INTERNATIONAL MARITIME ORGANIZATION

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MARITIME SAFETY COMMITTEE
88th session
Agenda item 5

MSC 88/5/2
20 September 2010
Original: ENGLISH

GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

Information on long-term considerations for the continued development of GBS

Submitted by the Republic of Korea

SUMMARY

Executive summary:	This document provides information on long-term considerations relevant to validation of the results of the safety level approach by comparing with the prescriptive approach
Strategic direction:	10
High-level action:	10.0.1
Planned output:	10.0.1.2
Action to be taken:	Paragraph 7
Related documents:	MSC 84/24; MSC 86/26; MSC 87/26 and MSC 88/5

Background

1 The Committee, at its eighty-fourth session, agreed to a work plan for further development of GBS. For short-term considerations, it was agreed that the "Development of a plan to validate the results from the safety level concept" should be considered at MSC 86 (MSC 84/24, paragraph 5.20.4.2). It was also agreed that "Validation of the results of the safety level approach by comparing with the prescriptive approach" should be included in the list of issues under long-term consideration (MSC 84/24, paragraph 5.20.5.2).

2 At MSC 86 and MSC 87, however, due to the completion and adoption of the GBS for bulk carriers and oil tankers, no discussion took place on the item "Validation of the results of the safety level approach by comparing with the prescriptive approach" and the Committee invited Member Governments and international organizations to submit relevant comments and proposals to MSC 88 (MSC 86/26, paragraphs 5.40 and 5.41 and MSC 87/26, paragraphs 5.27 and 5.28).

Validation of the results of the safety level approach

3 Although there are many aspects influencing the ship's safety such as ship structure, machinery, equipment, stability, manoeuvrability, collision, grounding, and fire protection, it is considered that the ship's structure is the most important item in validating the results of the safety level approach by comparing with the prescriptive approach. This document has been developed with this in mind, focusing on the ship's structural safety.

4 The Republic of Korea, noting the item of validation of the results of the safety level approach by comparing with the prescriptive approach, has reviewed various prerequisites to be decided at the planning stage, as a result of which the following essential prerequisites have been identified:

.1 selection of an appropriate analysis method with safety level approach (e.g., in case of a ship's structure, SRA (Structural Reliability Approach) or FSA (Formal Safety Assessment));

.2 subject members to be reviewed and structural behaviour (e.g., structural strength, buckling strength, fatigue strength, maintenance level, etc.);

.3 philosophy for establishment of a target safety level; and

.4 guidelines incorporating the above items.

5 In addition, the Republic of Korea has undertaken a study on the development of "Ship structural rules for hull scantlings" as GBS Tier IV in case where SRA is applied with safety level approach. The results of the study, with a summary of items recommended to be included in the rules, are set out in the annex.

6 The Republic of Korea hopes that the above considerations are of assistance in the long-term consideration of the future safety level based standards.

Action requested of the Committee

7 The Committee is invited to note the information provided and take action as appropriate.

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ANNEX

CONSIDERATION ON THE DEVELOPMENT OF SHIP STRUCTURAL RULES FOR HULL SCANTLINGS BASED ON THE SAFETY LEVEL APPROACH

1 Preface

SLA-based GBS aim to design, construct and operate the ships meeting the target safety level. With respect to the detailed rules in Tier IV complying with GBS based on the safety level approach, the Republic of Korea has given its consideration to the need to develop structural rules limited to scantlings of ship hulls.

The key items to be included in the ship structural rules, in case where SRA is applied with safety level approach, are summarized in this document.

2 Safety level based ship structural rules for hull scantlings

Under the conventional hull structural rules based on the deterministic approach, designers can decide the scantlings of the ship's structures with the formulae of the rules. If the scantlings of the ship are higher than those required and calculated by the rules, it is generally accepted that the ship has been designed with structural safety.

The safety level based ship structural rules (hereinafter referred to as "the Rules") ensure the safety of ship structure by comparing and validating the following two safety levels:

.1 target safety level of ship structure; and

.2 design safety level of ship structure.

Approval criteria are the following two parameters. The Rules should include appropriate procedures for calculating the target safety level and the design safety level.

.1 Is the design safety level greater than or equal to the target safety level?; and

.2 Is the calculation of the design safety level carried out in an objective, reasonable and transparent way?

3 Target safety level for ship structure

Target safety level means the minimum safety level that the ship's structure should guarantee. In principle, the approval authorities decide and present a target safety level.

The target safety level is defined as reliability index or probability of failure according to the severity of the possible results when the ship structure is damaged (MSC 79/INF.5). When the ship structure has failed, the ship's structure shows various failure modes such as yield, buckling, fatigue, etc., and it should be noted that the safety level can be defined differently depending on the corresponding failure mode.

The target safety level is to meet the goals and functional requirements set out in Tier I and Tier II of the GBS framework (e.g., the probability that a failure occurs once in 25 years). The design safety level will be referred to in the process of deciding the target safety level and a set of background data used in choosing the target safety level will also be referred to when calculating the design safety level.

4 Design safety level of ship structure

Design safety level means the safety level that the designed ship structure can actually guarantee, and above all, an appropriate method for calculating the design safety level of the scantlings determined by the designer should be presented.

This method should take into account the probabilistic features of uncertainties of various design parameters relevant to the ship's structure.

4.1 *Structural Reliability Analysis (SRA)*

Structural reliability analysis (SRA) is considered the most appropriate tool for the design safety level calculation, and the failure probability of a structure can be calculated by SRA. The failure probability corresponds to the safety level, and can be used instead of the safety level. Now, various SRA methods for calculating failure probability have been developed and are well established. Appropriate limit state equations and random variables are required for applying SRA.

4.2 *Limit state equations*

The general limit state equation of a structure consists of loads acting on structures and strength withstanding the loads:

$$G = S – L$$

Limit state equations should be defined for various failure modes and structural members based on existing hydrodynamics and structural theory. Limit state equation is an essential that needs to be included in the Rules and it is important to develop appropriate limit state equations in developing the Rules.

4.3 *Random variables*

Stochastic characteristics of various random variables composing the limit state equations need to be defined. In case of a ship structure, random variables are categorized into four areas:

.1 random variable related to loads (hydraulic pressure, accelerations, concentrated loads, impact pressures, load cycles, etc.);

.2 random variables related to materials (thickness of plates, yield stress of steel plates, modulus of elasticity of steel plates, etc.);

.3 random variables related to product quality (width and height of steel plates, welding, alignment, QC, etc.); and

.4 random variables related to modelling uncertainties.

Designers should define the probability distributions and characteristics of random variables and submit the relevant data to the approval authorities. The approval authorities should review the objectivity, rationality and transparency of the probability data submitted by the designer and approve them. The Rules should provide a guideline to define the above probabilistic characteristics.

5 Conclusion

5.1 The minimum parameters to be included in the Rules are as follows and are to be developed by the approval authorities:

.1 target safety levels for all the failure modes of ship structure;

.2 limit state equations for all the failure modes of ship structure;

.3 probabilistic characteristics of random variables; and

.4 guidelines for defining the characteristics of random variables.

5.2 In the application of the Rules, the minimum items that need approval are as follows and are to be developed and submitted by the designer:

.1 validity of calculated design safety level;

.2 validity of SRA method applied by designer, and

.3 validity of characteristics of random variables.