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THE PART OF NAVIGATION IN SUPPORT OF HUMAN ACTIVITIES AT SEA

ABSTRACT The title of this paper is identical with the title of the International Scientific and Technical Conferences organized every other year by the Institute of Navigation and Hydrography of Naval University of Gdynia. Therefore, in this paper an attempt has been made to answer the question with whom the maritime navigation cooperates in process of support of human activities at sea, and what matter constitutes the substance of this part of support which is being rendered by the maritime navigation.

The development trends of navigational support of human activities at sea are also discussed and presented.

INTRODUCTION

Now, there exists a great amount of different kinds of human activities realized at sea. This amount is growing steadily and very fast. One of the most characteristic features of the realized now human activities at sea is their steady and fast differentiation. The human activities at sea are being performed by the different kinds of ships that include both: surface ships, merchant vessels and craft, as well as underwater manned and unmanned vessels.

The part of maritime navigation in support of human activities at sea is central and decisive. However, it does not mean that there is not needed the support rendered by other kinds of sciences and technologies, and other kinds of human activities.

Maritime navigation ensures the navigational safety and efficiency of conduct and operation of ships, vessels and craft at sea. However, maritime navigation is not capable of creation and maintaining all the technological, operational and legal conditions needed for realization of all kinds of human activities at sea. Therefore, maritime navigation must closely cooperate with other sciences and technologies in support of human activities at sea.

Taking into account the basic international maritime conventions, such as SOLAS 74 and others, as well as substance of human activities being realized at sea, it can be concluded that maritime navigation must cooperate and cooperates closely with the following sciences, technologies and activities:

- naval architecture and shipbuilding;

- hydrography;
- marine meteorology;
- maritime safety and maritime rescue sciences and technologies;
- radiocommunications;
- hydroacoustics;
- information technologies;
- realization's technologies, operations and procedures of particular kinds of human activities performed at sea.

Taking the above statements into consideration, we can conclude, what was already stated as assumption, that navigation does support the realization of human activities at sea in close cooperation with the above sciences, technologies and kinds of human activities. However, the navigation's support of realization of human activities at sea is decisive, i.e. is leading and organizing. We can also conclude that the expression "the part of navigation in support of the human activities at sea" may be and should be understood as "navigational support of realization of human activities at sea". Therefore, we should also conclude and assume that "the navigational support of realization of human activities at sea" consists in "ensuring such navigational conditions that allow carrying on the human activities at sea safely and efficiently".

In our further consideration, we will try to discuss and present the substance of the navigational support of human activities at sea, i.e. the substance of the expression "the part of navigation in support of human activities at sea". Below there are discussed and presented the following issues:

- characteristic features of main kinds of human activities at sea and their navigational support;
- ways and means of navigational support of standard human activities at sea;
- ways and means of navigational support of special human activities at sea;
- development trends of navigational support of human activities at sea.

1. CHARACTERISTIC FEATURES OF MAIN KINDS OF HUMAN ACTIVITIES AT SEA AND THEIR NAVIGATIONAL SUPPORT

All the human activities realized at sea can be divided into different kinds of human activities according to the assumed criteria. The most common division of human activities at sea is the division according to the kind of the surrounding environment. According to this criterion, there are:

- sea surface human activities (ships tasks);
- underwater human activities (ships tasks).

Both the surface human activities and underwater human activities can be divided into the kinds of activities according to the place where is situated the object of the ship's main task, as well as according to many other criteria. The main criterion of division of human activities into the above kinds of activities is the kind of navigation's environmental information necessary for its realization. However, the most useful division of human activities at sea, that is commonly acknowledged and applied, is the division of there activities into two main kinds of activities:

- standard human activities, called also as navigational human activities;
- special human activities, called also as non–navigational human activities.

As the human activities at sea are realized by the ships, the main criterion of division of human activities into the above kinds of activity we assume the equivalent criterion of the aforementioned one, this is:

Kind of ship's navigation process by means of which the proper kind of human activity is being realized.

