



## DEVELOPMENT OF SHIP TECHNICAL REQUIREMENTS BY INTERNATIONAL MARITIME ORGANIZATION

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### Abstract

*The International Maritime Organization (IMO) is a specialized agency of the United Nations deals with international shipping. Its primary purpose is to develop and maintain a comprehensive regulatory framework for shipping and its remit today includes: safety, environmental concerns, legal matters, etc. In order to achieve its objectives, the IMO has promoted the adoption of some documents such as conventions, codes and recommendations concerning maritime safety, the prevention of pollution and related matters. Many of these documents include the ship safety requirements. In order to apply them to ships, they first should be generated, prepared and recorded. This paper deals exactly with the origins of ship safety requirements. Depending on the safety requirement origins, the IMO actions can get the reactive or proactive character. Reactive actions are used in response to a particular situation being observed, whereas proactive actions involve acting in advance of a future situation, rather than just reacting. It means taking control and making things happen rather than just adjusting to a situation or waiting for something to happen.*

*In the paper, development of safety technical requirements for ships is presented based on experience of the author as a chairperson of Polish department for Subcommittee of Ship and Equipment Design (DE) of International Maritime Organization.*

**Keywords:** safety, requirements, origination, ship

### 1. Introduction

From the dawn of time, people had to reach agreements regarding various things, which facilitate their life. The Code of Hammurabi is one of the earliest known law codes and was probably compiled at the start of the reign of the Babylonian king Hammurabi (1792–1750 B.C.). It regulates in clear and definite the society organization. The Code is famous for demanding punishment to fit the crime (an eye for an eye) with different treatment for each social class. Its laws cover, inter alia: rent, the position of women, in inheritance, labour conditions. Such codification can be considered as a process of forming a legal code for example standards. They, in turn, have existed since the beginning of recorded history. Some of them were created by royal decrees. For example, King Henry I of England standardized measurement in 1120 AD by instituting the ell, which was equivalent to the length of his arm. Agreements concerned ways of people communication appearing along with development of the human's civilization. In order to increase their quickness, the people had to unify them, for example railways. The invention of the railroad was a fast, economical and effective means of sending products cross-country. In fact, in the nineteenth century there were 70 railways with different gauges in England alone. For example, the Portland Company built and worked on cars

and locomotives of five or six different track gauges in the nineteenth century. This achievement was made possible by the standardization of the railroad gauge, which established the uniform distance between two rails on a track.

The first international bodies dealing with the unification and standardization of means of transport came into being in the nineteenth century. More or less in the same time it arose a need to establish international body dealing with a shipping especially its safety aspects. One of the most important tasks was to unify of tonnage measurement - a problem that had annoyed the shipping industry almost ever since ships were first constructed [1]. Another duty undertaken was to regulate safety aspects of maritime trade. Seafaring has always been one of the most dangerous occupations. The unpredictability of the weather and the vast power of the sea itself seemed so great that for centuries it was assumed that little could be done to make shipping safer. During the nineteenth century, this almost fatalistic attitude began to change. The invention of the steam engine meant that ships were less at the mercy of wind and tide. At the same time, maritime commerce was increasing and vast numbers of people were moving from continent to continent. Accidents involving the loss of hundreds of lives led to demands for action and several international treaties and agreements, which were developed as a result.

