

# Understanding the Interrelation between the Safety of Life at Sea Convention and Certain IMO's Codes

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**ABSTRACT:** Over the last few decades, the International Maritime Organization (IMO) has very heavily utilized the Safety of Life at Sea (SOLAS), 1974 Convention as the main legal instrument (and implementation tool) concerning safety at sea for merchant vessels engaged in international trade. During this more than a century of existence and continuous improvement of the Convention, wide-ranging safety risks have been addressed via SOLAS and certain relevant "supporting" Codes, covering for example the issues of design, construction and equipment of ships, as well as paving the way for the introduction of a structured framework of operational procedures that ensures a high level of professional performance for the crew onboard those seagoing vessels (the International Management Code for the Safe Operation of Ships and for Pollution Prevention-ISM Code) and even including human factors topics. Until this point in time, the IMO has developed the SOLAS Convention with fourteen (14) chapters that are covering all the main risks associated with shipping operations and are working in parallel with other related Conventions and Codes to enhance the level of safety at sea, under a holistic approach that is working under the principle of interrelation. This paper aims to briefly discuss SOLAS' history of development and highlight just a few of those important risks that this Convention is addressing, with certain emphasis on the topic of "safety of navigation". Apart from helping to understand the way this Convention and other IMO's legal instruments are interrelated, it will also provide a few educated guesses about the "upcoming" challenges that in the near future should also be included into the scope of the SOLAS, with the topic of Maritime Autonomous Surface Ships (MAAS) clearly standing out.

## 1 INTRODUCTION

The sea is, has been and will continue to be a dangerous place to work; it is not a coincidence that throughout the course of human history, a quite extended number of maritime accidents are recorded [2]. It is also necessary to note that shipping activities have always been vital for the support of international trade; quite often they have been termed as the "obedient servants of globalization". In any case, it is a rather self-explanatory fact that with the globalization phenomenon gaining momentum during the last couple of decades, the size of the

maritime transport industry has also simultaneously increased significantly and today more than fifty thousand (50.000) merchant ships are trading internationally [10]. By considering this very high number and different type of vessels that are crossing the seas and oceans of our planet on a daily basis, coordinated efforts such as a very expanded portfolio of international regulations (that are all based on/utilize the approach of "standardization") are needed to ensure the necessary level of safety.

From the very beginning of its establishment, the International Maritime Organization (IMO) has been

consistently working to enhance the safety of vessels at sea by implementing measures through very specific legal instruments. The IMO's principal instrument with such focus is the International Convention for the Safety of Life at Sea (SOLAS); with the expected introduction of new technology applications that can completely reshape the way the shipping industry operates, such as Maritime Autonomous Surface Ships (MASS), further adaptations and changes in the scope of SOLAS should also be expected.

Initially, the SOLAS Convention was created as a reaction towards the well-known Titanic disaster and as a response to address passenger ships' risks, but today it has increased/expanded its scope widely to become the most important instrument created by the IMO with 165 member States party to the Convention and a coverage of 99.04% of the gross tonnage of the world's merchant fleet. Nowadays, SOLAS applies to all passenger ships that carry of more than twelve (12) passengers, as well as to all cargo ships with over five hundred (500) gross tonnage that are engaged on international voyages [5].

Historically, the SOLAS Convention has five versions: the first one (was attempted to be) adopted in 1914, the second in 1929, the third one in 1948, the fourth in 1960, and finally the last major revision took place in 1974. Over these years, the IMO has most often deployed a reactive approach by introducing the necessary new regulations after the occurrence of an important accident that had attracted worldwide attention. On a positive note, lately there is a shift towards a preemptive approach within the IMO, by looking forward and identify relevant needs before a major disaster occurs. This latest version of SOLAS also includes an extended number of Codes that provide the international standards required for the elements mentioned in that particular chapter of the convention.

Following a path of continuous improvement, the wider regulatory framework under the auspices of the IMO has resulted in a safer, cleaner and more sustainable shipping industry that is capable to effectively support the global economy needs. The main purpose of this paper is to discuss the aforesaid evolution in the IMO's framework to enhance safety at sea, facilitate its better understanding and especially highlight the interrelating approach deployed via the numerous Conventions and Codes supporting this framework. Following this brief introductory section, the evolution of SOLAS is briefly discussed next. The methodology to be used is a qualitative comparison of the SOLAS different Chapters and the related Codes that are influencing safety at sea. In order to provide a structured summary, all SOLAS interrelations are summarized in a table format.