The additional criteria of division of human activities, into the above kinds of activities, are criteria that more precisely define the main criterion; these are:

- a. Objective of navigational support of proper kinds of human activity;
- b. Kinds of necessary navigation's environmental information;
- c. Necessity of modification of ship's navigation process.

The human activities are considered to be the standard, i. e. navigational human activities if for their realization is necessary the standard ship's navigation process, therefore, there are also fulfilled the additional, following criteria:

- a. the main objective of the navigational support of these activities is ensuring the safe and efficient conduct the ships at sea;
- b. for realization of these kinds of human activities there is needed only the standard navigation's environmental information;
- c. there is not needed any modification of ship's navigation process in the open sea. However, it needs to be assisted in navigation's hazardous areas.

Before we will specify the kinds of human activities being considered as the standard, i.e. navigational activities, there is necessary to define, more precisely, the meaning of such terms as: "standard ship's navigation process" and "standard navigation's environmental information".

The “standard ship’s navigation process” means such ship’s navigation process that ensures the safety and efficiency of conduct the ship at sea, i.e. process that is realized in accordance with the main international maritime conventions, as well as with resolutions regarding the “maritime safety and efficiency” passed by the International Maritime Organization – IMO. As the main international maritime conventions are considered the following: SOLAS–74, COLREG 72, STCW 79/95, MARPOL 78/79, SAR 79 [The Basic, 2002].

The term: “standard navigational information” means the kinds of information and presentation’s forms of navigation’s environmental information that is prepared and provided to users of sea in accordance with:

- a. Regulation 9, Chapter V of SOLAS 74 regarding hydrographic services;
- b. Resolution A.706 (17) on Word–Wide Navigation Warning Services,
- c. Chapter IV of SOLAS 74 regarding Maritime Safety Information (MSI) provided by the Global Maritime Distress and Safety System (GMDSS).

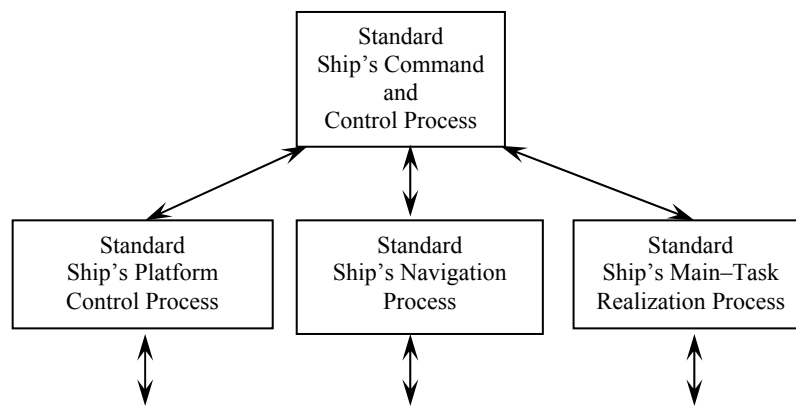


Fig. 1. The Standard Ship’s Operation Process, its component processes and place of the Standard Ship’s Navigation Process among them.

In Fig. 1, there is shown the standard ship’s operation process, its component processes, and place of the standard ship’s navigation process among them. It should be stressed that the ship’s main tasks realization process, shown in Fig. 1, is the process that realizes the ship’s main tasks, i. e. such tasks for which the ship has been built and equipped, and her crew have been trained. For one ship, it can be carrying on the goods, for another – combating sea bottom mines, etc. The ship’s main task is defined by the kind of the ship, i.e. by her kind, her class and type. "The object of the main ship’s task" is any thing, such as goods or persons carried on by the ship; buried sea mine being searched and destroyed; as well as any other thing or activity being the subject of ship's main task. The object of the main ship's task can be situated on own ship (carried goods and persons);

on sea surface or in the air (other ships, aircraft, or object); in sea water (submarines, underwater manned and unmanned vessels); at sea bottom, or in its sediments (buried sea mines, etc). Taking into account the criteria of allocation of the human activities, to the standard human activities, to this kind of activities can be included the following:

- transport of goods and persons;
- sea tourism;
- sea sports activities.