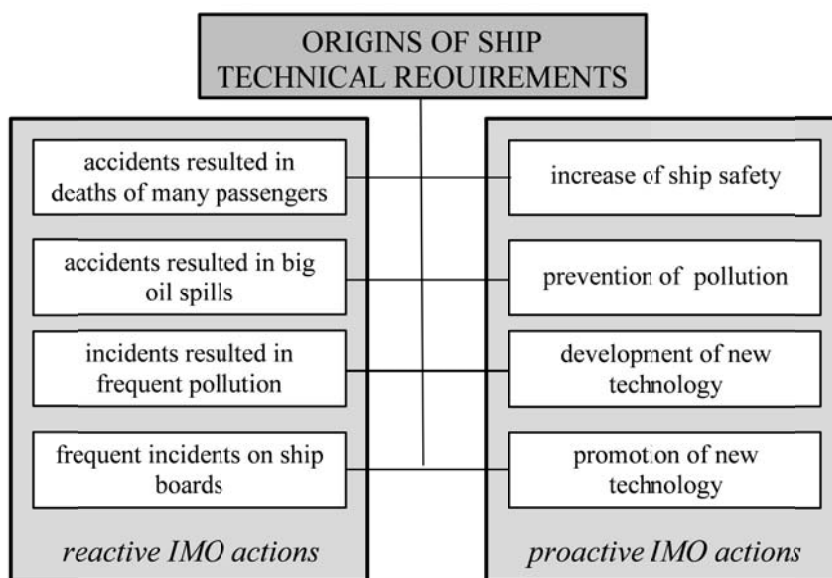


Fig. 1. Origins of ship technical requirements and types of IMO actions

Several countries proposed that a permanent international body should be established to promote maritime safety more effectively, but it was not until the establishment of the United Nations itself that these hopes were realized. In 1948 a conference convened by the United Nations in Geneva to consider the establishment of organization to deal with international shipping. The conference ended on 6 March 1959 with the successful adoption of a convention establishing the International Maritime Organization (IMO as the specialized agency of the United Nations. Its primary purpose is to develop and maintain a comprehensive regulatory framework for shipping and its responsibility today includes: safety, environmental concerns, legal matters, technical cooperation, maritime security and, the efficiency of shipping. In order to achieve its objectives, the IMO has promoted the adoption more than 40 conventions and protocols and adopted well over 700 codes and recommendations concerning maritime safety, the prevention of pollution and related matters. These IMO documents include many provisions concerning various technical aspects of the mentioned matters. Many of them include the ship safety requirements. In order to apply them to ships, they first should be generated, prepared and recorded. This paper deals exactly with the origins of ship safety requirements.

The ship safety requirements are generated on the IMO forum and they have various origins. Generally, they could be divided into several different groups (Fig. 1). Depending on the

mentioned sources, the IMO actions can get the reactive or proactive character. Reactive actions are used in response to a particular situation being observed, whereas proactive actions involve acting in advance of a future situation, rather than just reacting. It means taking control and making things happen rather than just adjusting to a situation or waiting for something to happen.

## 2. Reactive IMO actions

### 2.1. Accidents resulted in of numerous passenger's deaths

Milestones in developing ship technical requirements have been disasters of passenger vessels:

- Herald of Free Enterprise
- Estonia.

The *Herald of Free Enterprise* was a roll-on roll-off (RORO) car and passenger ferry. The ferry capsized on the night of 6 March 1987, moments after leaving the Belgian port of Zeebrugge, killing 193 passengers and crew. On the day the ferry capsized, she was working the route between Dover and Zeebrugge. This was not her normal route and the linkspan at Zeebrugge had not been designed specifically for such a class of vessels. The linkspan used comprised a single deck and so could not be used to load lower deck and upper deck simultaneously (Fig. 2a). The ramp could also not be raised high enough to meet the level of upper deck due to the high spring tides being encountered at that time (Fig. 2b). This was commonly known and was overcome by trimming the ship bow heavy by filling forward. In such situation, the linkspan could meet the level of upper deck. Before dropping moorings, it was normal practice for the Assistant Boatswain to close the bow doors. However, the Assistant Boatswain had taken a short break after cleaning the car deck upon arrival at Zeebrugge. He had returned to his cabin and was still asleep when the harbour-stations call sounded and the ship dropped its moorings. The First Officer normally stayed on deck to make sure the doors were closed, but he had returned to the wheelhouse to stay on schedule. The Captain could only assume that the doors had been closed since he could not see them from the wheelhouse due to their construction and had no indicator lights in the wheelhouse. The ship left Zeebrugge and when the ferry reached 18.9 knots 90 seconds after leaving the harbour, water began to enter the car deck in large quantities. The resulting free surface effect destroyed her stability. In a matter of seconds, the ship began to list 30 degrees to port. The ship briefly righted herself before listing to port once more, this time capsizing. The water quickly reached the ship electrical systems, destroying both main and emergency power and leaving the ship in darkness.

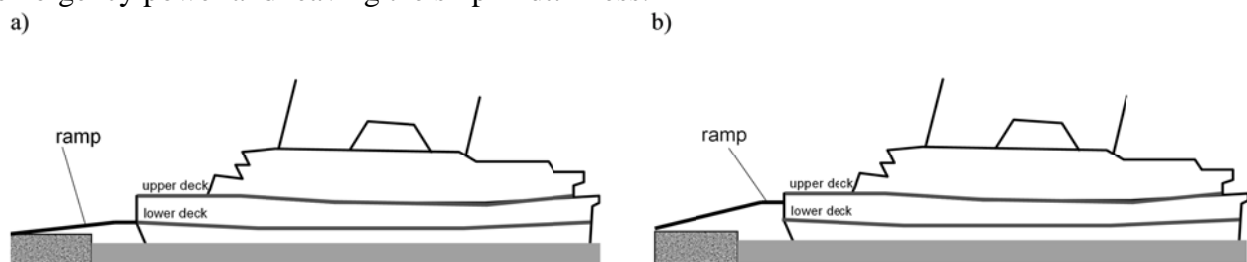


Fig. 2. The linkspan for a single deck used to load lower and upper decks: a) the linkspan uses to load the lower deck; b) the linkspan does not reach the upper deck

As the response of this accident, the new IMO regulations were introduced that prohibit an open (undivided) deck of this length on a passenger RORO vessel. Moreover, several improvements to the design of this type of vessel have been made, these include:

- 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,
- ‘freeing flaps’ to allow water to escape from a vehicle deck in the event of flooding.