## 2 DISCUSSING THE DEVELOPMENT OF THE SOLAS CONVENTION

The sinking of the Titanic in 1912 was the starting point of the shipping industry's international regulatory framework, as it is known today. The first international conference on safety at sea met two years later in 1914, and the first version of the SOLAS

Convention was discussed. After that point, more conferences and new versions of the SOLAS Convention were necessary to keep the safety regulations of the maritime transport industry updated. The SOLAS Convention with its successive versions has clearly become the most important of all international treaties concerning the safety of merchant vessels, but an expedite mechanism to put in force the regulations was necessary to make them mandatory to the increasing international merchant fleet.

In the year 1948, an international conference in Geneva adopted a Convention formally establishing IMCO (Inter-Governmental Maritime Consultative Organization, which changed the name to IMO in 1982). The IMCO Convention entered into force in 1958, and the new Organization met for the first time the following year. Since its beginning, in 1959, the Organization has applied every effort to protect human life at sea. The Organization is also empowered to deal with administrative and legal matters related to these purposes. IMO's first task was to adopt a new/updated version of SOLAS, the most important of all treaties dealing with maritime safety; this was achieved in 1960 [7].

IMO has used the concept of continuous development and improvement, by keeping abreast to the advancements in technology to ensure that relevant measures that have been incorporated in this Convention mitigate pre-existing or newly identified risks. Accordingly, significant revisions took place in 1929, 1948, 1960 and 1974 that resulted into the current International Convention for the Safety of Life at Sea, 1974, as amended. The Convention proper consist of thirteen (13) Articles. Its Annex consist of fourteen (14) chapters which contain the applicable regulation to all facets of maritime safety. SOLAS 1974 Convention, has also been amended twice in 1978, and 1988 via protocols. After that, the IMO with the Maritime Safety Committee (MSC) and the work of the concerned Subcommittees continuously keep up to date the Convention with periodic amendments. Since 1981, SOLAS has received the impressive number of a hundred and seventy six (176) amendments; in addition, the 1978 SOLAS Protocol is associated with four (4) amendments and the 1988 SOLAS Protocol with thirteen (13) amendments [8].

Amendments in the Convention can be made via two (2) different procedures. The first one is after a formal consideration within IMO, proposed by member states and adopted by a two-thirds majority of those contracting Governments present and voting in the MSC committee; the second one is via a dedicated conference. The SOLAS 1974 version includes a tacit acceptance procedure which allows that an amendment shall enter into force on a specified date unless, before that date, objections to the amendment are received from an agreed number of Parties [9].

Recently (in year 2014) the MSC implemented a four-year cycle for the entry into force of amendments to the 1974, SOLAS Convention on the notion to take a more proactive approach in making regulations after a period of time and revision of the existed ones, but always keeping in mind that exceptional circumstances such a serious casualty can always

trigger the need of amendments or changes into an instrument. It is also necessary to highlight the influence of the International Safety Management Code (ISM) and the International Ship and Port Facility Security (ISPS) Code. These two specific instruments were introduced by the IMO under the SOLAS Convention and have played an important role in relation to improving the current global maritime safety and security regimes and both include a significant portfolio of risk mitigation measures.

Nowadays, an extended number of technical committees and subcommittees of the IMO continue their work in creating mandatory international standard regulations to manage safety risks within the shipping industry and while the world is in constant change. As an example, a set of important amendments to the SOLAS Convention were adopted by the 96th to 99th sessions of the MSC and entered into force on 1 January 2020, addressing among others: lifeboat maintenance (SOLAS regulations III/3 and III/20), subdivision and damage stability (Chapter II/1), planning for evacuation on cruise ships, expanding maritime satellite communications equipment providers, etc.

Before moving to a different direction, it is necessary to note that during the 81st session of the MSC, the process to be followed for developing the regulatory framework for e-navigation was agreed, by taking well into account the expected future technological advances in shipping. Very briefly, the Correspondence Group on e-navigation of the Navigation, Communications and Search and Rescue (NCSR) sub-committee created a roadmap of the e-navigation strategy implementation plan (SIP) in 2014. The FSA-derived SIP aims at reaching five specific e-navigation solutions [6]. Once formulated and incorporated into SOLAS amendments, these solutions will improve safety of navigation further. The topic of e-navigation also needs additional consideration towards integration of systems by factoring the so called "net-centric" functionality of modern digital equipment and systems towards optimization of effective processing of high-quality data and information, an issue that can further enhance situational awareness/safety of navigation [4].