The main characteristic features of the above activities are that the objects of main tasks of these activities are at the board of the ships that realize these activities. However, in practice, there is not the sharp border line between the standard human activities and special human activities. Therefore, in practice, many ships' tasks, objects of whom are situated outside the ship, e.g. at sea surface or above it, and additional information being necessary for realization of these tasks can be archived by the means of the own ship's standard sensors, are also very often considered as standard ship's tasks, i.e. standard human activities.

Such situation takes place especially then, when object of main ship's task is not the material object but activity, such as surveillance, patrolling, monitoring, etc. Therefore, such human activities as law enforcement tasks, surveillance, patrolling and monitoring tasks as well as many other similar activities are also very often considered as the standard human activities.

However, it should be stressed here that standard ship's navigation process cannot everywhere ensure the sufficient level of navigational safety and efficiency of conducted ships. It regards mainly the confined and congested areas, as well as other navigation's hazardous areas. Such situation results from the following reasons:

- in such areas there is usually much higher ships-traffic density than in open sea areas;
- ships do not have the information regarding the dynamic oceanographical and geomorphological conditions in these areas;
- in such areas, there exist a much higher possibility of navigational danger than in open sea.

Therefore, in navigation-hazardous areas the standard ships navigation process must be assisted by the navigation assistance systems, but especially by the vessel traffic systems (VTS) (Kopacz et al., 2003, 2004).

In Fig. 2, there is shown the assisted standard ship's navigation process, i.e. the process that is realized in the confined and congested maritime areas and in other navigation-hazardous areas.

The human activities are considered to be the special, i.e. non–navigational human activities if for their realization are needed the special ship’s navigation process. Therefore, the following, additional criteria must be also fulfilled:

- a. The objectives of navigational support of realization of the special (non–navigational) human activities are:
 - ensuring the safety and efficiency of conduct the ships at sea;
 - ensuring the possibility and high (sufficient) efficiency of being realized human activities,
- b. For realization of the special (non–navigational) human activities there is needed, besides the standard navigational information, also the special navigational information. The term: “special navigation’s environmental information” means the additional (to the standard) kinds of navigation’s environmental information needed for realization of the non–navigational human activities. The special navigational information, like the standard navigational information, contains three main kinds of navigation’s environmental information, i.e. geographical, operational and legal. Special geographical information comprises, as a rule, the following kinds of information:
 - precise bathymetric information regarding sea bottom configuration, sea bottom sediments, sea bottom layers, etc.;
 - oceanographic information describing the physical properties of sea water and its static and dynamic characteristics;
 - geophysical information presenting the characteristics of the different kinds of physical Earth’s fields;
 - precise information describing the physical properties and characteristics of the beach zones, etc.
- c. There exists the necessity of modification of ship’s navigation process in order to adapt it for realization of the non–navigational (special) kinds of human activities.