The most important consequences of the *Herald of Free Enterprise* capsizing were introducing International Safety Management (ISM) Code. Because of the potential beneficial impact of the Code in advancing safety and pollution prevention the IMO Assembly recognized that the Code should be mandatory. The Assembly determined that the best way to achieve this was by adding the ISM Code to International Convention for the Safety of Life at Sea (SOLAS 1974) . In 1994, SOLAS was amended to add Chapter IX entitled ‘Management for the Safe Operation of Ships’. The Code became mandatory for passenger ships, high-speed craft, oil tankers, and other cargo ships and to mobile offshore drilling units of 500 gross tonnage.

The stated purpose of the ISM Code is to establish minimum standards for safety management and operation of ships and for pollution prevention. The objectives of the Code are to:

- ensure safety at sea,
- prevent human injury and,
- avoid damage to the environment and to property.

The Code does not create specific operating rules and regulations, but provides a broad framework for vessel owners and operators to ensure compliance with existing regulations and codes, to improve safety practices and to establish safeguards against all identifiable risks.

The *Estonia* was a car and passenger ferry built in 1980. The ship sunk in the Baltic Sea on 28 September 1994, claimed 852 lives and was one of the deadliest maritime disasters of the late twenty century. According to the final disaster report, the weather was rough, with a wind of force 7–8 on the Beaufort scale and a significant wave height of 3 to 4 metres compared with the highest measured significant wave height in the Baltic Sea of 7.7 metres. The official report says that while the exact speed at the time of the accident is not known, the *Estonia* had very regular voyage times, averaging 16–17 knots, perhaps implying she did not slow down for adverse conditions. In the night, the bow visor (Fig. 3) (allows the bow to articulate up and down, providing access to the cargo ramp and storage deck near the water line) separated and the ship took on a heavy starboard list. Soon the vessel lurched some 30 to 40 degrees to starboard, making it practically impossible to move safely inside the ship. The official report blamed the accident on the failure of locks on the bow visor that broke under the strain of the waves. When the visor broke off the ship, it damaged the ramp that covered the opening to the car deck behind the visor [2]. This allowed water into the car deck, which destabilized the ship and began a catastrophic chain of events.

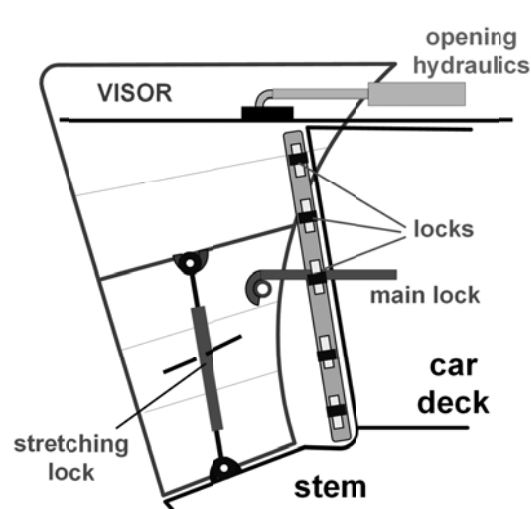


Fig. 3. The bow visor providing access to the cargo ramp and storage deck near the water line

As consequence of this disaster, the new SOLAS regulations regarding RORO passenger ships were introduced. The most important changes relate to:

- the ship stability (to ensure damaged ships have sufficient buoyancy to remain afloat),
- fitting with public address systems,
- full information on the details of passengers on board,
- the provision of a helicopter pick-up or landing area.

Moreover, the *Estonia* accident showed that lifeboats and life rafts alone could not effectively save lives. Therefore the new regulation was also introduced. It states that all RORO passenger ships shall be equipped with a fast rescue boat.

## 2.2. Accidents resulted in big oil spills

Typical examples of accidents resulted in the big oil spills were ships: Torrey Canyon, Amoco Cadiz, Exxon Valdez, Erika and, Prestige.

The *Torrey Canyon* was a super tanker capable of carrying a cargo of 120 000 tons of crude oil, which was shipwrecked causing an environmental disaster. At that time, the tanker was the largest vessel ever to be wrecked. On 18 March 1967, owing to a navigational error, the *Torrey Canyon* struck Pollard Rock on Seven Stones reef between the Cornish mainland and the Scilly Isles. An inquiry found that the ship master was guilty because he took a shortcut to save time in getting to Milford Haven. The disaster led to many changes in international regulations, for example the Civil Liability Convention (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.

