

Elaboration of detailed study on the establishment of a new ship routing system in territorial sea of the Republic of Bulgaria

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ABSTRACT. The current manuscript aims to present the main content and results of the analysis of the system for vessel traffic in the territorial sea of the Republic of Bulgaria, consisting of 485 pages. As a result of the study the research team proposed a new ship routing system to be established in the territorial waters of the Republic of Bulgaria. The new system will enhance safety of navigation and will have ecological impact - moving the system eastward (off the coast) provides the coastal State with more time in combating the consequences of a pollution.

KEYWORDS. analysis; routing system; territorial sea; new traffic separation scheme.

I. INTRODUCTION

By its geographical position the Black Sea is an internal, intercontinental sea. It is relatively small in size - its total area is 422 000km², with kidney-shaped form. The Black Sea waters wash the shores of Bulgaria, Romania, Ukraine, Russia, Georgia and Turkey.

The link of the Black Sea to the World Ocean is through so named "the Black Sea straits". The Bosphorus Strait connects it to the Sea of Marmara. Through the Dardanelles Strait, connecting the Marmara and Aegean (White) Sea, the Black Sea is linked to the Mediterranean Sea and the Atlantic Ocean. Over 50 000 transit vessels pass through the Black Sea straits per year. On the northeast, through the shallow Kerch Strait (between Kerch and Taman peninsulas), the Black Sea is connected to the Sea of Azov.

The coastline of the Black Sea is poorly lacerated. Its total length is 4090 km. Only 378 kilometers, or 9.2% of it is Bulgarian. The coastline of the Bulgarian Black Sea coast is quite variable. This is due to geology, bedrock shore recent vertical movements of the earth layers. Alternating areas of depressions and elevations on the ground formed a different type of coastline. In the southern part of the coast (Strandja Black Sea coast) were characterized by numerous small bays, coves, peninsulas and several smaller islands. In the northern part to the border with Romania dominates the abrasive nature of the beach. Coastal forms are highlighted by multiple platters and decreases near estuaries Provadiyska and Batova. Distinctive features are the presence of numerous landslides formation firth lakes, numerous sandy beaches. Two large bays give shelter to the main Bulgarian ports – Varna and Burgas.

The term "Bulgarian sector of the Black Sea" has arisen as a result of the new geography of the oceans, laid out by the "United Nations Convention on the Law of the Sea" from 1982 (UNCLOS'82). According to this unique international relations document each coastal State exercises exclusive sovereignty or certain sovereign rights and jurisdiction over part of its respective adjacent sea areas, the boundaries of which are determined on the basis of contracts with neighboring or opposite coast countries. Based on this assumption, the Republic of Bulgaria, by the power of its 1987 "Law on Maritime Spaces" exercise the above rights over part of the Black Sea, which we call "Bulgarian sector."

The area of the Bulgarian Black Sea Coast is located in the western part of the Black Sea between the parallels 43°44,2' and 41°59' north latitude. The maritime areas of the Republic of Bulgaria, covering internal waters, territorial sea, contiguous zone, continental shelf and exclusive economic zone, are located along the sector.

The territorial sea (12 nautical miles width, measured from the baselines) and internal waters, together with the airspace above them, their seabed and subsoil are part of the territory of the Republic of Bulgaria over which the state carries out its sovereignty.

In order to ensure the safety of the vessel traffic, as well as to perform business, science, entertainment and other activities, and not least in order to effectively protect the marine environment, currently in the maritime spaces of the Republic of Bulgaria there is a system of zones in which specific activities are performed, as follows:

a) Zone "Traffic separation scheme" (TSS) – according to Annex № 5 of the "Ordinance on traffic systems, reporting and traffic management and information services for the movement of vessels in the maritime spaces of the Republic of Bulgaria" issued by the Minister of Transport, Information Technologies and Communications.

b) Zone „Berths” – in accordance with Chapter 5 of the Mandatory rules for the seaports of the Republic of Bulgaria issued by the EA "Maritime Administration";

c) Zone "Areas prohibited for marine traffic" - in accordance with areas declared via "Notices to Mariners" and published in the Admiralty and Bulgarian charts;

d) Zone "Areas prohibited for anchoring, demersal fishing, underwater and dredging works, bottom trolling and explosions" - in accordance with areas declared via "Notices to Mariners" and published in the Admiralty and Bulgarian charts;

e) Zone "Areas for disposal of dredging materials" - in accordance with areas declared via "Notices to Mariners" and published in the Admiralty and Bulgarian charts;

f) Zone "Areas for underwater activities with educational purposes and underwater tourism"- in accordance with "Ordinance H-7 from 2008 on the performance of diving and other underwater activities" issued by the Minister of Defence, Minister of Internal Affairs and Minister of Transport, Information Technologies and Communications.

Maritime traffic of commercial vessels traveling daily in areas of the Bosphorus, ports of Bourgas, Varna, Constanta, Odessa and the Sea of Azov exceeds 2,500 ships simultaneously. If the fishing vessels, yachts and other vessels for entertainment, are added, their number will significantly increase. The maritime routes in the Western Black Sea with most intensive traffic are presented in Figure 1. In the recent decades, vessel traffic has constantly been increasing, which creates prerequisites for the emergence of more incidents and accidents at sea.

The implementation of the vessel traffic system for movement in the maritime areas of the Republic of Bulgaria aims at increasing the safety of life at sea, ensuring safety of navigation, better protection of the environment from pollution by ships and reducing the risk of vessels accidents. The system is entirely located in the internal waters and territorial sea of the Republic of Bulgaria. The system is not adopted in accordance with Regulation 10 "Ships' Routing" of the "International Convention for the Safety of Life at Sea" from 1974, as amended (SOLAS'74).

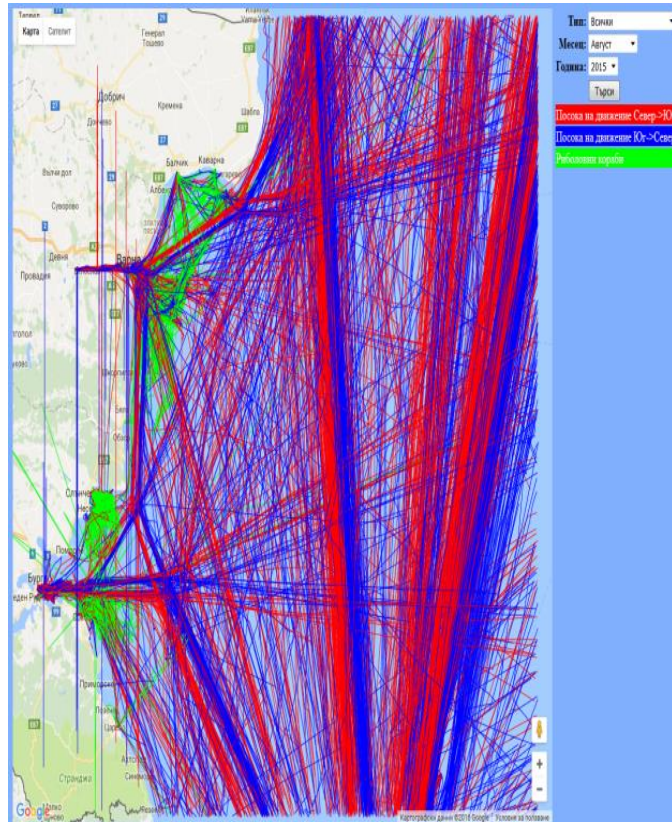


Figure. 1. Maritime routes in the Western Black Sea

II. CRITERIA FOR THE ANALYSIS OF THE EXISTING SYSTEM FOR THE MOVEMENT OF VESSELS IN THE TERRITORIAL WATERS AND INTERNAL WATERS OF THE REPUBLIC OF BULGARIA

The system for movement in the maritime spaces of the Republic of Bulgaria brings together 9 parts: 1) TSS; 2) Bidirectional routes; 3) Recommended routes; 4) Areas that shall be avoided; 5) Areas prohibited for anchoring; 6) Coastal zones for movement; 7) Roundabout zones; 8) Protection zones and 9) Deepwater routes.