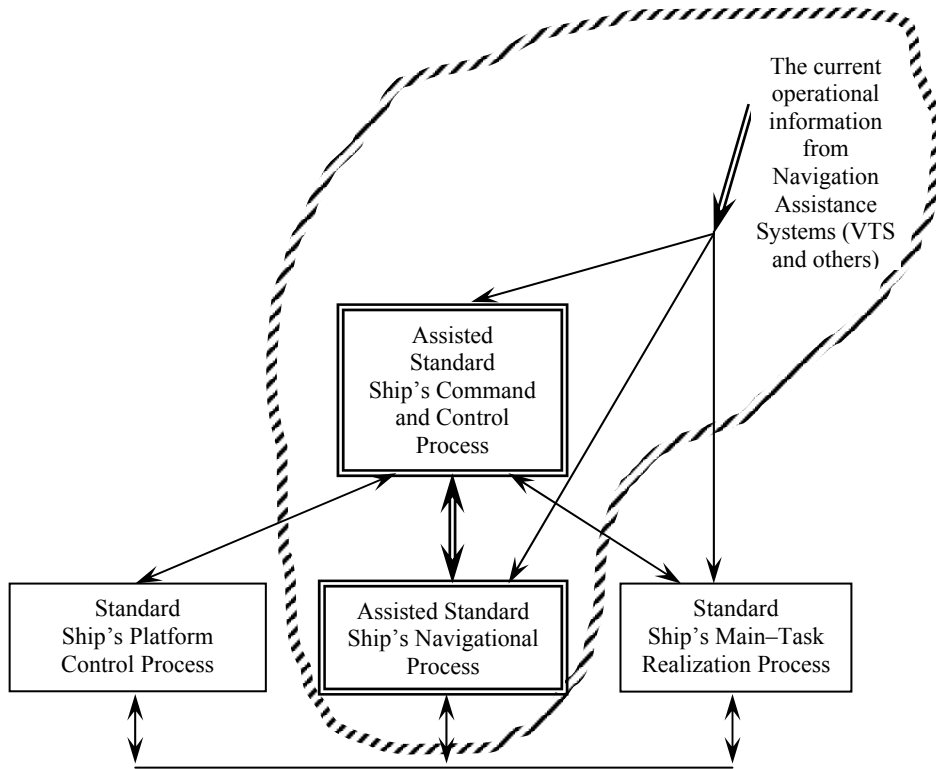


Fig. 2. Assisted Standard Ship's Operation Process, its component processes and Assisted Standard Ship's Navigation Process among them.

In Fig. 3, there is shown the special ship's operation process, its component processes and special ship's navigation process among them.

