INTRODUCTION OF MODERN MARINE TECHNOLOGIES IN SHIP NAVIGATION PROCESS

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Summary. Safety of navigation is a direct obligation of countries party to the International Convention for the Safety of Life at Sea (SOLAS Convention, 1974), which provides that every government must take all measures, including the prompt communication of information relating to the safety of navigation to all persons concerned, whether to ships or coastal stations. This task depends not only on the collection, processing and storage of navigational and hydrometeorological information, but also on technical measures aimed at the transfer of this information and its reception on board the ship. This paper proposes a new approach to navigational safety, based on the introduction and use of digital technologies applicable for application in navigation equipment, and improving the efficiency of navigation data transfer in the broadband system.

Key words: navigational telex, data transmission, communication systems, safety of shipping

Ensuring the safety of the process of operating complex technical transport vehicles is an urgent problem for the global maritime industry, which feels the lack of information about risk levels and the consequences of their incorrect assessment. Among the requirements for ship management and operation, the presence of a highly professional crew as well as modern navigation equipment is of great importance. In view of this, navigational safety is one of the components of the integral concept of safe operation of the merchant ships. Modern experience in the implementation of technically complex projects requires the use of digital technologies, including the application of digital modeling and design, which can
reduce the development time of navigation equipment and devices, reduce the cost of field testing, solve resource constraints in the design and construction projects of ships, including navigation devices and systems, hull and power plant, and obtain a ship with competitive characteristics. The result of automation of the process of navigation safety information broadcasting of ships and coastal navigation warnings was the appearance of the NAVTEX system, which greatly facilitated the receiving and timely warning of seafarers by the necessary information. The use of a single frequency of 518 kHz made it possible to unify the system and introduce it worldwide.

The first middle-wave teletype transmissions were carried out in the early to mid-80's in the high-latitude regions. This was due to the fact that in polar latitudes the signal transmission is extremely difficult and subject to strong atmospheric interference. The teletype code standard used at that time - MTK-5 was not sufficiently anti-jamming as the later MTK-7 appeared. At the same time, the passage of the signal on medium waves in these areas was very confident. Therefore, at that time on merchant ships modified receivers were available, which the radio operators adapted to receive in F1B mode on the medium waves. Such re-equipment was not very complicated, but gave not a few advantages including further qualitative changes and innovations, such as teletype, receivers with digital frequency synthesizers, equipment of increased reliability, etc. By using a single frequency and limiting power, the shore stations created for NAVTEX use were conveniently organized in chains. The number of chains was determined according to NAVAREA areas, and each station was assumed to be identified alphabetically. The algorithm for identifying messages by station and message type was implemented simply and conveniently. Thus by the mid-1980s the foundation of NAVTEX had been laid.

Further development and coordination of the system proved so successful that NAVTEX became one of the first components of GMDSS.

At the same time the process of realization of the unified approach to integration of marine communication systems, navigational and meteorological provision of ship navigation, demanded by time and technological development, has caused the necessity to create a unified information space on the basis of modern digital technologies. Among the latest solutions in this area was the use of new maritime digital information systems, based on the transfer of digital navigational data for ensuring the safety of navigation.

![Informational interaction of NAVDAT elements](image)

**Fig.1.** Informational interaction of NAVDAT elements
The Global Maritime Distress and Safety System (GMDSS) is an international service governed by the International Maritime Organization (IMO) Convention on Safety of Life at Sea (SOLAS). Its purpose is to provide assistance to ships in distress. More than 60,000 ships around the world may require such assistance today. According to the International Maritime Organization (IMO) Maritime Safety Committee's review and modernization work plan, search and rescue activities are to be considered at various levels of review to modernize and develop new standards for shipboard and shore-based equipment.

On the one hand, a review of basic functional requirements and clarification of definitions are expected. The other level of review is detailed and includes consideration of the inclusion of new systems and electronic technologies into the GMDSS: automatic identification systems, ship security alert systems, identification of ships at a long range, elements of e-navigation, new requirements for equipment of lifeboats and life rafts in terms of ensuring long range radio communication, review of the evolution of emergency radar beacons taking into account the introduction of a medium orbital satellite system with a search and rescue mission, as well as other aspects.