The Bulgarian TSS consists of 13 sections (see Figure 2). It serves for movement between the main ports along the coast and approaching (exit) to (from) them by all foreign and Bulgarian vessels with a displacement of over 300 BT. Ships must sail only in the designated corridors for movement, while respecting the rule that the separation zone (line) is always to the left of their board. Traffic lanes should be entered and exited through their ends, as a rule. When the ship leaves the corridor in a middle section or enters it from the side, this should be done in the most acute angle to the main direction of motion. Crossing the traffic lanes should be avoided and, where necessary, shall be made in the most perpendicular possible direction to the main direction of movement. When moving in a traffic separation scheme seafarers must comply with Rule 10 of the “Convention on the International Regulations for Preventing Collisions at Sea” from 1972 (COLREG’72). The TSS is in a functional connection to the recommended routes to sail to ports Balchik, Kavarna, Nessebar, Sozopol, Primorsko and Tsarevo.

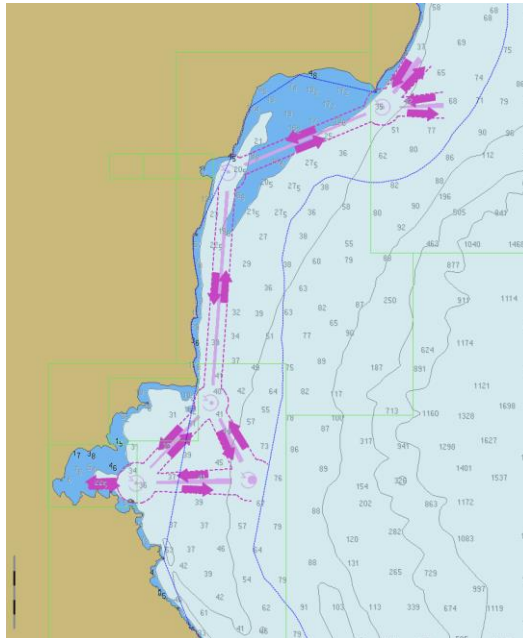


Figure. 2. Existing TSS in the Republic of Bulgaria

The TSS is designed for safe maneuvering of ships when sailing in high traffic areas and entry and exit ports, berths and other distinct areas. Traditionally, the systems for separate movement are designated in areas where the traffic is more intense than usual and the regulations introduced by COLREG'72 and applicable at open sea, are not enough to ensure the safety of shipping.

In this regard, the TSS should provide for the following tasks:

- a) Safe movement of the vessels, including the safe maneuvering when passing by, overtaking other vessels and any possible situations;
- b) Reliable traffic control by the authorized coastal and sea-based platforms.

The first task is essential for the system and is associated mostly with the need to build and implement a system of movement that can satisfy the utmost requirements for safety of navigation. It should also provide comfort in the activities related to the navigation such as navigation guidance, maneuvering for safe passing by, maintenance of course and speed, etc.

The second task is related to the need for maintenance of the existing manner of vessel movement in the TSS. This mainly includes the following activities:

- Traffic surveillance;
- Two-way communication;
- If necessary, enforcing compliance with the safety measures for movement in the TSS.

Additionally, the TSS serves to regulate the traffic in order to provide convenience in the process of exploitation of the maritime areas by the state, and in this sense, the following additional tasks can be formulated:

- Ensuring the maritime economic activities of the state;
- Providing convenience and compatibility in various maritime activities.

A **system of criteria** is used to assess the suitability of the traffic separation system for the implement the inherent tasks. These criteria can directly be formulated based on the tasks that are being addressed by the TSS. For the purposes of this study, the following specific criteria were developed in the areas:

1. Criteria arising from the regulations of International Maritime Organization (IMO), EU and national regulations (Cr.1)

The main criteria related to legislative base are as follows:

- Applicability of conditions stemming from COLREG'72 regarding entering, passing, overtaking, avoidance collision and exit from TSS;
- Ability to use the established rules of "good sea practice" in maneuvering.
- Degree of reporting on the recommendations of Part A "General provisions on ships'routing" Section 6 "Design criteria" of the "Ships' Routeing" 2015 edition (published by IMO);
- Accordance with the right of innocent passage under part II. „Territorial sea and contiguous zone”, section3 „Innocent passage in the territorial sea” of UNCLOS'82;
- Ability to comply with the procedure for declaring the TSS in case part(s) of it is located outside the territorial sea, in accordance with Article 3.8 of Res.A.572(14),„General Provisions on Ships' Routing” of the IMO;
- Compatibility with the national legislation.

2. Criteria related to maritime safety (Cr.2)

The main criteria related to maritime safety can be synthesized as follows:

- extent of the influence and relative constancy of the physio-graphic characteristics affecting the navigation. (It is reasonable to assume that where the characteristics are constant throughout the area, safety is higher);
- overlap with areas of tourist activity and cabotage;
- geometric dimensions of the traffic separation system in order to have enough space to maneuver safely, including in emergency situations;
- proximity to zones with intensive traffic, for example the proximity to entrances to ports;
- presence of physical obstacles (islands, capes and other obstacles, limiting visibility);
- obstacles related to visual and radar observation;
- distance from navigational hazards (shallow waters, etc.);
- time required to help in emergencies -the faster it is to the shore, the faster the assistance;
- complexity of the system (need for frequent change of course);
- proximity and intensity of the economic activity(resource extraction, fishing, etc.);
- necessary navigation equipment for the system.

3. Criteria related to maritime security (Cr.3)

The topic of maritime security gains importance in view of the increasing number of threats related to the unstable international situation and the growing number of terrorist attacks in recent years.

The following criteria for evaluation of security in the TSS were derived:

- degree of protection from terrorist attacks with small-sized vessels (high-speed boats and other vehicles);
- protection from underwater explosives (mines);
- protection in times of conflict;
- control in order to prevent smuggling and other illegal activities;
- monitoring of the traffic;
- degree of overlap with areas of Navy activities;

- possibility of unauthorized actions by vessels, using the TSS, against the sovereignty of the state (release of saboteurs, placement of mines, terrorist act with the use of a ship as a weapon, etc.).

4. Criteria related to the prospects of development of national maritime areas in the areas of economy and tourism (Cr.4)

The diverse natural resources of the Black Sea region are a prerequisite for the development of broad economic activity. Climatic resources being most important. The increased activity in the Black Sea leads to competition between sectoral interests, such as shipping and maritime transport, offshore energy, ports development, fisheries and aquaculture, as well as problems related to the environment.

The following criteria for evaluation of the economic activity were derived:

- compatibility with projects for development of the energy transport and power generation infrastructure (offshore activities);
- compatibility with areas for maritime tourism;
- compatibility with areas for fisheries and aquaculture.

5. Criteria related to ecology (Cr.5)

The criteria related to ecology are classified as follows:

- provision of adequate time to respond to spills;
- convenience of the management, maneuvering and provision of forces to counteract a spill;
- possibility of contamination of the coast line by spills and other pollutants. This concerns the scheme of currents and the possibility of a spill spreading to the coastal line;
- extent of overlap with areas with ecological status;
- ability to control violators of the environmental regime.

6. Criteria related to the technical requirements to the system for vessel traffic management (radar observability, range of constructed systems for communication and control, etc.) (Cr.6)

For the purposes of managing vessel traffic, an information system VTMS is built in the national maritime spaces, and additionally the systems of Border Police, Navy, Customs Agency exist in parallel.

The following criteria are listed to assess the technical requirements for the vessel traffic management system:

- extent of coverage by technical means for surveillance;
- extent of coverage by technical means for connection;
- ability to combine politype surveillance systems to enhance the authenticity of the visual image. Meaning the combination of radar, visual and other types of surveillance;
- capability to deliver other technical services (internet, mobile operators, etc.);
- reliability of the operation of the technical systems for surveillance and connection.

III. ANALYSIS OF THE EXISTING VESSEL TRAFFIC SYSTEM IN THE TERRITORIAL SEA AND INTERNALS WATERS OF THE REPUBLIC OF BULGARIA

The analysis is performed in the following sequence:

- the advantages and disadvantages of the existing system under the criteria listed in Part II of this work;

- recommendations for compensation of the disadvantages in combination with retention of the advantages are formulated;
- a new system is formulated;
- the advantages and disadvantages of the newly formulated system are determined;
- measures for compensation of the disadvantages of the new system are generated.

The research team analysis the advantages and disadvantages of every criterion. The general conclusions are listed below:

Criteria	Main recommendations
<p>Cr.1 - Divided into 12 sub- criteria</p>	<p>Rec.1.1 - Shift of the TSS eastwards in order to separate classic (conventional) vessel traffic and reduce the overlap of the areas for movement of vessels of less than 20 meters, sailing ships, vessels engaged in fishing. Rec.1.2 - Organization of maritime traffic of fishing vessels moving from/to fishing areas shall be created. Rec. 1.3 - When the new TSS falls outside the territorial sea, it shall be adopted by IMO. When developing the TSS fully inside the territorial sea, items 3.12 and 3.13 of the Res.A.572(14) of the IMO shall be followed.</p>
<p>Cr.2 - Divided into 20 sub- criteria</p>	<p>Rec.2.1 - Increasing the distance of the elements of the TSS from the shore reduces the likelihood of realization of tourist activity in them. Conflict points with the cabotage shipping are reduced. Rec.2.2 –Moving the system away from the coast has an advantage, represented in the relative degree of persistence of the impact of winds, currents and swell. Rec.2.3 – There is a possibility for the new TSS to be shifted away from the routes and areas of fishing vessels. Rec.2.4 - The main advantage of moving the TSS eastward is the presence of sufficient depths and practically absent of navigational hazards. Rec.2.5 - The shift of the TSS away from the coast leads to an increase in reaction time in case of emergency. Rec.2.6 - The shift of the TSS away from the coast allows for a simplification of the new system in a structural aspect.</p>
<p>Cr.3 - Divided into 9 sub- criteria</p>	<p>Rec.3.1 - Increasing the distance from shore reduces the likelihood of detecting small-sized vessels. The deployment of a new system shall be coordinated with the Ministry of Defense and Ministry of Interior in order to provide reliable surveillance system at all hydro-meteorological conditions, and counter the detected threats. Rec.3.2 - New areas shall be investigated for the presence of old underwater explosives and for the acquisition of a detailed imaging of the seabed. Rec.3.3 - The shift away from the shore hinders the monitoring for the performance of smuggling and other illegal activities. The deployment of the new system shall be coordinated with the Ministry of Interior and Ministry of Defense to provide a reliable surveillance system, applicable in all hydro-meteorological conditions, and countering the detected threats. Rec.3.4 - The shift to the east will cause an overlap with areas of Navy activities and will require a new spatial planning. Rec.3.5 - The deployment of the new system is recommended to allow for the optimum combination of reliable detection of vessels with features forecasting that they will perform a terrorist act, rapid response against the source of the threat and hindering to reach the critical infrastructure and other potential targets.</p>
<p>Cr.4 - Divided into 3 sub- criteria</p>	<p>Rec.4.1 - The new TSS shall be moved away at a maximum distance from the areas for maritime tourism. Rec.4.2 - The TSS must be shifted eastwards in order to prevent the conflict arising from the placement of anchoring buoy (part of Burgas – Alexandrupolis oil pipeline plan) near the roundabout in front of Bourgas.</p>

<p>Cr.5 - Divided into 5 sub- criteria</p>	<p>Rec.5.1 - Shift of the traffic separation scheme eastwards in order to provide greater time period for preparation and implementation of operations for combatting spills. Rec.5.2 - Shift of the traffic separation scheme eastwards in order to provide greater freedom of maneuvering of the forces, engaged in countering a spill. Rec.5.3 - Shift of the traffic separation scheme to the east in order to reduce the degree of overlap with protected areas of the single European ecological network of areas with special regime of protection.</p>
<p>Cr.6 - Divided into 5 sub- criteria</p>	<p>Rec.6.1 - The new traffic separation system must remain within the coverage of the existing means for surveillance from VTMISS. Rec.6.2 - The new traffic separation system shall remain within the coverage of the existing networks of the mobile operators. Rec.6.3 - The technical means and capabilities for monitoring and control are also currently owned by the Navy of the Republic of Bulgaria (Radar system for control of shipping and security of the maritime borders "Screen") and the Border Police of the Ministry of Interior (Integrated Surveillance System for monitoring of the maritime borders of the Republic of Bulgaria "Blue border"). At present, there is no possibility for technical integration of information from these 3 systems. A project to integrate information from the existing systems is expected to be developed under the initiative of the European Commission in the maritime region CISE (Common Information Sharing Environment).</p>

The analysis shows both strong and weak features of the existing system as the later are predominant.

The strengths of the existing system are:

- The TSS has been used for a long time, it is reliable and reflects upon the Maritime transport system;
- The proximity of the TSS to the coastline contributes to the visual surveillance and identification, as a supplementary channel for confirmation of the identification of vessels, lowers the extremity of the hydro-meteorological conditions and shortens the response time in the conduct of search and rescue operations.

The negatives of the existing system are:

- The small distance of the TSS from the coast line creates natural conditions for the occurrence of hazards to loss of lives in collisions between vessels, in fire, danger for stranding or sinking;
- The TSS creates conditions for the rapid attainment of petroleum contaminants to the coastal areas, beaches, critical infrastructure, mussel farms and other protected areas, thus reducing critical response time in such incidents.
- The proximity or overlap of part of the TSS with NATURA 2000 zones and the zones for security and safety of the critical infrastructure brings risks for these zones due to the reglamented passage of vessels through them;
- The location of the TSS is in conflict with the routes of fishing vessels and vessels for entertainment and maritime sports, as well as with potential projects for development of the economy, which are prerequisites for accidents with navigation safety.

Conclusion: A general amendment to the zones, aimed at compensating for the identified weaknesses, shall be conducted.

IV. PROJECT FOR THE AMENDMENT OF THE VESSEL TRAFFIC SYSTEM IN THE TERRITORIAL SEA AND INTERNALS WATERS OF THE REPUBLIC OF BULGARIA

The traffic separation scheme for vessels in the area of the Bulgarian Black Sea coast passes too close to the coastline. In the current conditions of intensive shipping, the dimensions of the passing ships, the type of freight and particularly dangerous goods such as chemicals and petrochemicals, under the influence of overwhelming natural forces, human error, technical faults and others, creates real conditions for marine pollution of the sea and coastal area including the beach. Based on the analysis of ship traffic, it can be concluded that it is necessary for shipping lanes and approach areas to move deeper into the sea (in the east, close to the border of the territorial sea).

The concept for amendment reduces the unnecessary turn circles and moves the TSS away from the coast to protect the sea from pollution in cases of sudden accidental spills of oil and / or other dangerous loads, by providing the forces and means to combat emergency spills with a longer time to organize and respond appropriately. The proposed draft amendment to the TSS (see Figure 3) has been designed so that it does not interfere with amateur diving at shipwrecks suitable for tourist purposes. It is necessary to define and officially select and announce an official location of a depot for damaged ships.

Zones west, north and south of the restrictive lines shall be free for navigation of vessels of under 300 tons, fishing vessels up to 24 m., entertainment vessels, vessels involved in rescue, diving and underwater-technical activity, vessels for scientific research, passenger cruise ships with a local destination, supply vessels, serving platforms - regardless of their tonnage.

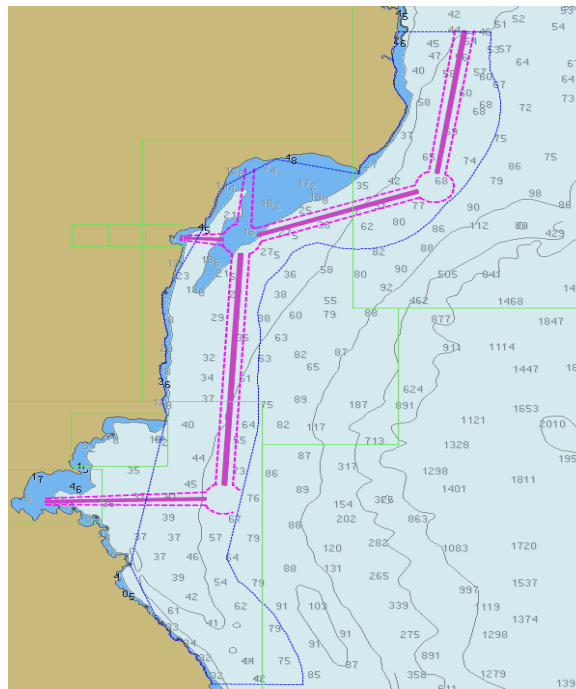


Figure. 3. Proposal for a new TSS

Navy, Police and State vessels, sailing under Bulgarian flag in implementation of their target functions are not obliged to comply with the traffic separation scheme.

Maritime traffic between the Bulgarian ports and the Bosphorus or the Romanian ports requires an optimization of the TSS by adding parts, providing navigation between them in the territorial sea.

The proposal for a traffic separation system covers 8 parts, 3 of which are roundabouts (for comparison - the existing system consists of 13 parts with 5 roundabouts). It determines the mandatory routes of the vessel traffic to and from the ports of Varna and Bourgas.

V. COMPARATIVE ANALYSIS OF THE EXISTING AND NEW SYSTEMS FOR VESSEL TRAFFIC

Table 1 shows the comparative analysis of the existing TSS and the proposed such. Totally 54 sub-criteria from the six categories listed in Part II were expertly evaluated. The assessment is in a scale from 1 to 10 (1-fully non-compliant with the criterion; 10 fully compliant with the criterion).

Criteria	Number of sub-criteria	Assessment of the existing TSS (points)	Assessment of the new TSS (points)
Cr.1	12	110	111
Cr.2	20	137	166
Cr.3	9	70	60
Cr.4	3	19	28
Cr.5	5	30	48
Cr.6	5	50	48
TOTAL	54	416 of 540	461 of 540

Table 1 – Comparative analysis of the systems

The comparative analysis shows that the new vessel traffic system significantly contributes to the enhancing of the safety of navigation due to division of cabotage shipping from classic maritime transport. Additionally, it should be recognized that an important advantage of the new system is its ecological orientation. The system first, minimizing entry of commercial vessels in areas of special ecological status. In second place was more important advantage - providing enough time and freedom to maneuver in overcoming the consequences of the oil spill, coupled with decreasing the possibility of contamination of the coast line due to influence of contra course spill over.

The predominant traffic of cargo ships and tankers to and from the ports of Varna and Bourgas to and from the Bosphorus strait goes through the existing traffic separation scheme. The proposed change does not affect the efficiency of the movement of those ships as the total length of the route does not change significantly. Single ships sailing in the direction Varna - Bosphorus outside the existing traffic separation scheme, after the amendments, will directly approach the roundabout zone also without changing the length of the route.

The approach of large ships to the main ports of Varna and Burgas from a long distance at an angle of 270° contributes to increase the security in regard the possibility of detecting a vessel-violator and taking timely action. On the other hand the shift of the TSS to the east will lead to an increased vulnerability of the vessels moving in terms of security because of:

- reduction of the probability of optical detection, monitoring and control over the activities of vessels, especially in rain, snow and fog;

- reduction of the probability of radar detection and tracking of small vessels, which are the main ships used for trafficking, smuggling and sabotage;
- reduction of the probability of detecting the placement of mines in the TSS;
- increase in response time and costs of necessary action in the TSS (check for violation, use of force, assistance, etc.);

The deployment of a new system shall be coordinated with the Ministry of Defense and Ministry of Interior in order to provide reliable surveillance system at all hydro-meteorological conditions, and counter the detected threats.

Additionally the need for the conduct of anti-mine actions to ensure the cleanliness of the new areas would require expenditure of time and burden to the State budget and these costs will grow exponentially when going beyond the isobaths 20 m., 50 m. and 100 m.

The new maritime traffic system will be in confront with the polygons and areas, used for training and exercise of the Navy. Its introduction will require a whole new zoning of military polygons and areas and will burden the State budget.

As for technical equipment and systems for monitoring and control of traffic, there is no significant difference between the two systems.

VI. CONCLUSION

This analysis is a complete review of all the features that describe the proper and reliable functioning of a system of separate movement. Each system is characterized by its strengths and weaknesses. The proposal for a new system is no exception in this respect. However, the comparative characteristics between the new and the existing ones show the advantage of the new system.

In general, the enactment of the new system is recommended.

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