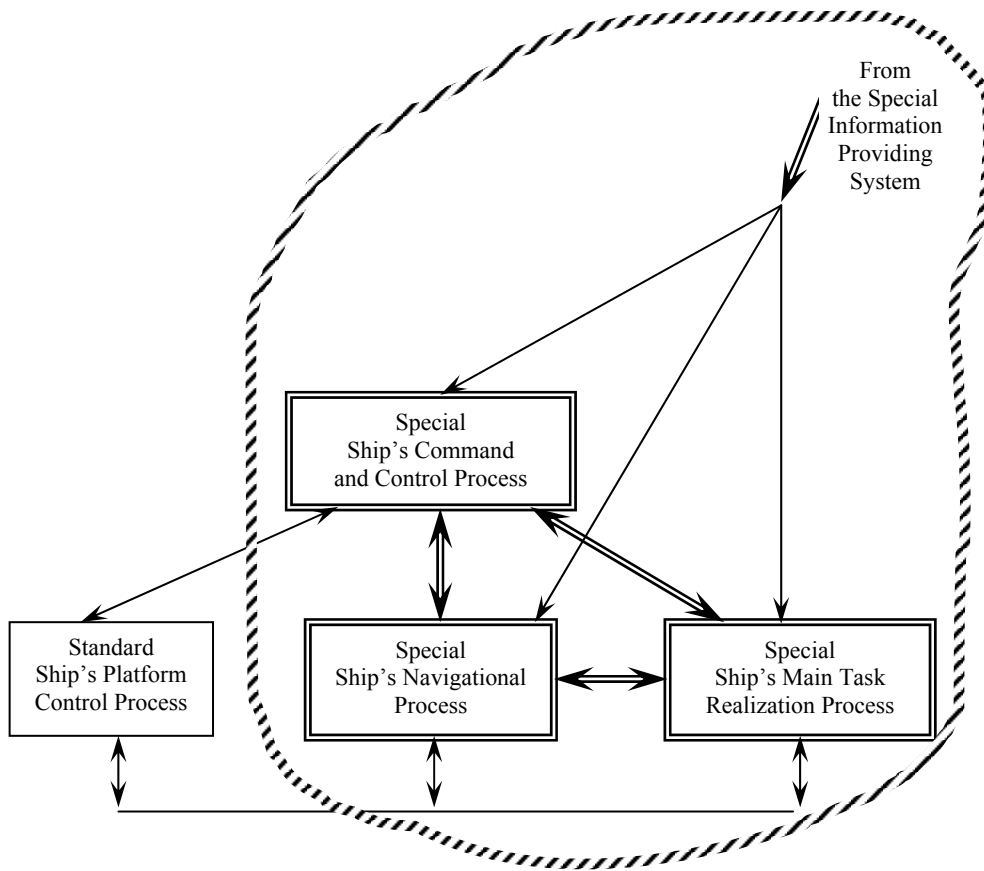


Fig. 3. Special Ship's Operation Process, its component processes and Special Ship's Navigation Process among them.

According to the aforementioned criteria, to the non-navigational human activities belong the following kinds of activities at sea:

- a. Submarine and anti submarine warfare activities;
- b. Mine warfare activities;
- c. Special warfare activities;
- d. Amphibious warfare activities;
- e. Sea fishing;
- f. Sea surveying;
- g. Oceanographical, geophysical and geological explorations;
- h. Searching and removing the underwater obstacles;

- i. Establishing and maintaining the elements of navigational infrastructure;
- j. Establishing and maintaining the objects of the sea–resources, exploitation infrastructure, including pipe and cable laying, etc.;
- k. Underwater archeology tasks, as well as many other activities being the special ones.

In Table 1, there are given the main features of ship’s navigation process being the function of kinds and forms of human activities realized at sea.

Table 1. The main features of ship’s navigation process as a function of kinds and forms of human activities realized by ships at sea.

Main and additional features of ship’s navigation process	Kinds of human activities		
	Standard (navigational) human activities at sea		Special (non–navigational) human activities at sea
	At open sea	In navigation–hazardous areas	
Name of ship’s navigation process	Standard ship’s navigation process	Assisted ship’s navigation process	Special ship’s navigation process
Main objectives of navigational support of realization of human activity at sea	Ensuring the safety and efficiency of conduct the ships at sea	Ensuring the safety and efficiency of conduct the ships in confined and congested maritime areas	<ol style="list-style-type: none"> 1. Ensuring the safety and efficiency of conduct the ships at sea 2. Ensuring the navigational possibility and high efficiency of special human activities at sea
Kind of necessary navigation’s environmental information	Standard navigation’s environmental information	Standard navigation’s environmental information	<ol style="list-style-type: none"> 1. Standard navigation’s environmental information 2. Special navigation’s environmental information
Necessity of modification of standard ship’s navigation process	Not necessity of modification of standard ship’s navigation process	It is necessity of slight modification of standard ship’s navigation process	There is necessity of transformation of standard ships navigation process into special ship’s navigation process
External Navigation System supporting the realization of ship’s navigation process	Safety Of Navigation System (Safety and Security of Life and Property System)	- Safety Of Navigation System (Safety and Security of Life and Property System) - Nav–assistance systems (VTS system and others)	<ol style="list-style-type: none"> 1. Safety of Navigation System (Safety and Security of Life and Property System) 2. System supporting the realization of special (non–navigation) human activities (special ships tasks)
Number of figure illustrating the ship’s navigation process	Fig. 1	Fig. 2	Fig. 3

2. WAYS AND MEANS OF NAVIGATIONAL SUPPORT OF THE STANDARD HUMAN ACTIVITIES AT SEA

The main objective of the navigational support of human activities at sea is ensuring the safety and efficiency of conduct the ships at sea. Therefore, ensuring the navigational safety of these activities is the basic requirement as well as precondition of realization of each kind of human activity at sea. Without ensuring the navigational safety, i.e. safety of conduct the ship at sea, the ship can be damaged or wrecked, and her crew can suffer injuries or loss their life. The safety of navigation is being achieved in the two-step process contains:

- creating and maintaining, by the international Safety-Of-Navigation System, the necessary conditions for achieving the safety of navigation;
- conducting the ships at sea safely and efficiently, i.e. according to the rules and requirements laying down by this system.