### 3 CODES ASSOCIATED WITH THE SOLAS CONVENTION

The safety of maritime transportation and especially passenger ships has been for many years one of the main concerns of member States. The work of the IMO in this regard with the SOLAS convention have been significantly and very important. The visible result of this work is the high number of Codes associated and clearly interrelated with the SOLAS Convention. A Code should be viewed as an integral part of the Convention that provides the international standards and additional details required for the topic/issue discussed are "introduced" via the particular chapter of the Convention. For effectively summarizing all these, table 1 below provides the association of the fourteen (14) Chapters within the SOLAS Convention, the safety issues and risks addressed by each one of them, as well as the additional Codes that are used to elaborate on an issue covered by a SOLAS Chapter.

The adoption of a new Chapter –along with its associated Code– for the SOLAS Convention until recently came via the previously mentioned "reactive" approach, following an important incident or accident, for example disasters like the Herald of the Free Enterprise, the Estonia and the Doña Paz. Although with a slow pace, this approach allowed the creation of regulations under SOLAS pertaining to damage and intact stability, as well as paved the way for the introduction of a safety management regime through the International Safety Management Code (ISM) Code in Chapter IX of SOLAS.

Table 1 is non-exhaustive; there are also other Codes and Conventions that are equally important with regard to particular aspects of ship safety that are not under a direct association with SOLAS Convention, such as:

- The International Regulations for Preventing Collisions at Sea Convention COLREG, 1972, which deals with navigation procedures to avoid collisions at sea.
- The International Load Lines (LL) Convention, 1966, which is interrelated to the topic of "seaworthiness" of ships.
- The International Convention on Tonnage Measurement of Ships, 1969, which deals with ship measurements for design, construction and operations.
- The International Convention on Maritime Search and Rescue (SAR), 1979, which puts forward a framework of preparatory measures to rescue persons in distress at sea, no matter where an accident occurs.

The majority of these Convention and Codes were created/introduced during the 60's and 70's, at a time when the new tacit amendment procedure for the SOLAS Convention had not been established yet. For example, the Tonnage Measurement Convention has never been amended until now; probably, the main causes of this unfortunate situation are the absence of the tacit amendment procedure and the reluctance of certain stakeholders to open discussion on an issue that they consider as a "Pandora box" [2].

On the other hand, it is true that the inclusion of associated Codes under the SOLAS Convention has become a "legal facilitator tool" to quickly introduce biding standard regulations globally which are necessary because of fast pace of changes in technology (or, other external factors like climate change and the opening up of polar regions for shipping operations). For example, with a very strong preemptive approach, the International Code for Ships Operating in Polar Waters (Polar Code) become mandatory under the SOLAS and MARPOL Conventions by entering into force on 1 January 2017 and covering the full range of risks and environmental protection measures in the waters surrounding the two Poles.

The Polar Code is affiliated with both the SOLAS and MARPOL Conventions, imposing rather strict requirements for ships intended to sail in Polar waters, with the issue of a Polar Ship Certificate that ensures that the ship and crew are taking into account the training requirements and the anticipated range of operating parameters and hazards the ship may encounter in Polar Waters clearly standing out [3].

Table 1. Safety Issues &amp; Risks Addressed by the SOLAS Convention. (Created by the authors)

SOLAS Chapter	Safety Issues & Risks Addressed	Additional Codes
I General Provisions	Surveys in relation to different types of ships Control of ships in ports	
II-1 Construction-subdivision and stability, machinery and electrical installations	Subdivision of ships in watertight compartments Watertight integrity and bilge pumping arrangements Stability requirements Machinery and electrical installations requirements Steering gear requirements	
II-2 Fire protection, fire detection, and fire extinction	Fire safety provisions for all ships and specific provisions for passenger ships, cargo ships, and tankers.	International Fire Safety Systems Code (FSS)
III Life-saving appliances and Arrangements	Requirements for lifeboats, rescue boats, life jackets according to the type of ship	Life-Saving Appliance (LSA) Code
IV Radio-communications	GMDSS equipment Radiocommunication services ashore Radiocommunication equipment's onboard	
V Safety of navigation	Navigation safety services Maintenance of meteorological services for ships, ice patrol service, routing of ships, search and rescue services. Mandatory use of VDRs and AIS	
VI Carriage of cargoes	Requirements for stowage and securing of cargo or cargo units (except liquids and gases in bulk)	International Grain Code
VII Carriage of dangerous goods	Regulations for the carriage of dangerous goods in packaged form. Construction and equipment of ships carrying dangerous liquid chemicals in bulk Construction and equipment of ships carrying liquefied gases in bulk and gas carriers	International Maritime Dangerous Goods (IMDG) Code International Bulk Chemical Code (IBC Code) International Gas Carrier Code) IGC Code)
VIII Nuclear ships	Requirements for nuclear-powered ships and radiation hazards	Code of Safety for Nuclear Merchant Ships
IX Management for the safe operation of ships	Safety Management Systems on board.	International Safety Management (ISM) Code
X Safety measures for high-speed craft	Requirements for safety of the high-speed craft	International Code of Safety for High-Speed Craft (HSC Code)
XI-1 Special measures to enhance maritime safety	Authorization of recognized organizations. Obligations to investigate maritime casualties. Port State control operational requirements	Maritime Casualty Investigation Code
XI-2 Special measures to enhance maritime security	International ship and port facilities and requirements for security.	International Ship and Port Facilities Security Code (ISPS Code)
XII Additional safety measures for bulk carriers	Structural requirements for bulk carriers	
XIII Verification of compliance	IMO's Member State Audit Scheme	
XIV Safety measures for ships operating in polar waters	Measures for ships engaged in polar navigation	International Code for Ships Operating in Polar Waters (the Polar Code)

#### 4 THE NEED OF NEW INTERNATIONAL REGULATIONS

As sea-going vessels were increasing in size and complexity, it also become obvious that coordinated efforts to ensure the safety at sea were needed [9]. The on-going development of technology applications has indeed helped to make available better equipment and systems both on ships and in ports. Technology

in support of the conduct of navigation has been a mainstream issue within IMO; at the same time, regulations and guidelines to increase the safety standards each time a new technology application appeared was also the main path of action.

The shipping industry is moving fast towards a digital world; initiatives like "e-navigation" and "smart navigation" are now considered as the right tool towards the support/provision of vast quantities

of data and digital infrastructure for the benefit of maritime safety, while at the same time increasing the efficiency of maritime transport [6]. The E-navigation initiative started in 2005, aiming to increase the safety of navigation by modern technology in the fields of on-board navigation systems, shore side vessel traffic information management and communications infrastructure applied for SOLAS ships [1]. Smart navigation, on the other hand, is a Korean project that includes both non-SOLAS and SOLAS ships.

As a rather self-explanatory example of the necessity to increase regulations with the appearance and ongoing introduction of “more” and “new” technologies that are supporting better the Safety of Navigation, table 2 below is summarizing all those factors that have been addressed under Chapter V (Safety of Navigation) of the SOLAS Convention:

Furthermore, it is a well-known fact that safe and effective conduct of navigation is at the core of the seafaring profession; the safety of navigation (under all conditions) is also at the epicenter (and ultimate purpose) of the SOLAS Convention. There are numerous technology applications that have been introduced by IMO by using SOLAS as the main facilitator: from the introduction of Radars and the various Global Navigation Satellite Systems (GNSSs) after the 80's, to the mandatory use of voice data recorder (VDR) nowadays, as well as the very positive impact on the issue of situational awareness via the electronic chart display and information system (ECDIS) and the automatic identification system (AIS).

The use of all these advanced systems onboard ships and in base-landed monitoring centers are regulated by the IMO and have helped to improve reliability, resilience, and integrity of bridge equipment. Finally, it is clear that search and rescue services are very critical when referring to the issue of safety of navigation; the IMO's intensive work in this specific domain has helped to develop a worldwide

organization for communication and co-ordination for the rescue of persons in distress at sea. All types of ships -but mostly passenger ships, because of the large number of people onboard in case of an emergency- have benefited significantly from these services over the course the time.

## 5 FUTURE CHALLENGES FOR IMO REGARDING THE SOLAS CONVENTION

Cooperation is crucial for addressing new challenges; in the last few years, the IMO has been leading a Harmonization Group in Data Modelling (HGDM) with other international organizations such as the World Meteorological Organization (WMO), the International Hydrographic Organization (IHO), the International Maritime Pilots Association (IMPA), and the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) in order to integrate and facilitate the development of sixteen (16) Maritime Services defined as Maritime Services Portfolio (MSP). By integrating all these services into one single portfolio, the data for safety of navigation will be available 24/7 for seafarers and external sources. Besides, these services will be delivered, responding directly to the specific needs of each ship, increasing the safety of navigation significantly all around the world with more standardized, available, and accurate services.

Furthermore, the ongoing trend of digitalization and the issue of autonomy within the shipping industry are strongly affecting the current portfolio of regulations. The extensive use of artificial intelligence in ships should be expected in the future; certain “optimization” tasks probably provide the best indicative example. This issue should be appropriately regulated to determine who exactly is responsible for what, in case of a future accident.

Table 2. Factors addressed under Chapter V (Safety of Navigation) of the SOLAS Convention. (Source: [9])

SOLAS	Regulation Short Title	Factor addressed
Chapter V Reg 4 & 5	Navigational, Meteorological services and Warnings	Early warning of risks of weather and navigation
Chapter V Reg 7	Search and Rescue	Safety of life in case of rescue of persons in distress at sea or coast
Chapter V Reg 9	Hydrographic services	Charts and publications updated to avoid navigation incidents
Chapter V Reg 10 & 11	Ship's routing and reporting systems	Safety of life at sea, safety and efficiency of navigation, protection of marine environment
Chapter V Reg 12 & 13	Vessel Traffic Services	Ship traffic management and collision avoidance
Chapter V Reg 14	Aids to Navigation	
Chapter V Reg 15	Ship Manning	Safe Manning (Human Factor)
Chapter V Reg 15	Principles related to ship design, equipment and procedures	Ergonomics of bridge design
Chapter V Reg 15	Maintenance of navigational equipment	Planned Maintenance System (PMS), also addressed in the ISM Code
Chapter V Reg 19	Carriage requirements of navigational equipment	Mandatory Navigational equipment list
Chapter V Reg 19-1	Long-range identification and tracking of ships	Locating remotely the position of ships
Chapter V Reg 19	Voyage Data Recorders	“Black box” to access data recorded from various bridge equipment for incident investigation
Chapter V Reg 33	Distress situations: obligations and procedures	Master obligation to provide assistance in distress situation

Automation is nothing new, but it can be viewed as a continuous process that is creating far reaching implications for the maritime sector [10]. Automation can help to increase safety by taking advantage of the so called “smart positioning” technology applications or real-time dynamic positioning predictors or even combine the previous with Artificial Intelligence applications support in order to predict “behavior” of nearby vessels to avoid collisions. However, a question is still standing out: Will an “autonomous system” be as safe as one system that is currently operated by a human? Without a rigid regulatory framework in place, the answer is no. Therefore, new regulations will be needed to ensure the safety of navigation in a common collaborative environment where “regular” manned and unmanned/autonomous ships will be operating together. There is a follow up question that should be answered with future research: Changing and/or updating the various chapters of the SOLAS Convention and certain existing instruments will be enough, or creating (from scratch) a new specific Instrument and associated Codes that will cover the issue of autonomous ships should be considered?

## 6 CONCLUSIONS

The SOLAS Convention, which has its origin a couple of decades before the IMO’s establishment itself is a constantly evolving legislation. This adaptive approach of this specific legal instrument has contributed towards ensuring the safety of life at sea and at the same time facilitate the Organization to “uphold its leadership role as the global regulator of shipping, promote greater recognition of the sector's importance and enable the advancement of shipping, whilst addressing the challenges of continued developments in technology and world trade; and the need to meet the 2030 Agenda for Sustainable Development”.

During this more than a century of existence and continuous improvement of the SOLAS Convention, wide-ranging safety risks have been addressed via this specific Instrument, working in unison with certain relevant Codes, with the International Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM Code) clearly standing out. It is obvious that the regulatory framework that IMO has created over the course of time and implemented via a rigorous approach plays today a very crucial role in the effective functioning of the maritime industry by determining the numerous safety requirements and providing the necessary operational guidelines and standardization framework.

It is clear that the SOLAS Convention holds a pivotal role for maritime safety by helping to decrease accidents and/or loss of lives at sea. It is also true that risks associated with the conduct of shipping operations will never disappear, but bringing those risks under control via appropriate mitigation measures can have a really positive impact. After all, IMO is a forum of collaboration and ensuring the safety of ships is a complex process that depends on all

stakeholders involved in the maritime industry sector; it is not only a responsibility of the Captain and crew, but it is under the influence of IMO’s member States flag states, coastal states, port states and the respective port state control activities, ship-owners, etc. to name just a few.

On a positive notion, the work of the IMO in relation to addressing the main risks involved in shipping operations seem to be on-going and restless over the course of time. And to make things even better, nowadays, the support of member States and other relevant organizations is taking full effect. However, new regulations and amendments should be expected both in the near and mid-term future. Last, but not least, it is the issue of MASS that will most probably have a quite disruptive effect in the current regulatory framework and intensive research efforts will be needed to evaluate and clearly describe all the necessary “adjustments” and “changes” that will ensure a safe operating environment for vessels at sea.

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