The *Amoco Cadiz* was a very large crude carrier (VLCC) that ran aground on Portsall Rocks, 3.1 Nm from the coast of Brittany, France, on 16 March 1978, and ultimately split in three and sank, all together resulting in the largest oil spill of its kind in history to that date. A heavy wave hit the rudder of a ship causing to a lack of responding to the helm. In turn, this was due to the shearing of thread studs in the steering gear, causing a loss of hydraulic fluid. The major cause of this tragedy was the loss of steering because the steering system was a single system. The disaster led to many changes in international regulations, for example redundant steering systems.

On 24 March 1989, the oil tanker *Exxon Valdez* ran aground on the Bligh Reef causing a breach of the super tanker hull. The National Transportation Safety Board has presented findings [3]:

- failure of the third mate to properly manoeuvre the vessel, possibly due to fatigue and excessive workload,
- 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*,
- failure of the U.S. Coast Guard to provide an effective vessel traffic system,
- the lack of effective pilot and escort services.

The *Exxon Valdez* disaster led to many changes of IMO legislation in history:

- mandates, among other things, double hulls-bottoms for tankers or an alternative,
- worldwide implications on tanker design, operation and economics.

The *Erika* was a 24 year old, single hulled, badly maintained ship. On the 12 December 1999, this ship ran into trouble in a heavy storm 40 Nm off the coast of Bretagne. The ship broke in half and sank to the bottom of the sea. Of the 30 000 tons of heavy furnace oil it carried, 14 000 tons spilled into the sea. Classification Society for classed the *Erika* reported that the tanker was in good condition, and that it routinely requires certificates of good condition for vessels more than 20 years old. It was the faulty inspection procedures by Classification Society. The *Erika* disaster led to many changes in IMO regulations, for example:

- single hull phase out,
- tighter inspections by class and port state control,
- establishment of European Maritime Safety Agency (EMSA),
- better information and monitoring,
- liability and compensation regime.

During stormy weather on 13 November 2002 the 26 years the old tanker *Prestige* suffered a 50 meters gash in the right side of the hull. She sunk to the depth of 3600 meters with a large quantity of oil still on board - spilled oil in excess of 5 000 tonnes. The leakage so far has affected more than 1000 km of coast in different degrees, from the North Portugal to the South West France. *Prestige* suffered a fracture in the side shell. The fracture of hull has enlarged due to the external wave forces, more cracks formed. Structural failure caused ballast tank flooding and heavy listing.

The *Prestige* disaster led to many changes in IMO regulations, for example:

- accelerate single hull phase-out,
- ban on heavy fuel oil transport by single hulls,
- ban on single hulls inside 200 mile zone.

### 2.3. Incidents resulted in frequent pollutions

Incidents resulted in the frequent marine pollution led to demands for reactive actions of IMO. Typical examples of origins such marine pollution can be:

- ship recycling,
- ballast water exchanges.

It is obvious that in the developing countries recycled materials have value whereas in the developed countries recycled materials do not have much value. Moreover, in the developed countries the cost of dismantling a ship is high (even when the process is mechanized) whereas in the developing countries the cost of dismantling a ship is relatively low. Consequently, the natural home of ship recycling is in developing countries. Ship breaking, scrapping, demolition in these countries are dangerous for health and safety of workers, and contaminate environment. The implementation of measures for health and safety and for the prevention of pollution is not considered essential in the developing countries.

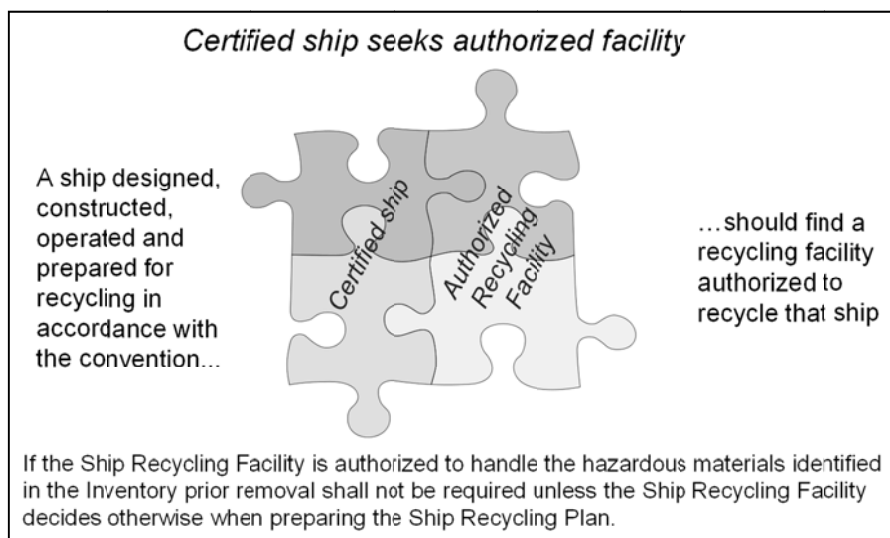


Fig. 4. Concept of the Hong Kong Convention regarding ship recycling

As a result of reactive IMO actions, the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships was adopted in 2009. The Convention is aimed at

ensuring that ships, when being recycled after reaching the end of their operational lives; do not pose any unnecessary risks to human health, safety and to the environment (Fig. 4). The Hong Kong Convention intends to address all the issues around ship recycling, including the fact that ships sold for scrapping may contain environmentally hazardous substances such as asbestos, heavy metals, hydrocarbons, ozone-depleting substances and others. It also addresses concerns raised about the working and environmental conditions at many of the world ship recycling locations.