“Safety of navigation”, called also as “navigational safety” is the constituent part of the maritime safety. The notion “safety of navigation” has two close related meanings. The first meaning of “safety of navigation” denotes “ship’s navigational safety”, i.e. the state of being safe from such dangers as:

- collision with other ships and sea-surface objects;
- grounding and running wrecks and other sea-bottom obstacles;
- extreme weather conditions and unfavorable hydrometeorological phenomena;
- pollution of marine environment from ships.

The second, much wider, meaning of the notion “safety of navigation” means the “safety of life and property at sea” from the above dangers, but included also the safety of shipwrecked persons.

Safety of navigation is being achieved by the strict obeying all the navigational requirements passed by the proper international (IMO), regional (Council and Parliament of the EU), national (parliaments and governments), and local maritime authorities.

The requirements regarding the safety of navigation are contained in the following legal acts:

- international maritime conventions and IMO’s resolutions;
- directives of the Council and Parliament of the European Union;
- national laws;
- orders of the local maritime authorities.

The basic international maritime conventions regarding the safety of navigation are the following:

- International Convention for Safety of Life at Sea, 1974 – SOLAS 74, (Chapter V, as well as Chapter III, IV and some regulations contained in other Chapters);
- Convention on International Regulations for Preventing Collision at Sea, 1972 – COLREG 72;
- International Convention on Standards of Training, Certification and Watchkeeping of Seafarers, 1978/1995 – STCW 78/95;
- International Convention for Prevention of Pollution from Ships, 1973/1978 – MARPOL 73/78;
- International Convention on Maritime Search and Rescue, 1979 – SAR 79.

The IMO's resolutions regarding the "safety of navigation" concern mainly the following issues:

- Ships' Routing;
- Vessel Traffic Services;
- Ships Reporting System;
- Pilotage;
- Navigational Charts;
- Shipborne Navigational Equipment;
- World-Wide Navigation Satellite Systems;
- World-Wide Navigation Warning System.

Safety of navigation is being achieved and checked while the realization of ship's navigation process that is the component part of the ship's operation process (cf. Fig. 1). The "safety of navigation", as aforesaid, is the constituent part of the "maritime safety". Therefore, the Safety-Of-Navigation System constitutes the component system of the Maritime Safety System. This system, after 11.09.2001, i.e. after the terrorist attack in USA, must also ensure the maritime security for all the maritime industries [The basic, 2002].

In Fig. 4, there is shown the place of the Safety-Of-Navigation System in the Maritime Safety System. In Fig. 5, there is shown the place of the Ships Navigation Safety System in the Safety-Of-Navigation System (Safety and Security of Life and Property System). And in Fig. 6, there is shown the hierarchical structure of the Ships Navigation Safety System.

The safety of navigation is being achieved and checked while the realization of navigation process of each ship and craft. This process has been comprehensively described and published in few papers (Kopacz et al., 2003, 2004, Urbanski et al., 1998). Therefore, it will not be presented here.

It should be also emphasized here, that now the ship's navigation process is being integrated with other ship's processes into the Integrated Ship's Navigation/Operation Process whose objective is "safe and deficient operating the ship at sea" (Kopacz et al., 2003).

