

Regulatory safety considerations about ship design

Consideraciones reglamentarias de seguridad sobre el diseño de barcos

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Abstract

In this article, some of the criteria established by the International Maritime Organization (IMO) will be described through technical documents related to the design of ships such as the Goal Based Standards (GBS) and the Risk-Based Ship Design (RBD). Later on, an approval model will be proposed for the design of new ships, taking into account the recommendations of the International Maritime Organization (IMO) while articulating the work of maritime administrations, the naval industry and classification societies.

Key words: Goal Based Regulations, Risk-Based Ship Design, Goal-Based Ship Construction, Ship Design Approval Process, SOLAS Convention, Safety Regulations.

Resumen

En el presente artículo serán descritos algunos de los criterios establecidos por la Organización Marítima Internacional (OMI) mediante documentos técnicos relacionados con el diseño de buques como son los Goal Based Standards (GBS) y el Risk-Based Ship Design (RBD). Posteriormente se propondrá un modelo de aprobación para diseños de nuevos buques que considera las recomendaciones de la Organización Marítima Internacional (OMI) mientras articula el trabajo de administraciones marítimas, industria naval y las casas clasificadoras.

Palabras claves: Reglamentos basados en objetivos, diseño de buques basado en riesgos, construcción de buques basada en objetivos, proceso de aprobación de diseño de buques, convenio SOLAS, reglamentos de seguridad.

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Introduction

Mariners and seafarers have always been exposed to deadly risks. It is not only because of the unpredictability of climate conditions or the enormous forces acting on the structure of ships, or the small error margins in the maneuvers of pilots and captains. Vessels and seafarers will always be exposed to risk (*IMO, 2012*) but there is definitely something that we can do about it.

Over time the maritime transportation industry has learned a lot. The bad experiences and even the catastrophes have left something good: “Valuable experience”. The experiences, collected over many years, takes several forms today, and has been converted into current regulations and industry standards. It is even possible to say that the documents have been created to avoid the same events that caused them to exist in the first place.

The International Convention for the Safety of Life at Sea (SOLAS), is the document developed by the International Maritime Organization (IMO) to stablish universal rules for maritime safety. The SOLAS Convention was issued as a response to major maritime disasters and consists of a compendium of safety related regulations (*IMO, 2014*).

This paper will deal with the needs of a Maritime Administration to establish an “Approval Process for New Ship Designs”. This paper considers the analysis of relevant criteria related to Design for Safety (DFS), Risk Based Design (RBD) and Goal-Based Standards (GBS). Based on the information above, a methodology will be proposed to evaluate the new designs of ships.

Maritime Safety and the New Approach

The Solas Convention

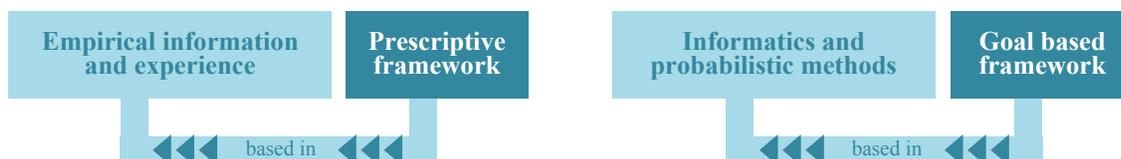
The International Convention of Safety of Life at Sea (SOLAS), was adopted in November of 1974 and entered into force on May 1980. Due to the technical character of the information included, and the fast technological development of the industry, the document has been updated and amended on numerous occasions. The objective of SOLAS is in setting the standards regarding the construction, equipment and operation of ships. It can be considered to be the most important international treaty about shipping safety. (*IMO, 2014*)

In the '90s the members of the Maritime Safety Committee realized that "prescriptive-based" regulations were not fit for purpose, and the IMO decided that the classical approach was not useful in solving the new needs of the industry. The response to this problem consisted in incorporating a "goal-based philosophy" into the technical regulations. (*IMO, 2015*)

The New Approach “Goal Based Regulations”

During recent years the International Maritime Organization has been working to change the method used to develop the maritime safety norms. The explanation for the change of thinking is that day by day more authors consider that the old prescriptive approach is based typically on the past experiences and prevents the advancement of the industry in the adoption of best practices (*Hoppe, 2010*).