Shipping moves over 80% of the world commodities. Ballast water is essential for safe ship operation, balance and stability. Serious environmental problems occur when ballast contains marine life. The problem is compounded as most marine species have microscopic life cycle stages. Non-native species are considered the second greatest threat to biodiversity after habitat destruction. Many non-native species are capable of causing significant ecological, economic or human health impacts.

The ballast exchange at the deep ocean is the most practical approach to minimizing the introduction of aquatic species from ballast. Therefore, the International Convention for the Control and Management of Ships Ballast Water and Sediments was adopted at IMO in 2004. The Convention will require all ships to implement a Ballast Water and Sediments Management Plan. All ships will have to carry a Ballast Water Record Book and will be required to carry out ballast water management procedures to a given standard. Moreover, it includes general recommendations for current new buildings:

- minimize use of ballast water,
- design for efficient flushing,
- minimize uptake of sediments,
- facilitate removal of sediments,
- prepare for delivery of ballast water to shore facilities,
- prepare space for later installation of ballast water treatments systems, etc.

#### **2.4. Frequent Incidents on Ship Boards**

The shipping industry is experiencing an alarming number of accidents, for example:

- fatal accidents during drills life boats,
- fires triggered by oil fuel, lubricating oil and other flammable oil system.

In recent years, there have been a number of accidents during routine lifeboat drills, despite updated training and new designs of hooks, boats and davits. Part of the problem is the number of designs of hooks and lifeboats in service, estimated at more than 70, and it is essential that the crew are familiar with and capable of operating the equipment fitted on their ship. The shipping community recognizes that there is a problem, and new regulations have been enacted in an attempt to address this.

The IMO has recently initiated a number of amendments to SOLAS regulations in response to casualties involving lifeboats. Some of the more relevant changes include:

- lifeboats can be lowered without crew but must be launched with operating crew on board,
- (weekly drills) lifeboats (except free-fall) can be moved from their stowed position without crew on board,
- (monthly drills) lifeboats (except free-fall) can be turned out from their stowed position, weather permitting, without any crew on board.

The IMO sub-committee on Ship Design and Equipment are, at its meetings, reviewing:

- standard on-load release hooks and systems,
- changes to seat sizes in lifeboats,
- guidance for qualification and certification of personnel carrying out servicing and

maintenance of lifeboats, launching appliances and on load release gear,

- worldwide servicing facilities for lifeboats.

The IMO recognized that oil fuel, lubricating oil and other flammable oil system failures are a major source of shipboard fires. And also, there are many potential ignition sources in a machinery space, the most common being hot surfaces, e.g., exhaust pipes and steam pipes.

As a response of such situations, the IMO introduced regulation to convention SOLAS 1974 which states that all external high pressure fuel delivery lines between the high pressure fuel pumps and fuel injectors shall be protected with a jacketed piping system capable of containing fuel from a high pressure line failure. The jacketed piping system is composed to a jacketed pipe, means for collection of leakage and alarm device (Fig. 6). Each of them is designed by engine manufacturer or a factory which is certified by ISO or classification society.

### **3. Proactive IMO actions**

#### **3.1. Increase of ship safety**

The large passenger vessel trade has increased dramatically in recent years and projections are for even greater increases in the future. This increase in business has been accompanied by an increase in vessel size and attendant public exposure. For example, the *Oasis of the Seas* has 16 passenger decks and can carry 5 400 passengers and a crew of 2 800. Operation of such large passenger ships generate many problems for ship-owners and caller harbours, regarding to:

- fire safety measures - such as escape routes and fire protections systems for the large atrium typical of cruise ships,
- life-saving appliances and arrangements,
- responsibility for Search and Rescue (SAR) at sea in the small country region,
- a tremendous amount of waste produced during voyages.

One is solution of fire safety measures is the concept of the ship as ‘its own best lifeboat’, what means that in the event of a casualty, persons can stay safely on board as the ship proceeds to port.

A comprehensive package of amendments to the IMO regulations affecting new passenger ships entered into force on July 2010. The amendments include, *inter alia*:

- alternative designs and arrangements,
- safe areas and the essential systems to be maintained while a ship proceeds to port after a casualty, which will require redundancy of propulsion and other essential systems,
- on-board safety centres, from where safety systems can be controlled, operated and monitored,
- fixed fire detection and alarm systems,
- fire prevention,
- time for orderly evacuation and abandonment.

#### **3.2. Prevention of pollution**

Ship emissions one of the last major ship pollutants to be regulated. The work started at IMO in the late 1980’s. Annex VI to MARPOL convention was adopted in 1997 and was revised in 2010. Its essential provisions concern:

- prohibits Ozone Depleting Substances (ODS) in line with the Montreal Protocol,
- regulates exhaust gas: oxides of nitrogen (NOx) and sulphur oxides (SOx).

Annex VI prohibits deliberate emissions of ODS, which include halons and chlorofluorocarbons (CFCs). New installations containing ODS are prohibited on all ships. But new installations containing hydro-chlorofluorocarbons (HCFCs) are permitted until 1 January 2020.



NOx emission limits are set for diesel engines depending on the engine maximum operating speed (n, rpm). Tier I and Tier II limits are global, while the Tier III standards apply only in NOx Emission Control Areas.

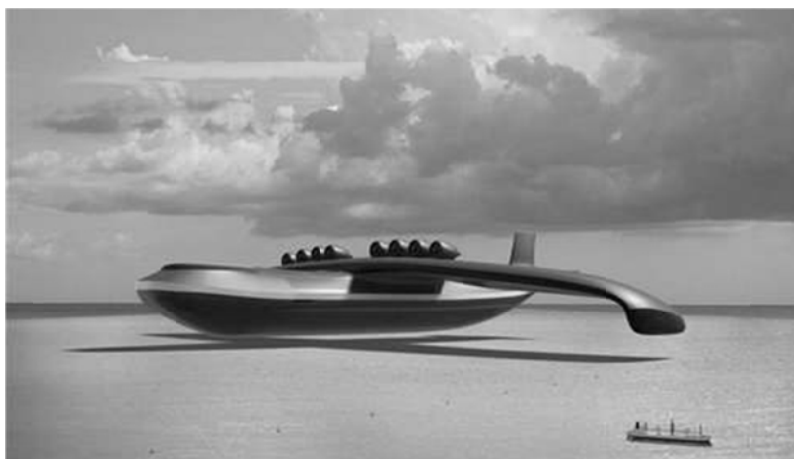
Tier II standards are expected to be met by combustion process optimization. The parameters examined by engine manufacturers include fuel injection timing, pressure, and rate (rate shaping), fuel nozzle flow area, exhaust valve timing, and cylinder compression volume.

Tier III standards are expected to require dedicated NOx emission control technologies such as various forms of water induction into the combustion process (with fuel, scavenging air, or in-cylinder), exhaust gas recirculation, or selective catalytic reduction.

Annex VI regulations include caps on sulphur content of fuel oil as a measure to control SOx emissions and, indirectly, particulate matter (PM) emissions (there are no explicit PM emission limits). Special fuel quality provisions exist for SOx Emission Control Areas (SOx ECA or SECA).

### 3.3. Development of new technology

The IMO tries to keep up with the changes of technology. Examples could be the IMO provisions regarding development of Wing-in-Ground effect crafts (Fig. 7).



*Fig. 5. Wing-in-Ground effect craft [5]*

The WIG is a vessel with wings that cruises just above the water surface, it is floating on a cushion of relatively high-pressure air between its wing and the water surface. It is also known as a WIGE (Wing-in-Ground Effect), or a Wingship. It is the ultimate low-drag marine craft with a very high-speed, sea-based platform. Some WIG vehicles have the ability to fly without ground effect as well, but inefficiently as compared to aircraft.

The IMO has studied the application of rules based on the International Code of Safety for High-Speed Craft (HSC code) which was developed for fast ships such as hydrofoils, hovercraft, catamarans, etc. Accordingly, their arrangement, engineering characteristics, design, construction and operation have a high degree of commonality with those of aircraft. However, WIG craft operate with other waterborne crafts and must utilize the same collision avoidance rules as conventional shipping. Amendments to the International Regulations for Preventing Collisions at Sea take into account the operational peculiarities of WIG craft.

### 3.4. Promotion of new technology

The IMO promotes development of new technology increasing maritime safety, the prevention of pollution and related matters. For instance, to promote the prevention of oil pollution from machinery spaces of ships, it is very important to minimize the amount of oily

bilge water generated in machinery spaces. The IMO recognized the concept of an Integrated Bilge Water Treatment System (IBTS).

The IBTS concept was promoted by Japan and recognized by the IMO through its document MEPC.1/Circ 511 [5] as an excellent concept to minimize the amount of oily bilge water generated in machinery spaces and with an integrated means to process the oily bilge water and oil residue (sludge). In principle, the IBTS is a concept of an installation containing a bilge primary tank and proper control of the flow of drain streams, aiming to segregate as much as possible oily streams from the drain streams of clean water, and avoid their admixture. Unfortunately, ships which use oily water separator systems based on the IBTS concept have reported negative experiences with port state control officers who are not convinced that ships can generate significantly low oily water volumes. To avoid this, Japan and the International Association of Classification Societies (IACS) have suggested that ships equipped with installations based on the IBTS concept.

#### 4. Preparation and enforcement of ship technical requirements

From the start, IMO has been primarily a technical organization, with shipping safety and pollution prevention being its greatest priorities. Its governing body is Assembly, which meets once every two years. Between its sessions, Council acts as the IMO governing body. Most of IMO work is carried out in a number of its committees and sub-committees. The Maritime Safety Committee (MSC) is the most senior of these. It has a number of sub-committees which titles indicate the subjects they deal with. The Marine Environment Protection Committee (MEPC) is responsible for co-ordinating IMO activities in the prevention and control of pollution of the marine environment from ships.

As it was mentioned, ship technical requirements should be generated, prepared and recorded. In order to do this, the IMO uses several types of documents. They can be divided into four different groups (Fig. 6):

- documents related with preparation international agreements,
- documents related with decisions of IMO bodies,
- documents related with preparation decisions of IMO bodies,
- documents related with realizing of decisions taken.

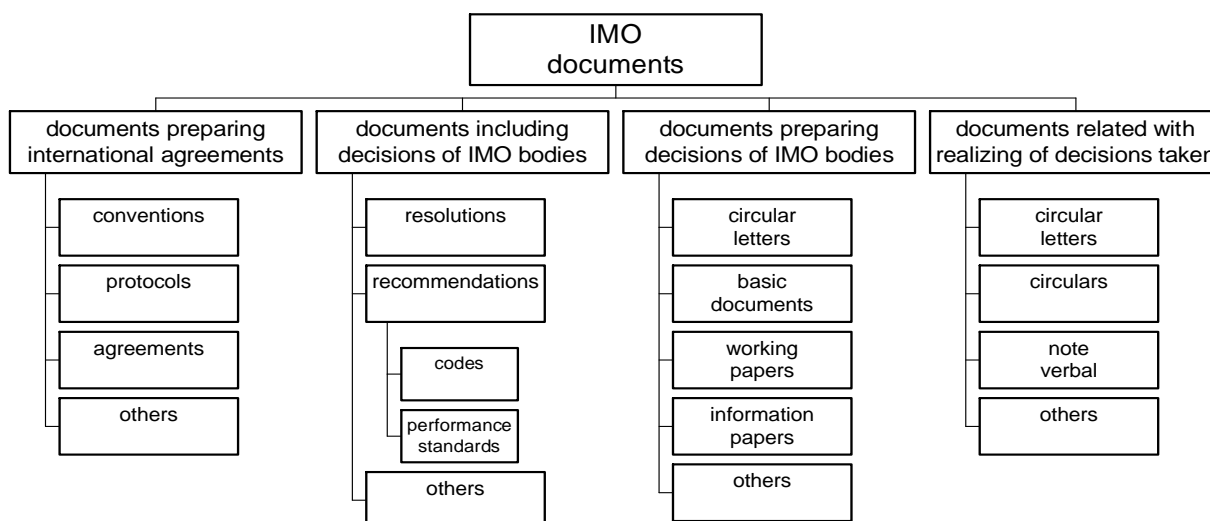


Fig. 6. Types of the IMO documents

All IMO bodies can make any decisions but only decisions taken by the Assembly, the Council, Maritime Safety Committee, and Marine Environment Protection Committee have legal meaning.

The IMO document management structure has been presented in Figure 7.

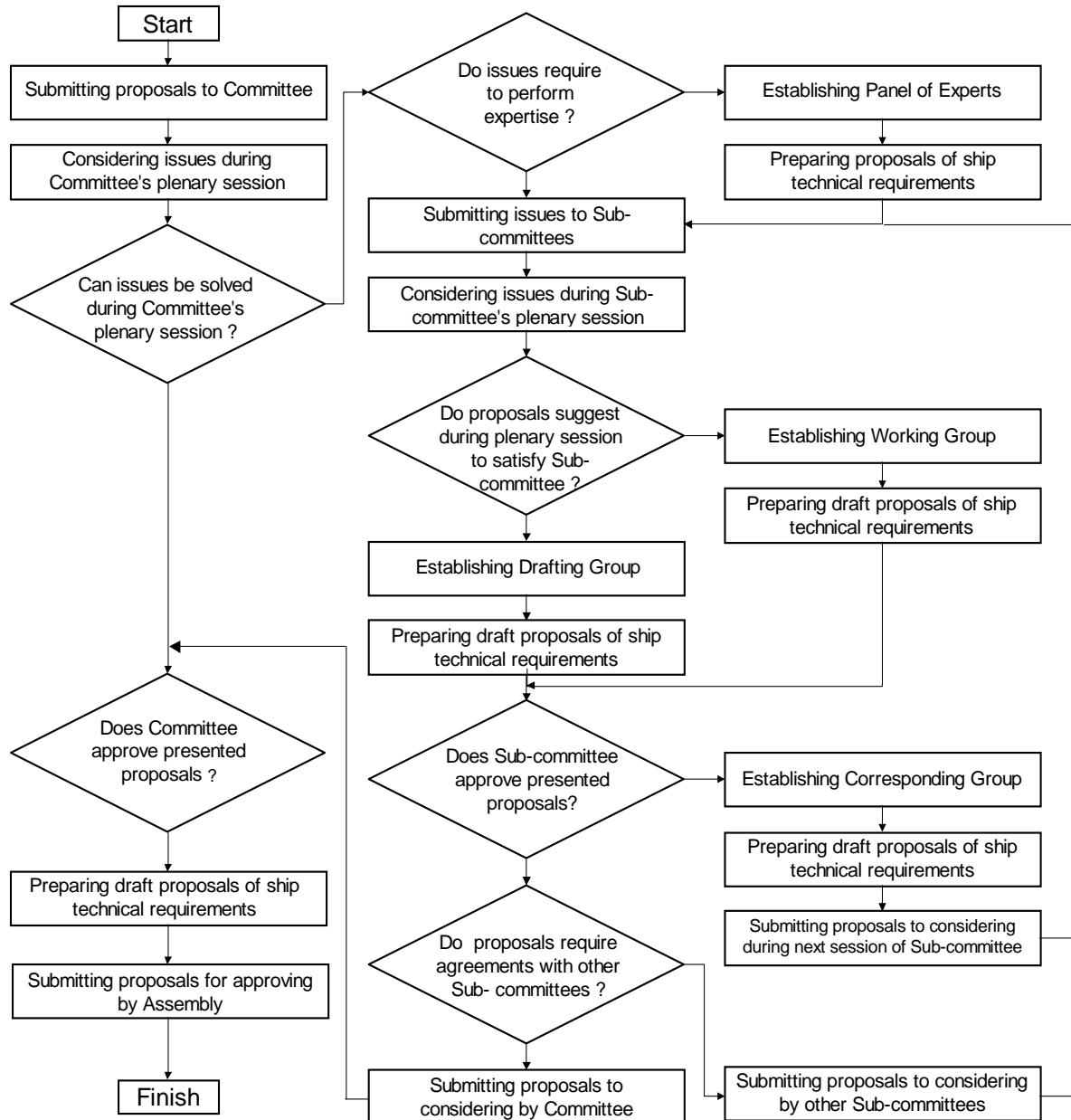


Fig. 7. Structure of the IMO document circulation

As a rule, the majority of IMO activities regarding to generating, preparing and recording of ship technical requirements have the proactive character. It means that the IMO policy based on the following assumptions:

- early stage identification of main factors that affect ship safety,
- development of regulatory action to prevent undesirable events,
- formulation of policy before event,
- formulation of policy after careful analysis of its implications.

The most important ship technical requirements have been reflected in the following IMO documents:

- the International Convention for the Safety of Life at Sea (SOLAS),
- the International Convention for the Prevention of Pollution From Ships (MARPOL).

The SOLAS Convention requires flag States to ensure that their ships comply with minimum safety standards in construction, equipment and operation. It includes articles setting out general obligations, etc, followed by an annex divided into twelve chapters.

The MARPOL Convention is designed to minimize pollution of the seas, including dumping, oil and exhaust pollution. It contains 6 annexes, concerned with preventing different forms of marine pollution from ships. Its stated object is: to preserve the marine environment through the complete elimination of pollution by oil and other harmful substances and the minimization of accidental discharge of such substances.

The majority of the IMO members have turned these international requirements into national laws. Flag states enforce IMO technical requirements through inspections of ships conducted by a network of international surveyors. Much of this work is delegated to bodies called classification societies.

However, flag state enforcement is supplemented by what is known as Port State Control, whereby officials in any country which a ship may visit can inspect foreign flag ships to ensure that they comply with international requirements. Port State Control officers have the power to detain foreign ships in port if they do not conform to international standards. As a consequence, most IMO regulations are enforced on a more or less global basis.

## 5. Conclusion

It is difficult to state precisely how effective the ship technical requirements have been in increasing shipping safety. Due to economic factors, the average age of the world ships has risen steadily. The fleets of the traditional maritime countries have declined, while many of the flags that are growing most rapidly have relatively poor records. Statistics show that old ships have more accidents than young ones.

The IMO, over the years of its existence, has continually evolved to meet changing conditions and requirements. Some of the IMO efforts have very significant results. For example, oil pollution of the sea is less of a threat now than it was 20 years ago.

As a result, nobody can be satisfied and the IMO is concentrating not only on better implementation of ship technical requirements but also on improving such factors as management and training.

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