The ship's navigation process should be safe and efficient. Therefore, we want here to discuss how the efficiency of ship's navigation process is being achieved. The expression "efficiency" has many meanings. The basic meaning of this expression denotes "the ratio of effects to costs". To this end, the effects and costs must be expressed in the same kinds of measure, e. g. money, etc. However, not always it is possible to fulfill these requirements. Therefore, in maritime navigation the efficiency is being also expressed as relation of costs and benefits. The main kinds of benefits are: decreasing the probability of collisions, groundings, traffic densities, as well as danger of environmental pollution etc. Benefits can be also expressed as increase of the economic efficiency of ports and their facilities. The methodology of evaluating such efficiency is given in "Guidelines for Formal Safety Assessment (FSA) for Use in the IMO Rule-Making Process". The human reliability analysis and evaluation are also provided by these Guidelines [The basic, 2002].

Another meaning of the expression "efficiency" denotes the ability of producing the desired effect skillfully and perfectly, i.e. with minimum efforts, expenses and use of time [Webster, 1986]. This meaning of expression "efficiency" is very close to meaning of the expression "proficiency", i.e. the ability and skill of doing anything very competently, i.e. without delay and without losses. This meaning of notion "efficiency" is being applied for evaluation of the quality of controlling the ship's navigation process and all its procedures.

The issues of the navigational efficiency, considered as professional efficiency, are being considered and expressed by the Convention STCW 78/95 and by other regulations and standards regarding human reliability and its influence on the quality of ship's navigation process.

3. WAYS AND MEANS OF NAVIGATIONAL SUPPORT OF SPECIAL HUMAN ACTIVITIES AT SEA

Starting the presentation of ways and means of navigational support of special human activities at sea, it should be stressed that, in Poland, the navigational support of special human activities, carried on by the naval forces, is called "navigational and hydrographic support". In NATO's naval forces such support is called the "geographical support".

However, the “navigational support” has very wide meaning because it comprises all kinds of human activities, including the industrial activities, and it comprises the whole navigational environment and its information, including the oceanographical and meteorological ones. The special human activities are not the homogenous ones. In contrary - they are very heterogeneous. Therefore, the navigational support of such heterogeneous activities, but especially the planning and organizing of navigational support of these activities, can differ considerably. Hence, our further considerations, statements and conclusions regard mainly the navigational support of naval warfare activities.

The main objective of navigational support of realization of special, human activities is to ensure:

- safety and efficiency of conduct the ships at sea;
- navigational possibility and high efficiency of realized human activities at sea (cf. Tab. 1).

The ways and means of achieving the first part of the above objective has been already presented in the previous section of this paper. Therefore, below, there are presented the ways and mean of the achieving the second part of the objective of navigational support of special human activities, i.e. ensuring the navigational possibilities of realization of special human activity and high (sufficient) efficiency of its realization.

Ensuring the navigational possibilities of realization of special activity at sea starts with the evaluation and establishing the technological, operational, legal and navigational conditions that should be fulfilled in order this kind of special human activity could be realized.

Ensuring the high (sufficient) efficiency of realization of given kind of human activity at sea consists in assessment and establishing – according to Formal Safety Assessment methodology or similar one – the most proper variant of realization of given kind of special human activity at sea, i.e. such variant that ensures the best effect (benefits) and the lowest costs.

Below, there are given, in shortened form, only the general principles of the planning and organizing the navigational support of special human activities at sea. In addition, we assume that the process of planning and organizing the navigational support is being fulfilled by the team of experts of navigational support.

In order to achieve the objectives of the navigational support of being realized ships’ special tasks, the team of experts of navigational support must work out the answers to the following questions:

- are needed the additional elements of the navigational infrastructure, including the additional elements of position–fixing system;
- what kind of special information are needed, in what form, and how should operate the special information providing system;

- how should be modified the ship's navigation process (what kinds of new shipborne equipment and systems are needed, etc.);
- how should be organized and realized the ship's operational process and procedures realizing the special tasks.

In Fig. 7, there are shown the elements of the process that prepares the necessary data and plan for organizing and carrying on the navigational support of ships special tasks. Here, it should be stressed the necessity that while working out the plan of navigational support of realization of ships special tasks, the issues of ensuring the maritime security must be also taken into considerations (Kopacz et al., 2004).

