the navigational watch in taking other actions that he may deem prudent to take in the particular circumstances.

Swimming when approaching and leaving the port

The approaches to the port and port water areas, in addition to being areas with limited navigation conditions, also have specific features. Typically, these areas have UDS systems. As a rule, ship traffic separation systems are organized at the approaches to ports at the points of convergence of sea routes.

Navigation in port waters is regulated by local rules different from COLREGs-72, which should be studied in advance. In discrepancy with small vessels, the possibility of their non-compliance with international rules must be taken into account.

On the approaches to the port, there may be accumulations of anchored, drifting and moving vessels at different speeds. At night, consideration should be given to obstruction from shore lights masking objects on the water.

When approaching the place of acceptance and delivery of the pilot, it is necessary to provide for actions in case of his delay or impossibility of disembarkation.

Navigation in the ship traffic separation system

When navigating in traffic separation systems, information from the coastal monitoring station should be continuously received.

In such areas, two VHF radios are usually used.

If, while sailing in a traffic separation system, you think that another vessel should be on the wrong side, you should recheck your vessel's position and, even if it is confirmed, proceed with extreme caution.

In case of violation of the rules, immediately inform the control station about the fact and the reasons for this.

Conclusions

This paper presents a navigation study of a bulk carrier flight. Based on the results of the work carried out, the following conclusions can be drawn.

The chosen route is the most profitable both from the economic point of view and from the point of ensuring the safety of navigation and cargo transportation. When choosing a route, navigation maps were raised and navigation hazards along the route were taken into account. The errors in determining the position of the vessel when navigating in areas hazardous in terms of navigation have been calculated. Based on the results

of these calculations, recommendations are given for planning observations when sailing in these areas.

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