Fig. 1. Difference between approaches



It has been found that the “goal-based regulations” are effective ways to incentivize innovation in the industry as the new model does not specify the means of achieving compliance. This fundamental fact contributes to enhancing creativity and the development of new technical solutions (Hoppe, 2010). As the opposite of the prescriptive model, the new approach of setting goals permits the introduction of new alternatives to achieve conformity.

"Goal-based standards" will be the support of classifications for the development of definitive prescriptive norms. This perspective also intends to be the foundation for the future international standards for shipping safety (Hoppe, 2010).

The document titled “International Goal-Based Ship Construction Standards for Bulk Carriers and Oil Tankers” issued by the IMO Maritime Safety Committee gives a basic example that demonstrates the difference between a “goal-based” and “prescriptive” approach (IMO, 2015):

- Goal-based: “People shall be prevented from falling over the edge of a cliff.”
- Prescription: “You must install a 1-meter high rail at the edge of the cliff.”

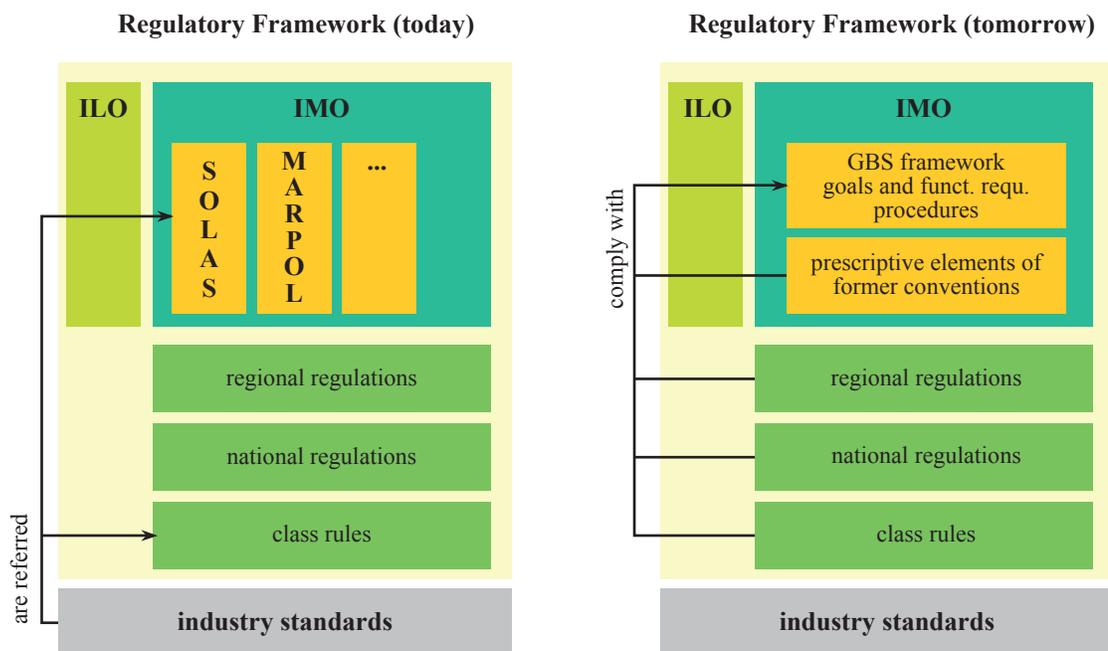
The Prescriptive approach, during the design stages will independently consider issues related to fire protection, marine engineering, naval architecture and other disciplines. Based on the experiences, the designer will propose the enhancing of the mentioned components in isolation from each other (IMO, 2015). This will be materialized in improvements to the fire protection system, propulsion systems, adjustments and so on.

On the other hand the Goal Based approach will take into account a specific goal for instance “the ship should be designed for improved survivability so that, in the event of an accident, persons can stay safely on board ” (IMO, 2015). This basic change creates an holistic view that integrates all safety-related issues. The designer takes into account the experience in addition to risk-based methodologies.

Risk-Based Ship Design

Risk-Based Ship Design (RBD) is an innovative methodology that involves the use of advanced computing tools that allow the integration of probabilistic and risk-based approaches. It is important to note that in the traditional approach prescriptive regulations were developed utilizing empirical knowledge. This critical aspect is the

Fig. 2. Long Term Vision of IMO GBS



reason why this philosophy produces limited design possibilities. (IMO, 2009).

The renowned industry expert, Mr. Vince Jenkins from Lloyds Register, explains in the article "Risk-based design" some of the challenges in the adoption of the new approach (Jenkins, 2012):

- To adjust the goals to the right levels.
- Obtain the approval from the regulators.
- The increase of cost and effort during the design and subsequent stages.
- The culture in the organizations must be transformed. From passive compliance in prescriptive rules to active management to achieve the goals.

Goal-Based Ship Construction

Concepts:

The "Goal-based ship construction standards" is the way how IMO intends to play a larger role in determining the minimum requirements for shipbuilding. Traditionally this issue used to be only under the responsibility of classification societies and shipyards.

Basic principles and methodology:

The basic principles of GBS were defined in the IMO document "Goal-based Ship Construction Standards for Bulk Carriers and Oil Tankers" (IMO, 2013) as follows:

- Vessels in compliance with the environmental

and security standards required during all their lifecycle.

- Ships designed according the norms and requirements applied by classification societies, recognized organizations, Administrations and IMO.
- Ship design and technology in clear compliance with demonstrable and verifiable, patterns and criteria.
- Ship design specific enough to avoid wrong interpretations.

In May 2010, IMO's Maritime Safety Committee (MSC) adopted a set of Resolutions related to Goal-Based Ship Construction Standards (GBS) (Toshiro, 2016). The International Association of Classification Societies (IACS) collaborated with the IMO Maritime Safety Committee (MSC) to create a five-tier system as follows:

- Tier I – Goals: High-level objectives to be met.
- Tier II – Functional requirements: Criteria to be satisfied. Goal-based Ship Construction Standards for Bulk Carriers and Oil Tankers.
- Tier III – Verification of conformity: Procedures for verifying that the rules and regulations for ship design and construction.
- Tier IV – Rules and regulations for ship design and construction. Detailed requirements.
- Tier V – Industry practices and standards: Standards, codes of practice and safety and quality systems for shipbuilding, ship operation, maintenance, training, manning, etc...

Fig. 3. Relations Between RBD and GBS

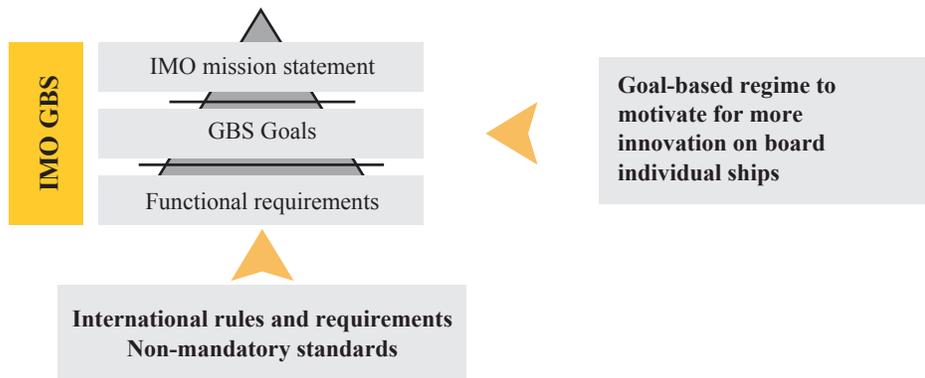


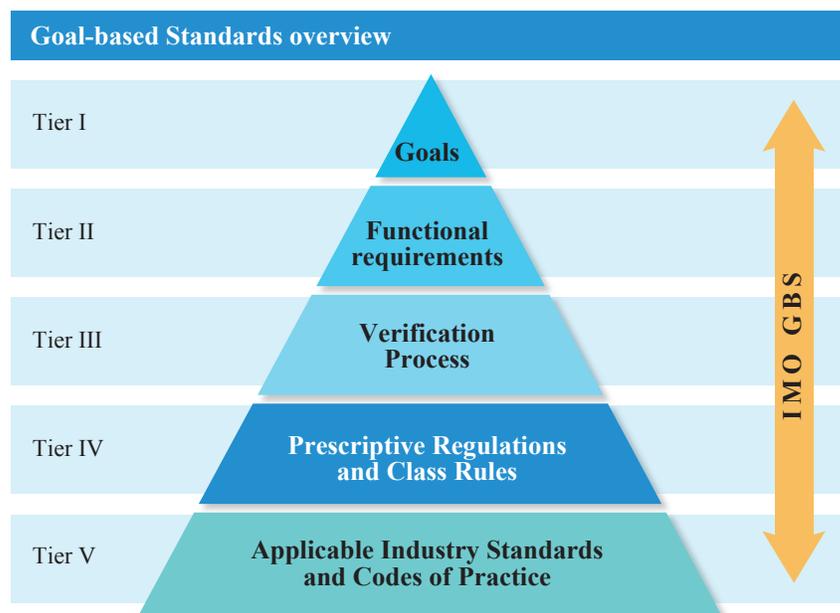
Fig. 4. Approaches to Fulfilling GBS



The new framework demands extra effort to generate innovative alternatives that achieve the goals without the existence of prescriptive requirements. It is an open door for engineers to innovate and to

create solutions motivated by a raise in safety and sustainability standards. From that perspective, the goal-based standards framework can be considered as a license for innovation. (Kent, 2011)

Fig. 5. GBS Five-Tier System



Proposal of "Ship Design Approval Process"

Delimitation of the Process

Considering the available information comprised by documents, guidelines and industry standards the following proposal is developed towards establishing a procedure for New Ship Building design. This kind of process should be established by the national maritime administrations while considering inputs from stakeholders.

- The nature of the process; The process starts when the person submitting the design sends the preliminary sketch to the Maritime Administration officials and ends when the design is ready to initiate the construction process.

IMO Recommendations

The MSC.1/Circ.1455 "Guidelines for the Approval of Alternatives and Equivalents as Provided for in Various IMO Instruments" provides useful ideas to structure an approval process (IMO, 2013):

1. The new designs should have different levels of approval.
2. A structured "approval process" is necessary to confirm that the design complies with the minimum statutory requirements for their intended operation. The process should be predictable and reliable.

3. Designers and administrations should develop a cooperative work to evaluate the safety and environmental protection aspects of the proposals.
4. In the alternative designs, the substitution of design measures with operational or procedural measures to reduce risk it is typically not permitted. The designs measures take priority over procedural measures.

The Evaluation Process

The MSC.1/Circ.1455 "Guidelines for the Approval of Alternatives and Equivalents as Provided for in Various IMO Instruments" defines the phases that should be accomplished during the process (IMO, 2013):

1. Development of a preliminary design.
 2. Approval of preliminary design.
 3. Development of final design.
 4. Final design testing and analyzes.
 5. Approval
- Four levels of evaluation:
 1. The process starts with the reception in the maritime authority of the preliminary design. A designated group of experts evaluates the conceptual idea and returns it to the designer with observations.
 2. In the second phase, the classification society verifies the design and compliance with the established technical rules in the relevant

Fig. 6. Basic scheme of the process

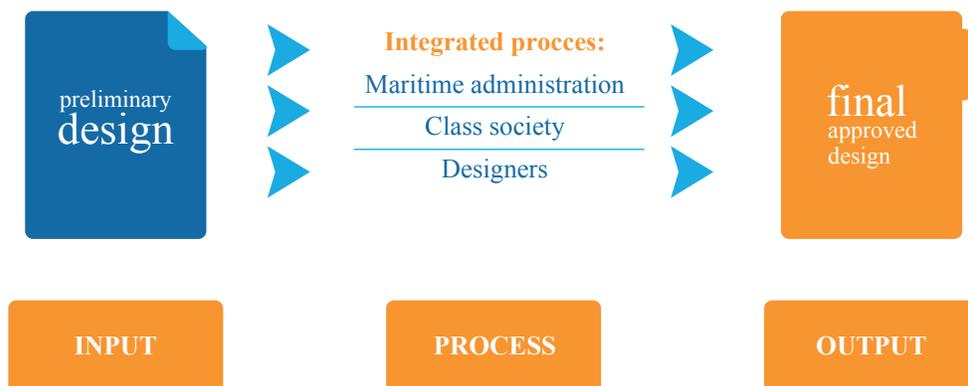
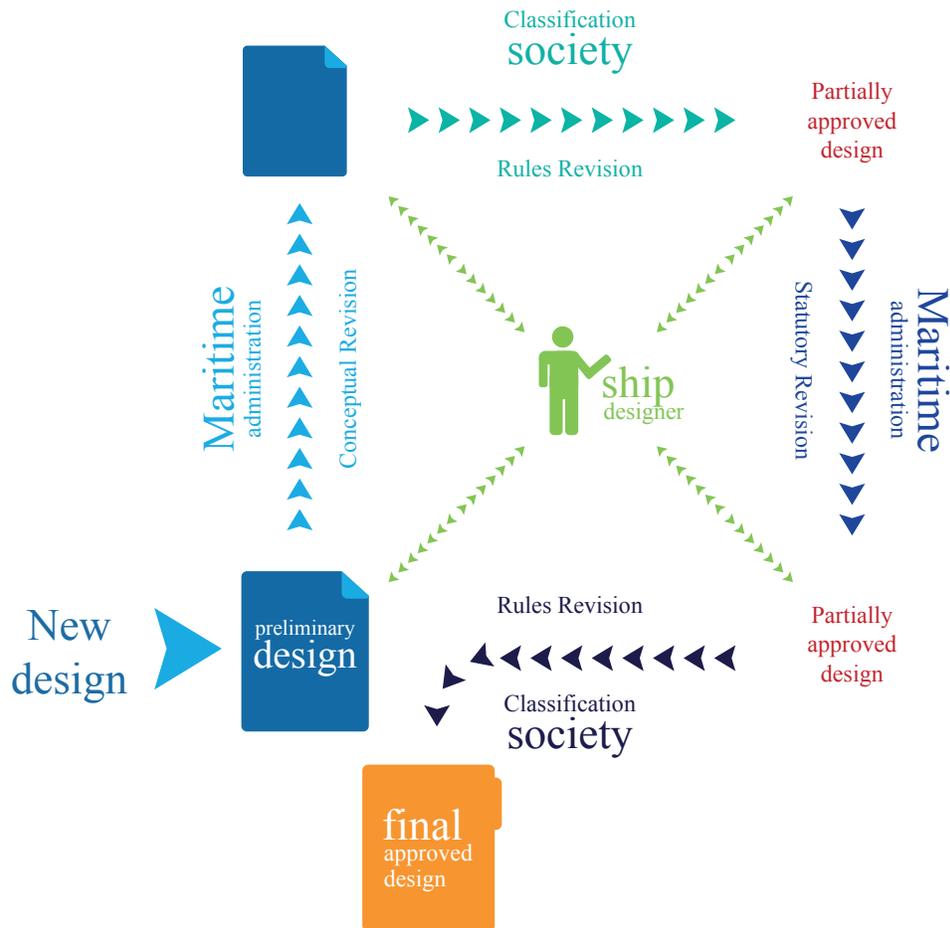


Fig. 7. Proposal of "Ship Design Approval Process"



- scopes (stability, fire protection, life-saving appliances etc...)
- The document is evaluated again by the experts of the maritime authority. In this stage, the main idea is to verify that the design is in agreement with the minimum regulations requirements for the intended operation.
 - In the fourth stage, the classification society evaluates the final design and verifies the construction plan.

It is important to highlight that throughout all the stages of the process the designer is receiving feedback and recommendations from the maritime authority designated group and classification society experts.

Fig. 7 illustrates the stages that a "Vessel Designs Approval Process" should have to assure

compliance with the international instruments. The critical aspect of the system is the pooled work of Designers, Classification Societies, and Maritime Administrations.

Conclusions

After analyzing the material of several authors regarding the concepts of Goal-Based Standards (GBS), design for safety (DFS) and Risk Based Design (RBD) is possible to reach the following conclusions:

- The tendency in the International Maritime Organization (IMO) is to establish a "Goal Based" regime. However, the "Prescriptive" approach will still be valid for particular technical issues. In other words, "Prescriptive"

and “Goal Based” methods must be used as complementary parts in order to develop the future framework.

- According to the recommendations from International Maritime Organization (IMO) and maritime experts it is necessary to establish a "New Ship Design Approval Process" with several levels. This paper proposes a "New Ship Design Approval Process" of four stages. The proposed frame is in compliance with IMO regulations and includes a clarification of the role of Maritime Authority and Classification Societies. Both institutions should carefully follow the work of the designer and provide the necessary feedback.

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