2. THE DEVELOPMENT TRENDS OF THE NAVIGATIONAL SUPPORT OF HUMAN ACTIVITIES AT SEA

The present world's economic, political and social development and its tendency show that the human activities at sea are more and more numerous and differentiated. More and more of these activities are the underwater activities. Therefore, they are the special, i.e. non-navigational activities. It means that especially rapidly are being developed the special human activities. All kinds of activities must be navigationally supported.

However, in the same time, follows the steady and fast progress of sciences and technologies what results among other, in:

- producing and applying more and more perfect hydroacoustic systems of gathering the standard and special information, as well as systems of its processing, to the forms, in which this information can be applied by users of sea realizing both standard and special human activities at sea,
- providing the users of special information with the Additional Military Layers for Electronic Navigational Charts what simplifies incommensurably the whole process of navigational support of realization of special ships tasks,
- easy access and use of more and more accurate global positioning systems fulfils practically all requirements of all surface users of sea what considerably alleviates and simplifies the navigational support of all human activities at sea, including the navigational support of special human activities

Taking the above into consideration, as well as fast development and perfection of underwater communication devices and systems, it can be concluded that there exist all necessary conditions for increasing and perfecting the organic ships possibilities for realizing the navigational support of human activities at sea, especially, the special human activities. It means that ships and underwater vessels are being less and less dependent upon the coastal Positioning and Special-Information-Providing System. This tendency regards mainly the surface naval ships and their underwater manned and unmanned vessels as well.

However, it should be stated that there exist very many reasons that considerably decrease the level of safety and efficiency of conduct the ships at sea. The most important of these reasons are the following:

- steady increase of the amount and size of ships what results in increasing the danger of collisions, groundings, etc.;
- steady increase of the amount and sizes of tankers that are carrying a huge amount of dangerous liquids and gases. The above results in increase of the danger of marine-environment pollution, as well as danger of ecological catastrophes;
- permanently is being increased the threat of terrorist attacks of ships, ports and their facilities, inshore exploitation infrastructure and even the marine environment.

This threat must be effectively counteracted. Monitoring and controlling not only ships traffic but also the goods being transported by the ships constitute the very effective measures for fighting the world's terrorism.

Taking into account the current state of dangers and threats for human activities at sea, the most probable scenario of future dangers and threats as well as permanent development and improving the VTS systems and other coastal navigation-assistance systems – the following conclusions can be made:

- VTS systems, as well as other navigation-assistance systems are not only increasing coverage ranges but also their involvement in the safe and efficient conduct the ships at sea;
- The safety and efficiency of the ships conduct at sea will be in greater and greater degree dependent not only on the quality of the standard ship's navigation process but also on the quality of the assistance rendered by the navigation-assistance systems;
- VTS system, together with the AIS systems and other ones, because these systems are very effective for ensuring not only the maritime safety but also for ensuring the maritime security, i.e. security against the terrorist threats - these systems will be transformed stepwise

into the Maritime Monitoring System of the ships traffic and all activities realized at sea.

CONCLUSIONS

The general principles, as well as the basic ways and means of the standard and special human activities at sea have been presented in this paper. Presented considerations and statements allow to draw up the following conclusions:

- navigational support of special human activities at sea, especially activities realized by the naval ships and their underwater manned and unmanned vessels, are being less and less dependent upon the additional navigational measures that in the past were essential in order to ensure the possibility of realization and high efficiency of having been realized special human activities at sea;
- navigational support of standard human activities, i.e. ensuring the safety and efficiency of being conducted ships at sea, in greater and greater degree are becoming dependent also upon the assistance rendered by the coastal navigation–assistance systems;
- today’s coastal navigation–assistance systems, such as VTS, AIS, and others, are being stepwise transformed into national, regional and international the Maritime Monitoring Systems supervising the ships traffic and all kinds of human activities being performed at sea.

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