Comparative analysis of existing narrowband systems of direct transmission of information NAVTEX and TELEX, which transmit information from the shore station to the ship at a low speed of 50 bps and a delay of 20 m per sec, shows their obsolescence and does not meet modern requirements of information exchange. It is not possible to increase the speed by decreasing the duration of the signal because of the effect of multipath and defects in the deformation of the message formation when the signal passes through the Earth's atmosphere. Such deformation defects lead to retraction of the message in time and overlapping them one on one.

Inventions in the field of navigation instrumentation find their application in automatic vessel navigation systems, which significantly expands their functionality. During the 16th session of Committee on Radio Communications (Search and Rescue) of the International Maritime Organization a new development of the French company Kent, namely the digital maritime information system for the transmission of navigational data - NAVDAT (Navigational Data) was presented, which aims to introduce a new digital system of marine communication, accessible to ships around the world, using a universal frequency of 500 kHz, which is the analog of the system NAVTEX (Navigational Telex), and which is the result of a joint project called Shipboard Communication Internet Protocol. The data transfer speed offered by NAVDAT enhances the service provided by the NAVTEX flowing global system and includes the same basic functions (navigation warnings, weather forecasts and urgent navigational information). In addition, the system NAVDAT offers increased speed of transmission and improved quality of processing, providing access to low additional data in text format, as well as in the form of images and graphs. This data is set in such a way as to include meteorological and oceanographic information in the form of diagrams (e.g., isobaric) or numerical data (e.g., regular updates of the weather situation), regular updates of the tropical cyclone's location, information on the location of ice and icebergs on the chart, interim reports on piracy, and other information related to search and rescue. The NAVDAT system also offers a range of
broadcast options for ships sailing in a particular geographic area, and has the option of encryption for transmission of confidential information at significant distances, which without a doubt is a practical way to implement a common approach to the integration of maritime communication and networking systems, navigational and hydrometeorological safety provisions for ships and increasing the safety level of international shipping.

The NAVDAT digital broadband system for MSI (maritime safety information) and security related information presented by KENTA (France) has a central frequency of the system as mentioned above of 500 kHz with a 10 kHz shift. Used 228 subcarrier frequencies. They abandoned the use of frequency modulation to reduce the width of the signal spectrum in favor of a multiple-amplitude-phase coding, which increases the ability to receive large amounts of information. NAVDAT stations are located off the coast of Europe and Asia. The speed of NAVDAT data transmission, given the presence of some disadvantages grows hundreds of times over in comparison with existing systems, analogous to its intended use. The signal/noise ratio in the signal reception area is also improved.

The new version of the NAVDAT system is able to provide a higher speed of data transmission due to a number of technological solutions: high frequency signal transmission; QAM (quadrature amplitude modulation) of the signal; over-link coding. Nevertheless, the main thing is that the digital broadband transmission of data via NAVDAT enables to replace the narrowband transmission of data via TELEX. Additional advantages of the NAVDAT system include a higher data transmission speed than NAVTEX. The method of transmission NAVDAT based on the standard Digital Radio Mondiale (DRM) using one of two modes of modulation 16-QAM and 64-QAM, depending on the required coverage, transmitter location, the power and height of the antenna. The types of transmissions and messages that are broadcast may be as follows:

- navigational safety messages;
- information on safety of the crew, ship or cargo;
- warnings on the dangerous areas;
- urgent notices;
- ice situation and icebergs;
- search and rescue;
- meteorological bulletins;
- currents and tides;
- pilotage and port notifications;
- transmission of ship traffic service files;
- information of the automatic identification system;

Messages can be transmitted as a collective broadcast to all ships or selective communication to a particular ship. In addition, notifications are sent to a group of ships or a specific navigation area or in a separate notification mode addressed to one ship using an identifier. The most important feature is that the system provides not only text files, but also graphs, charts, images.

Conclusion. Implementation of NAVDAT maritime information system, its integration with the modernized Global Maritime Distress and Safety System on the basis of the e-navigation concept within the context of maritime technology
development is quite capable to play an important role in the navigation information and communication support system of navigation process. It is fully capable of providing an effective communication component in the maritime safety system by increasing the speed of data transfer and expanding the types of transmitted information on safety of navigation.

References: