ZESZYTY NAUKOWE AKADEMII MARYNARKI WOJENNEJ
SCIENTIFIC JOURNAL OF POLISH NAVAL ACADEMY

2017 (LVIII) 4 (211)

DOI: 10.5604/01.3001.0010.6741

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THE IMPACT OF MAJOR MARITIME ACCIDENTS ON THE DEVELOPMENT OF INTERNATIONAL REGULATIONS CONCERNING SAFETY OF NAVIGATION AND PROTECTION OF THE ENVIRONMENT

ABSTRACT

The article presents the impact of major maritime accidents on the development of international regulations concerning the safety of navigation and environmental protection of the seas and oceans. It contains analysis of the reasons and consequences of maritime disasters like the accidents of: 'Titanic', 'Torrey Canyon', 'Amoco Cadiz', 'Herald of Free Enterprise', 'Exxon Valdez', 'Estonia', 'Erika' and 'Prestige' as well as international agreements established in order to prevent this type of accident in the future or, at least, limit their consequences.

Key words:
international conventions, maritime safety, environmental protection, maritime accidents.

INTRODUCTION

The twentieth century was a period of very intensive development of the maritime economy: maritime trade, exploration and exploitation of the seas and oceans and the seabed, shipbuilding and navigational and radio communication techniques. A new branch of maritime economy popularly called 'offshore' was developed and

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new types of ships (container vessels, oil, chemical and gas tankers, heavy lift carriers, etc.) were introduced. Large commercial vessels, equipped with modern radio navigational and radio communication systems have created a false feeling of safety, understood as resistance of vessel on threats that may arise during the sea voyage. Satellite communication and maritime traffic monitoring systems liquidated the traditional autonomy of seagoing vessels — practically any time, everybody can see where every merchant ship is and establish radio contact with her. The development of technology is not affected, however, in reducing the number of marine accidents. The increase in vessel size (fig. 1) and in the number of passengers and dangerous, harmful and polluting goods transported at the same time on one ship makes that the consequences of her accident can be tragic and the costs of the removal of its effects on the environment high.

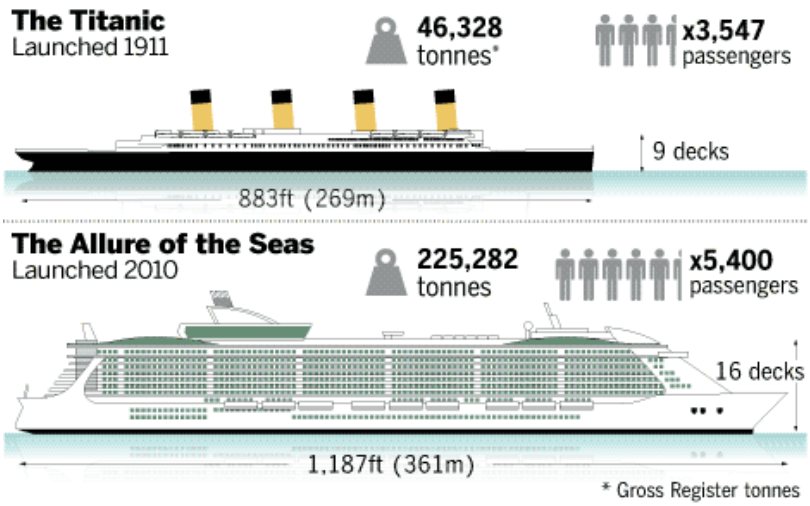

Fig. 1. Comparison of the RMS 'Titanic' and cruise vessel Allure of the Saes [www.vesseltracking.net/biggest-cruise-ships (access 17.05.2017)]

The consequence of the development of shipping was the adoption of legislative work on the establishing of international standards defining the minimum requirements for the safety of navigation and protection of the marine environment from pollution by ships and professional qualifications of seafarers. It should be emphasized that the impetus to work in this area were primarily ships accidents which resulted in the deaths of large numbers of persons carried on board or high financial consequences. For example, works on the basic international act regarding safety of life at sea — the International Convention for the Safety of Life at Sea (SOLAS),

were initiated after the tragedy of the royal mail steamer RMS 'Titanic' owned by the White Star Line, which sank on 14 April 1912 after a collision with an iceberg. Before this tragedy it was widely believed that the issues related to the construction and equipment of ships are sufficiently regulated by the flag state legislative acts. It should be emphasized that the 'Titanic' met all requirements of the United Kingdom provisions on rules of construction and equipment, including life saving equipment, and the captain and deck officers have professional qualifications significantly higher than those required by the applicable provisions of the British regulations.

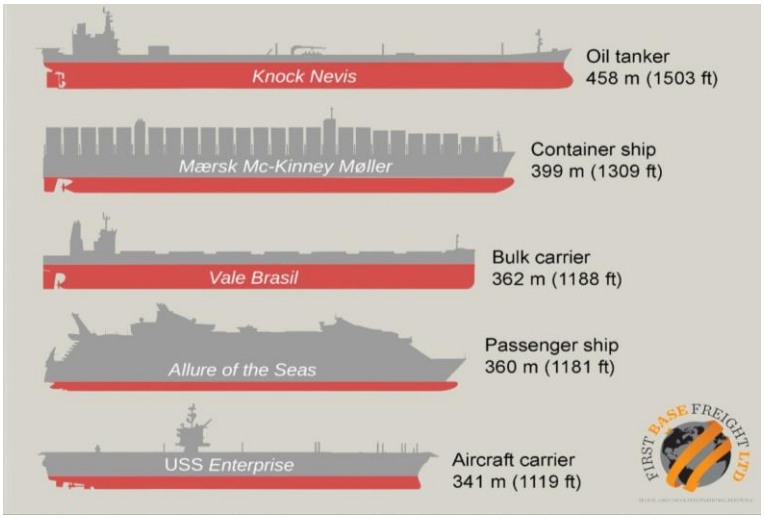

Fig. 2. Length of large modern ships [visual.ly/ocean-giants-comparison-worlds-largest-ships (access 17.05.2017)]

The SOLAS Convention was only the tenth international agreement regarding the widely understood human activities at sea. Earlier had been adopted the following acts:

1. The valid till today Treaty of Copenhagen dated 14 March 1857 on the freedom of navigation of commercial vessels in the straits of the Baltic (the Sound and the Great and Little Belt), according to which Denmark gave up the levying of any charge of ships and cargoes and pledged failure to stop and display on any obstacles merchant ships passing through the Baltic Straits.
2. International Convention for regulating the police of the North Sea fisheries outside territorial waters (three-mile limit from land) signed at the Hague on 6 May 1882 with a supplementary convention signed at the Hague on 16 November 1887

among the same contracting parties, relating to the liquor traffic in the North Sea (forbidding the sale of spirituous liquors within it to persons on board fishing vessels).

3. Convention for the Protection of Submarine Telegraph Cables signed in Paris on 14 March 1884, introducing, among other, a safe distance passing vessels engaged in laying and repairing submarine cables showing adequate daily signs and navigation lights at least equal to 1 nautical mile from the vessel and 2.5 cables from beacon indicating the position of the cable.
4. Hague Convention signed on 29 July 1899 for the Adaptation to Maritime Warfare of the Principles of the Geneva Convention of 22 August 1864 provided for the protection of marked hospital ships and required them to treat the wounded and shipwrecked sailors of all belligerent parties.
5. Convention on Hospital Ships signed at The Hague on 21 December 1904 establishing that during times of war, hospital ships would be exempted from dues and taxes imposed on vessels in the ports of the states that ratify the treaty.
6. The International Radiotelegraph Convention of Berlin signed on 1st International Radiotelegraph Conference conducted in Berlin between 3 October — 3 November 1906 — the first regulatory conference of its kind regulating six years before the 'Titanic' disaster questions connecting with radio communications between coasts and ships at sea, and those exchanged between ships. The wavelengths 600 m (frequency 500 kHz) and 300 m (1 MHz) were allocated for maritime communications. Coast stations were generally required to be operational 24 hours a day. The radio distress signal 'SOS' and general procedures for transmitting radio telegrams were established. After 1906, the conference met in 1912 (three months after the 'Titanic' casualty), 1927, 1932, 1938, and still meets roughly every four years, as the International Telecommunications Union World Radio Conference. On the conference in 1912 obliged ships to maintain contact with vessels in their vicinity as well as coastal onshore radio stations. Conference decisions are still recognized as having treaty status.
7. Hague Convention of 18 October 1907 consisting of thirteen treaties, of which twelve were ratified and entered into force, and one declaration, e.g.: Conventions:
   - relating to the Status of Enemy Merchant Ships at the Outbreak of Hostiles (Hague VI);
   - relating to the Conversion of Merchant Ships into War Ships (Hague VII);
   - relating to the Laying of Automatic Submarine Contact Mines (Hague VIII);
   - concerning Bombardment by Naval Forces in Time of War (Hague IX);

- for the Adaptation to Maritime War of the Principles of the Geneva Convention (Hague X);
- relative to Certain Restrictions With Regard to the Exercise of the Right of Capture in Naval War (Hague XI);
- concerning the Rights and Duties of Neutral Powers in Naval War (Hague XIII).

8. Two conventions signed in Brussels on 23 September 1910:
   - Convention for the Unification of Certain Rules of Law with respect to Collisions between Vessels;
   - Brussels Convention for the Unification of Certain Rules with Respect to Assistance and Salvage at Sea amended by a Protocol issued in Brussels on 27 May 1967.

The above statement shows that the first international agreements related to the issues, which could not be settled by the flag or coastal state national regulations only, first of all, freedom of navigation and fishing, the legal status of merchant ships during the war and the rules of collision avoidance and rescue of life at sea.

BASIC INTERNATIONAL MARITIME CONVENTIONS AND AGREEMENTS

Currently, dozens of international agreements regulate the various aspects of international shipping. As three basic acts, regarding the minimum requirements for maritime safety, protection of the environment against pollution from ships and professional qualifications of seafarers, should be listed following conventions introduced by the International Maritime Organisation (IMO):

- International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended;
- International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto and by the Protocol of 1997 (MARPOL), as amended;
- International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW), 1978, including the 1995 and 2010 Amendments.

Other international IMO conventions are:

1. Relating to maritime safety and security and ship/port interface:
   - Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972;

- Convention on Facilitation of International Maritime Traffic (FAL), 1965, as amended;
- International Convention on Load Lines (LL), 1966 with Protocol of 1988;
- International Convention on Maritime Search and Rescue (SAR), 1979;
- Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation (SUA), 1988 with Protocol for the Suppression of Unlawful Acts Against the Safety of Fixed Platforms located on the Continental Shelf (2005 Protocol);
- International Convention for Safe Containers (CSC), 1972, as amended;
- Convention on the International Maritime Satellite Organization (IMSO C), 1976;
- The Torremolinos International Convention for the Safety of Fishing Vessels (SFV), 1977, superseded by the 1993 Torremolinos Protocol and Cape Town Agreement of 2012 on the Implementation of the Provisions of the 1993 Protocol relating to the Torremolinos;
- International Convention on Standards of Training, Certification and Watch keeping for Fishing Vessel Personnel (STCW-F), 1995;
- International Convention on Tonnage Measurement of Ships (TONNAGE), 1969;
- International Convention on Salvage (SALVAGE), 1989; and
- Special Trade Passenger Ships Agreement (STP), 1971 and Protocol on Space Requirements for Special Trade Passenger Ships, 1973.

2. Relating to prevention of marine pollution:
   - International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (INTERVENTION), 1969 with Protocol of 1973;
   - Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LC), 1972 with the 1996 London Protocol, as amended;
   - International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1990 with Protocol on Preparedness, Response and Co-operation to pollution Incidents by Hazardous and Noxious Substances, 2000 (OPRC-HNS Protocol);
   - International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS), 2001;
   - International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004;
   - The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009.

3. Covering liability and compensation:
   - International Convention on Civil Liability for Oil Pollution Damage (CLC), 1969, renewed by the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (IOPC) with Protocols of 1992 (FOUND92) and 2003;
   - Convention relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material (NUCLEAR), 1971;
   - Athens Convention relating to the Carriage of Passengers and their Luggage by Sea (PAL), 1974;
   - Convention on Limitation of Liability for Maritime Claims (LLMC), 1976 with Protocol of 1996;
   - International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (HNS), 1996 with Protocol of 2010;
   - International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001;
   - Nairobi International Convention on the Removal of Wrecks, 2007.

THE IMPACT OF MAJOR MARITIME ACCIDENTS ON THE DEVELOPMENT OF INTERNATIONAL REGULATIONS CONCERNING SAFETY OF NAVIGATION AND PROTECTION OF THE ENVIRONMENT

RMS 'Titanic' (14 April 1912)

RMS 'Titanic' sank on 14 April 1912 after a collision with an iceberg during inauguration trip from Southampton to New York. Of the 2224 passengers and crew aboard, more than 1500 died in the sinking, making it one of the deadliest commercial peacetime maritime disasters in modern history.

As already emphasized in the introduction 'Titanic' met all the requirements of the flag state provisions on rules of construction and equipment, including life saving equipment. The ship's hull was divided into 16 compartments by 15 bulkheads which extended well above the waterline but not to the main deck. Eleven automatic vertically closing watertight doors could seal off the compartments in the event of an emergency. Vessel was fitted with 20 lifeboats that could accommodate 1178 people, despite the fact that 'Titanic' had a maximum capacity of 3327 passengers and crew. The shortage of lifeboats was not due to the lack of space — ship had been designed to accommodate up to 64 boats. The reason laid in a combination

of outdated British safety regulations and ship owner's desire to preserve the biggest deck area accessible to passengers. In accordance with current at that time regulatory requirements for the merchant vessels issued in 1886 by a Committee of the British Board of Trade, updated by the Merchant Shipping Act 1894 and modified subsequently later, a vessel of 10 000 tons or more shall be fitted with 16 lifeboats with a total capacity of 272.5 m^3, sufficient for 960 people. 'Titanic' carried four more lifeboats than she needed under these regulations. Her total lifeboat capacity was 320.77 m^3, which was theoretically capable of taking 1178 people. It should be noted that passenger ships flying the flags of other countries were equipped with lifeboats in similar manner. At the time, lifeboats were intended to ferry survivors from a sinking ship to a rescuing ship — not to keep afloat the whole population or power them to shore [12].

Ship was fitted with the most modern radiotelegraph equipment in existence leased to the White Star Line by the Marconi International Marine Communication Company, which also supplied two of its employees as operators. The service maintained a 24-hour schedule, primarily sending and receiving passenger telegrams, but also handling navigation messages including weather reports and ice warnings. The ship was equipped with a 5 kilowatt rotary spark-gap transmitter, operating under the radio call sign MGY. It was one of the most powerful in the world, and guaranteed to broadcast over a radius of 563 km. The normal operating frequency was 500 kHz; however the equipment could also operate on the frequency of 1000 kHz that was employed by smaller vessels with shorter antennas. The ship's radio handled 250 passenger telegrams from the time the ship left Southampton until her sinking, some 36 hours later. This is notable, as passenger telegrams financed the radio's operation. 'Titanic' received six warnings of ice bergs and pick ice in vicinity, among others an ice report from the M/V 'Mesaba' of the Atlantic Transport Line at 7:50 p.m. on April 14 and warning telegram about the pack ice transmitted by S/S 'Californian'. Both messages were transmitted without prefix 'MSG' and radio officers reportedly rejected the communications [12].

As the cause of the tragedy of the ship can be identified:

- failure bulkheads dividing the hull into watertight compartments to continuous deck, which meant that outboard water could flood the further compartments of the vessel;
- fitting of the ship with insufficient number of lifeboats;
- not reducing the ship's speed after receiving warnings of icebergs and a drop in temperature of sea water, accepted by present on board President of White Star Line and possible, at his suggestion;

- the lack of legal requirement to conduct on seagoing vessels radio listening watch 24 hours per day;
- delivery to the ship's master by radio operators only one of the six received messages informing about the icebergs and pack ice in the vicinity;
- no fitting seaman conducting observation with binoculars;
- poor quality of steel and rivets connecting metal plating;
- firing from the deck of 'Titanic' rockets white instead of red and possible misunderstanding of their meaning by ships in the vicinity, mainly by S/S 'Californian';
- delay in sending a distress signal and the sounding of the alarm to abandon the ship;
- the application in disembarkation action current at the time provision requiring the separation of the third class passengers from the other;
- admission, especially in the first phase of the evacuation, launching partially empty lifeboats and inaction castaways from the water.

In response to the sinking of the RMS 'Titanic' the first version of the International Convention for the Safety of Life at Sea (SOLAS) was agreed in 1914. It established International Ice Patrol, an agency of the United States Coast Guard that to the present day monitors and reports on the location of North Atlantic Ocean icebergs that could pose a threat to transatlantic sea traffic and introduced regulations regarding [15]:

- ship's hull subdivision into watertight and fireproof compartments, double bottom, etc.;
- obligatory fitting of all ships engaged on international voyages and carrying on board fifty persons or more with radiotelegraph installation and continuous radio watch;
- obligations and procedures in distress situations;
- broadcasting of information on dangerous ice and dangerous derelicts;
- obligatory numbers of lifeboats and the pontoon life-rafts sufficient for all persons on board and requirement for emergency equipment (life saving and fire protection) along with safety procedures;
- ship certificates and initial and subsequent surveys of ships;
- recognition of firing of red rockets from a ship as a sign of need for help.

The 1914 treaty never entered into force due to the outbreak of the First World War. Further versions were adopted in 1929, 1948 1960 and 1974. They represented considerable steps forward in modernising regulations and keeping them up with technical developments in the shipping industry. In 1974 a completely new Convention was adopted to allow SOLAS to be amended and implemented

within a reasonable time scale, instead of the previous procedure to incorporate amendments, which proved to be very slow. Under SOLAS 1960, it could take several years for amendments to be come into force since countries had to give notice of acceptance to IMO and there was a minimum threshold of countries and tonnage. Under SOLAS 1974, amendments enter into force via a tacit acceptance procedure. This allows an amendment to enter into force on a specified date, unless objections to an amendment are received from an agreed number of parties [15].

SS 'Torrey Canyon' (18 March 1967)

Crude oil tanker 'Torrey Canyon' was laid down in the United States in 1959. At the beginning it had a capacity of 60 000 tons but later it was enlarged to 120 000 tons. It was 297.0 m long, 38.2 m wide and fully loaded had a draught of 20.9 m. In February and March 1967 the ship was sailing with 119 000 tons of crude oil from Mena Al Ahmadi in Kuwait to Milford Haven in Great Britain. Ship's captain, under pressure to meet the narrow tidal window in the port of destination, decided to proceed between Land's End and Scilly Isles. The tanker did not have a scheduled route and as such lacked a complement of full scale charts of the Scilly Islands. To navigate the region, the vessel used LORAN system, but not the more accurate Decca Navigator. During this passage on 18 March 1967, following a navigational error, ship struck Pollard's Rock on Seven Stones reef between the Cornish mainland and the Isles of Scilly causing spillage of cargo. In the hours and days to follow, extensive attempts to float the vessel off the reef proved unsuccessful and even resulted in the death of a member of the Dutch salvage team after the explosion in the tanker engine room. On 26 of March ship broke in half and the focus became cleanup and containment of the resulting oil spill. Detergent was deployed on a large scale by Cornwall fire brigade and attending Royal Navy vessels in an attempt to disperse the oil. Aircraft of the Royal Air Force and Fleet Air Arm dropped petrol and napalm to set the cargo alight. Despite these measures, there has been a leak of an estimated 94–164 million litres of crude oil. It was the world's worst oil spill at the time. About 80 km of French and 190 km of Cornish coast were contaminated. Around 15 000 sea birds were killed, along with huge numbers of marine organisms, before the 700 km^2 slick dispersed. Much damage was caused by the heavy use of so-called detergents to break up the slick. These were first-generation variants of products originally designated to clean surfaces in ships' engine-rooms, with no concern over the toxicity of their components. A total of 161 bombs, 16 rockets, 1500 tons of napalm and 44 500 litres of kerosene were used.

At the time of the accident, ship was registered in Liberia, owned by Barracuda Tanker Corporation, a subsidiary of Company of California but chartered to British Petroleum and manned by Italian crew. Neutralization of the spill and cleaning of the shoreline were very expensive and French and Great Britain Governments had problems with obtaining financial compensation from the culprit of the disaster.

The disaster led to many changes in international regulations. Inter-governmental Maritime Consultative Organisation (IMCO) adopted the International Convention on Civil Liability for Oil Pollution Damage (CLC) of 1969, which imposed strict liability on ship owners without the need to prove negligence, and the 1973 International Convention for the Prevention of Pollution from Ships (MARPOL).

MT 'Amoco Cadiz' (16 March 1978)

'Amoco Cadiz' was a VLCC (334 m long, 51.1 m wide) launched in 1973, owned by Amoco International Oil Company and exploited under the Liberian flag. In March 1978, on route from the Persian Gulf to Rotterdam with 219 797 tons of light crude oil the ship encountered in English Channel stormy weather with gale conditions and high seas. On 16 March a heavy wave hit the ship's rudder causing a loss of steering possibility. Attempts to repair the damage were made but proved unsuccessful. The German tug Pacific responded to the call for tug assistance and offered assistance under a Lloyd's Open Form. Due to the stormy sea several attempts were made to establish tow line and 'Amoco Cadiz' dropped its anchor trying to halt its drift. Even establishing the towing line did not prevent the tanker from drifting towards the coast because of its mass and force of stormy wind. The ship ran aground the first time on Portsall Rocks, 5 km from the coast of Brittany, flooding its engines, and after half hour second time, breaking the hull and starting the oil spill. The crew was rescued by French Naval Aviation helicopters. Next morning the vessel broke in two, releasing its cargo of 250.000 m^3 of oil, and broke again eleven days later from the buffeting of high stormy seas. North-westerly winds spread heavy pools of oil onto the French shoreline. Oil penetrated the sand on several beaches to a depth of 50 cm. The total extent of oiling one month after the spill included approximately 320 km of coastline. In 1978, it was estimated to have caused US$ 250 million in damage to fisheries and tourist amenities [1].

The French government presented claims totalling US$ 2 billion to United States courts. In subsequent legal proceedings France was awarded US$ 120 million from the American oil company Amoco in 1990 [14].

The 'Amoco Cadiz' disaster resulted in amendments to the MARPOL and CLC Conventions.

Fig. 3. Broken into two parts tanker 'Torrey Canyon'
[home.bt.com/news/world-news/march-18-1967-environmental-disaster-feared-as-tanker-torrey-canyon-hits-rocks-off-cornwall-11363968852975 (access 17.05.2017)]

Fig. 4. Sinking 'Amoco Cadiz'
[upload.wikimedia.org/wikipedia/commons/b/b6/Amoco_Cadiz_2.jpg (access 17.05.2017)]

MF 'Herald of Free Enterprise' (6 March 1987)

MF 'Herald of Free Enterprise' owned by Townsend Thoresen (1980–1987) and Compania Naviera S.A. (1987–1988), operated by Townsend Thoresen and

hoisted flag of Saint Vincent was a RORO car and passenger ferry built in 1980 and designed for rapid loading and unloading on the competitive cross-channel route between Dover and Calais. It had not watertight compartments. It capsized moments after leaving the Belgian port of Zeebrugge on the routine way to Dover on the night of 6 March 1987, when the ship left harbour with her bow-door open. The sea immediately flooded the decks, and within minutes vessel was lying on its side in shallow water. Before dropping mooring lines, it was normal practice for the assistant boatswain to close the hull doors. However, this time the assistant boatswain had returned to his cabin for a short break after cleaning the car deck upon arrival, and was still asleep when the harbour-stations call sounded and the ship dropped her moorings. The first officer, was required to stay on the car deck to make sure the doors were closed but being under pressure to get to his harbour station on the bridge, he had left car deck with the bow doors open in the expectation that assistant boatswain would arrive shortly. Ship's captain assumed that the doors had been closed since he could not see them from the wheelhouse owing to the ship's design and had no indicator lights in the wheelhouse, and begun manoeuvres to leave the port. 193 passengers and crew members lost their lives in this accident. Although the immediate cause of the sinking was found to be negligence by the assistant boatswain, asleep in his cabin when he should have been closing the bow-door, the official inquiry placed more blame on his supervisors and poor communication and ship's management in Townsend Thoresen [7, 11].

Fig. 5. The wreck of MF 'Herald of Free Enterprise'
[pl.pinterest.com/pin/391391023845300741 (access 17.05.2017)]

After the accident IMO begun works on the International Management Code for the Safe Operation of Ships and Pollution Prevention and several improvements

to the design of the RORO car and passenger ferry boats were introduced. These included changes in SOLAS regulations [11]:

- to require 125 cm of freeboard for all new RORO vessel, instead of the previous value of 76 cm and to prohibit an undivided deck of this length on a passenger RORO vessel;
- introducing indicators that display the state of the bow doors on the bridge, watertight ramps being fitted to the bow sections of the front of the ship, and 'freeing flaps' to allow water to escape from a vehicle deck in the event of flooding.

MT 'Exxon Valdez' (24 March 1989)

'Exxon Valdez' was a single-hull tanker 301 m long, 51 m wide, with the draft in fully loaded condition 26 m, built by National Steel and Shipbuilding Company in San Diego and delivered to Exxon Shipping Company in December 1986. The ship was able to transport up to 235.000 m^3 of oil. At the time of the accident she was employed to transport crude oil from the Alyeska consortium's pipeline terminal in Valdez, Alaska, to the lower states of the United States. On 24 March 1989, 'Exxon Valdez' carrying about 201.000 m^3 of oil, after departure from the oil terminal in Valdez, passing the Valdez Narrows and leaving the ship by pilot, encountered icebergs in the shipping lanes. Ship's captain ordered the helmsman to take the vessel out of the shipping lanes to go around the icebergs. He then handed over control of the ship to the watchkeeping officer (third mate) with precise instructions to turn back into the shipping lanes when the tanker reached a certain point. For some reason the OOW and helmsman failed to make the turn back into the shipping lanes and the ship ran aground on Bligh Reef causing a spillage of approximately 38.000 to 42.000 m^3 of crude oil. Ship's Captain was in his quarters at the time. Oiled were: heavily or moderately approximately 370 km of the Alaska coastline and lightly or very lightly additionally 2040 km. The ecosystem was utterly destroyed. According to information received from Exxon, company spent about US$2.1 billion on the cleanup effort [13].

The US National Transportation Safety Board investigated the accident and determined that the probable causes of the grounding were:

- the failure of the third mate to properly manoeuvre the vessel, possibly due to fatigue and excessive workload;
- the failure of the master to provide a proper navigation watch, possibly due to impairment from alcohol;
- the failure of Exxon Shipping Company to supervise the master and provide a rested and sufficient crew for the 'Exxon Valdez';

- the failure of the U.S. Coast Guard to provide an effective vessel traffic system;
- the lack of effective pilot and escort services;
- the failure of Exxon Shipping Company to properly maintain the Raytheon Collision Avoidance System (RAYCAS) radar, which, if functional, would indicate to the third mate an impending collision with the Bligh Reef by detecting the radar reflector, placed on the next rock inland from Bligh Reef (this cause is not present in the official accident report).

This disaster resulted in introducing by IMO comprehensive marine pollution prevention rules through various conventions.

MF 'Estonia' (28 September 1994)

MS 'Estonia', previously Viking Sally (1980–1990), Silja Star (1990–1991) and Wasa King (1991–1993) was a ferry boat with bow visor and stern ramps built in 1979/80 in the Germany. It sunk on 28 September 1994 on route from Tallinn to Stockholm. The ship was fully loaded and listing slightly to the port side due to poor cargo distribution. The weather was rough, with a wind of 15 to 20 m/s, force 7–8 on the Beaufort scale and a significant wave height of 4 to 6 m. The strokes of the waves failed the locks of the bow door which had separated from the rest of the vessel, pulling ajar the ramp behind it. The subsequent failure of the bow ramp allowed water into the car deck and resulted in the capsizing and sinking of the ship. It was the deadliest European shipwreck disaster to have occurred in peacetime, costing 852 lives. It needs to be highlighted that the bow visor was under-designed for the conditions 'Estonia' was operating — the ferry was designed for coastal waters, not open regions like the Baltic Sea. The investigation report was critical of the crew's actions, particularly for failing to reduce speed before investigating the noises emanating from the bow, and for being unaware that the increasing ship's list was being caused by water entering the car deck. There were also general criticisms of the delays in sounding the alarm, the passivity of the crew, the lack of guidance from the bridge and fitting the ship with EPIRBs requiring manual activation, which did not happen. Drawing conclusions from the accident IMO introduced [9, 10]:

- recommendations for modifications to be applied to similar ships included separation of the condition sensors from the latch and hinge mechanisms of the bow visor and ramp;
- special training requirements in crowd and crisis management and human behaviour for crew on all passenger ships (in 1999);

- amendments to watchkeeping standards;
- new regulations regarding rescue from listing ships in rough water;
- requirement that passenger ships operating in North West Europe must be able to survive 50 centimetres of water on the car deck (came into effect in 2010).

All ship EPIRBs were required to activate automatically and the accident was 'instrumental in the move to legislate Voyage Data Recorders' [9].

MT 'Erika' (12 December 1999)

'Erika' a Maltese single hull tanker built in Japan in 1975, owned by Giuseppe Savarese (since 1996) and last chartered by Total-Fina-Elf, sailing from Dunkerque to Livorno with a cargo of around 31 000 t of crude oil as cargo, broke in two in a severe storm in the Bay of Biscay, 75 km from the coast of Brittany on 12 December 1999. About 20 000 t of oil were spilled causing a major environmental disaster. The bow sank on 12 December and the stern on the following day. The French Naval Command in Brest took charge of the response operations at sea in accordance with the French National Contingency Plan. Response vessels were mobilised immediately, but attempts at skimming ultimately met with little success owing to the poor weather and widespread fragmentation of the slick. It has been estimated that less than 3% of the total spill volume was collected during the response operations at sea. Oiled was approximately 400 km of French shoreline between Finistère and Charente-Maritime. During the cleanup operation was collected from the shorelines between 190 000 and 200 000 t of oily waste. Operations to pump out oil remaining in the sunken sections of 'Erika' began once the weather improved in June 2000 and were successfully completed within three months. Some 10 000 t of oil were recovered during the main pumping operations. The main environmental impact of the spill was on sea birds. Almost 74 000 oiled birds were recorded ashore along the coast of the Bay of Biscay, of which almost 42 000 were dead [4].

'Erika' was classified by Registro Italiano Navale (RINA) and had valid all certificates. After the accident, classification society had reported that the tanker was in good condition, and that it routinely required certificates of good condition for vessels more than 20 years old. In 2008, the 'Erika's' owner and its manager were found guilty of negligence, as was RINA that declared the ship seaworthy. Total was fined 375 000 euro and ordered to pay nearly 200 m euro in damages to the French state and the local fishing industry [4, 8].

Fig. 6. Sinking tanker 'Erika' [www.wrecksite.eu/wreck.aspx?31185 (access 17.05.2017)]

In response to the disaster of tanker 'Erika' IMO had decided that from 1996 only double hull oil tankers should be constructed and existing single hull tankers shall be replaced by double hulls till 2026. Baltic countries agreed and signed on 10 September 2001 Declaration on the safety of navigation and emergency capability in the Baltic Sea area (HELCOM Copenhagen Declaration). European Union, reacting on disasters of 'Erika' and 'Prestige' (described in the next chapter), adopted, to improve safety standards in maritime transport, three legislative packages known as 'Erika I', 'Erika II' and 'Erika III'.

Adopted by the European Parliament and Council in December 2001 'Erika I' package addressed the most serious gaps in the maritime safety rules revealed by the oil spill of December 1999 and [5]:

- strengthened the existing regulations on Port State Control by introducing Port State Control Directive 2001/106/EC amending Directive 95/21;
- strengthened regulations regarding the activities of classification societies by introducing Directive 2001/105/EC amending Directive 94/57;
- insisted to accelerate the process of gradual replacement of single hull tankers by double hulls and to banned single hull tankers from EU waters by 2015 according to the new international and EU standards (Regulation 417/2002 of 18 February 2002, chapter 24 'Double hull tankers' (DHT)).

Adopted by the Parliament and Council in June 2002 the 'Erika II' package provided the practical solutions to underpin the 'Erika I' measures [5]:

- with the creation of a European Maritime Safety Agency (EMSA) to monitor the effectiveness of EU maritime safety rules;
- with a Directive 2002/59/EC of the European Parliament and of the Council of 27 June 2002 establishing a Community vessel traffic monitoring and information system and repealing Council Directive 93/75/EE;
- with a proposal of the EU Commission to raise the upper limits of the amounts payable in the event of major spills in European waters (up to EUR 1 billion from the current ceilings of EUR 200 million), and to ensure that adequate penalties are imposed on those who caused pollution damage by negligent behaviour.

Package 'Erika III' is described in next section.

MT 'Prestige' (19 November 2002)

'Prestige' was a 26-year old Greek-operated single hull tanker constructed in Japan, officially registered in the Bahamas but with a Liberian-registered single-purpose corporation as the owner. The classification society in charge of the periodical safety inspections was the American Bureau of Shipping (ABS). On 13 November 2002, sailing off the West Coast of Galicia with 77 000 t of heavy fuel on board in stormy weather conditions, tanker was in danger of sinking due to a large crack in the starboard side of the hull. The Spanish maritime authorities airlifted off the crew, with the exception of the master and two other crewmembers that stayed on board to participate in towing operation. Upon request of the owner and his insurer, the Dutch salvage company SMIT took control of the vessel. The ship was towed to sea, and while the discussions were on-going on where it could find a safe haven to transfer its cargo to another ship, the tanker broke into two and sunk on 19 November. A significant part of the cargo was spilled polluting thousands of kilometres of the Spanish, French and Portuguese coast, as well as causing great harm to the local fishing industry. After the sinking, the wreck continued leaking oil. It leaked approximately 125 tons of oil a day, polluting the seabed and coastline. The question was whether classification societies can be held responsible for the consequences of this type of incidents. In May 2003, the Kingdom of Spain brought civil suit in the Southern District of New York against the ABS that had certified the ship 'Prestige' as 'in class' for its final voyage. The judge ruled that ABS is a 'person' as defined by the International Convention on Civil Liability for Oil Pollution Damage (CLC) and, as such, is exempt from direct liability for pollution damage [6].

Following the 'Prestige's' incident the package 'ERIKA III', was adopted by the European Parliament and entered into force on 17 June 2009. The stated objective of this package is twofold: on the one hand preventing accidents at European

waters, and on the other improving the regulatory framework available to manage the consequences of accidents if they do happen, with a focus on the damaged parties. With these objectives in mind, seven topics have been addressed in six directives and two regulations, namely [3]:

- amended Directive 2009/16/EC of the European Parliament and of the Council of 23 April 2009 on Port State Control;
- Directive 2009/21/EC of the European Parliament and of the Council of 23 April 2009 on compliance with flag State;
- Directive 2009/17/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2002/59/EC establishing a Community vessel traffic monitoring and information system;
- Directive 2009/18/EC of the European Parliament and of the Council of 23 April 2009 establishing the fundamental principles governing the investigation of accidents in the maritime transport sector and amending Council Directive 1999/35/EC and Directive 2002/59/EC of the European Parliament and of the Council;
- Directive 2009/20/EC of the European Parliament and of the Council of 23 April 2009 on the insurance of shipowners for maritime claims;
- Regulation (EC) No 391/2009 of the European Parliament and of the Council of 23 April 2009 on common rules and standards for ship inspection and survey organizations and Directive 2009/15/EC of the European Parliament and of the Council of 23 April 2009 on common rules and standards for ship inspection and survey organisations and for the relevant activities of maritime administrations;
- Regulation (EC) No 392/2009 of the European Parliament and of the Council of 23 April 2009 on the liability of carriers of passengers by sea in the event of accidents.

Influence of the human factor on the safety of navigation and environmental protection

Marine accident statistics show that the cause of more than 80% of them is the human factor. According to information provided by Dr. A. M. Rothblum from the U.S. Coast Guard Research & Development Centre, human error was the reason of [2]:

- 84–88% of tanker accidents;
- 79% of towing vessel groundings;
- 89–96% of ships' collisions;
- 75% of ships' allusions;
- 75% of onboard fires and explosions.

Accidents are not usually caused by a single failure or mistake, but by the confluence of a whole series of errors.

In order to reduce influence of the human factor on the safety of navigation and environmental protection IMCO adopted in 1978 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), establishing basic international requirements in these areas. Amendments to the convention established in 1995 introduced, among other, international control of the fulfilling conventional requirements by contracting parties.

CONCLUSIONS

The global nature of maritime transport and the degree of risk posed by ships to the environment require the implementation of the international minimum requirements for the safety of navigation and prevention of pollution from ships, as well as efficient mechanisms for effective monitoring of compliance with these requirements and obtaining financial compensation by the victim parties. The article shows that the provisions in this regard have shaped and continue to shape largely accidents of ships, particularly those of a catastrophic nature. Financial aspects require keeping a reasonable balance between the requirements of safety and environmental protection, defined mainly by the governments of the flag, coastal and port states and public opinion, and the financial capacity of the parties involved in maritime transport, especially ship owners and operators.

The amount of implemented annexes to the MARPOL Convention and shown in table 1 expansion of requirements contained in the technical annexes to the individual versions of the SOLAS Convention testify to the development of analyzed requirements.

Tab. 1. Development of the SOLAS Convention [own study]

Data of:		Contents		Remarks
Adoption	Entering into force	Convention	Annex	
20.01.1914	–	74 articles	34 pages (52 articles)	
31.05.1929	01.07.1931	66 articles	47 pages (45 articles)	COLREG as Appendix
10.06.1948	19.11.1952	15 articles	105 pages	
17.06.1960	26.05.1965	14 articles	157 pages	
01.11.1974	25.051980	13 articles	223 pages	
Actual text (valid at 01.07.2016)		13 art. + 8 art. (1978 Protocol) + 9 art. (1988 Protocol)	More than 612 pages divided into 14 chapters	Plus 18 Codes

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WPŁYW NAJWIĘKSZYCH WYPADKÓW MORSKICH NA ROZWÓJ MIĘDZYNARODOWYCH PRZEPISÓW DOTYCZĄCYCH BEZPIECZEŃSTWA ŻEGLUGI I OCHRONY ŚRODOWISKA MORSKIEGO

STRESZCZENIE

Artykuł prezentuje wpływ największych wypadków morskich na rozwój międzynarodowych przepisów dotyczących bezpieczeństwa żeglugi i ochrony środowiska naturalnego mórz i oceanów. Zawiera analizę przyczyn i konsekwencji katastrof morskich statków „Titanic", „Torrey Canyon", „Amoco Cadiz", „Herald of Free Enterprise", „Exxon Valdez", „Estonia", „Erika" i „Prestige" oraz porozumień międzynarodowych ustanowionych w celu zapobiegnięcia tego typu wypadkom w przyszłości lub przynajmniej ograniczenia ich negatywnych skutków.

Słowa kluczowe:

konwencje międzynarodowe, bezpieczeństwo na morzu, ochrona środowiska, wypadki morskie.