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GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

MSC's work on goal-based new ship construction standards – an overview

Note by the Secretariat

SUMMARY

Executive summary: This document sets out the historical background, objectives and scope, structure, progress made and results achieved with regard to the Committee's work on goal-based new ship construction standards.

Action to be taken: Paragraph 28

Related documents: C 89/12/1; resolutions A.943(23) and A.944(23); MSC 78/6/2; MSC 78/23; MSC 79/23; MSC 80/24; MSC 80/WP.8; MSC 81/25; MSC 81/6/5; MSC 81/WP.7; MSC 82/24; MSC 82/WP.5; MSC 83/5/1; MSC 83/5/2; MSC 83/5/3 and MSC 83/5/4

INTRODUCTION

1 The Committee, at its eighty-second session, noted and appreciated the offer of the Secretariat to prepare a document for this session, providing updated information on the evolution and development of the GBS concept (i.e., historical background, objectives and scope, outline of its structure, gradual progress achieved at various sessions, actual position, etc.). Relevant information is given below.

BACKGROUND

2 The notion of "goal-based ship construction standards" was introduced at IMO at the eighty-ninth session of the Council in November 2002 through a proposal by the Bahamas and Greece (C 89/12/1), suggesting that the Organization should play a larger role in determining the standards to which new ships are built, traditionally the responsibility of classification societies and shipyards. The submitters argued that IMO should develop initial ship construction standards that would permit innovation in design and, at the same time, ensure that ships are constructed in such a manner that, if properly maintained, they would remain safe for their economic life. The standards would also have to ensure that all parts of a ship could be easily accessed to permit proper inspection and ease of maintenance.

3 Over the next two years the matter was extensively discussed in the Committee, the Council and finally the Assembly which, at its twenty-third session in 2003, included the item "Goal-based new ship construction standards" in the Strategic plan for the Organization (for the six-year

period 2004 to 2010) (resolution A.944(23) and the Long-term work plan of the Organization (up to 2010) (resolution A.943(23).

4 Detailed technical work on the development of goal-based new ship construction standards (GBS) started at MSC 78 in May 2004, continued through MSC 79, MSC 80, MSC 81 and MSC 82 and is still on-going. MSC 79 agreed that, for the time being, the work on GBS should remain under the auspices of the Committee, in consultation with relevant sub-committees as and when necessary, on the understanding that the MEPC would consider the issue from the environmental protection point of view and provide its contribution for discussion at the MSC (MSC 79/23, paragraph 6.1).

METHODOLOGY

5 From the outset there were diverging views in the Committee on how to approach the development of GBS for new ship construction. Some Members advocated the application of a holistic approach which would define a procedure for the risk-based evaluation of the current safety level of existing mandatory regulations related to ship safety and consider ways forward to establish future risk acceptance criteria using FSA (i.e. safety level approach). Other Members supported a more deterministic approach, based on the vast practical experience gained with oil tankers and bulk carriers over the years, and stressed the need for clearly quantified functional requirements (i.e. prescriptive approach).

6 The Committee had extensive and wide ranging discussions on the issue, with active participation by many different Administrations, during which support for both methodologies was expressed. Following this debate, which continued through MSC 79 and MSC 80, MSC 81 finally resolved to work on the prescriptive approach and the safety level approach in parallel (MSC 81/25, paragraph 6.8), i.e. the prescriptive approach for GBS for provisions for hull construction for bulk carriers and oil tankers and the safety level approach for all other ship types.

BASIC PRINCIPLES OF IMO GOAL-BASED STANDARDS

7 With regard to the basic principles of IMO goal-based standards, MSC 80 (MSC 80/24, paragraph 6.38) agreed that goal-based standards are:

.1 broad, over-arching safety, environmental and/or security standards that ships are required to meet during their lifecycle;

.2 the required level to be achieved by the requirements applied by classification societies and other recognized organizations, Administrations and IMO;

.3 clear, demonstrable, verifiable, long standing, implementable and achievable, irrespective of ship design and technology; and

.4 specific enough in order not to be open to differing interpretations.

8 It is understood that these basic principles are applicable to all goal-based standards developed by IMO and not only to goal-based new ship construction standards, in recognition that, in the future, the Organization may develop goal-based standards for other areas, e.g. machinery, equipment, fire protection, etc., and that all goal-based standards developed by the Organization should follow the same basic principles.

GBS FOR OIL TANKERS AND BULK CARRIERS

The five-tier system

9 The Committee agreed on a five-tier system, following a proposal by the Bahamas, Greece and IACS (MSC 78/6/2), as set out below. It is understood that the first three tiers constitute the goal-based standards to be developed by IMO, whereas Tiers IV and V contain provisions developed/to be developed by classification societies, other recognized organizations and industry organizations (MSC 79/23, paragraphs 6.7 and 6.18.2).

Tier I
Goals
↓
Tier II
Functional requirements
↓
Tier III
Verification of compliance
↓
Tier IV
Technical procedures and guidelines, classification rules
↓
Tier V
Industry standards, codes of practice and safety and quality systems for shipbuilding, ship operation, maintenance, training, manning, etc.

with the contents of the tiers as follows:

- Tier I: *Goals*
  A set of goals to be met in order to build and operate safe and environmentally friendly ships.

- Tier II: *Functional requirements*
  A set of requirements relevant to the functions of the ship structures to be complied with in order to meet the above-mentioned goals.

- Tier III: *Verification of compliance*
  Provides the instruments necessary for demonstrating that the detailed requirements in Tier IV comply with the Tier I goals and Tier II functional requirements.

- Tier IV: *Technical procedures and guidelines, classification rules*
  The detailed requirements developed by IMO, national Administrations and/or classification societies and applied by national Administrations and/or classification societies acting as recognized organizations to the design and construction of a ship in order to meet the Tier I goals and Tier II functional requirements.

- Tier V: *Industry standards, codes of practice and safety and quality systems for shipbuilding, ship operation, maintenance, training, manning, etc.*
  Industry standards and shipbuilding design and building practices that are applied during the design and construction of a ship.

Goals (Tier I)

10 MSC 81 approved the following Tier I goals (MSC 81/25, paragraph 6.14), applicable to all types of new ships, subject to any necessary adjustments resulting from the completion of Tier III (Verification of compliance), work on which is still on-going (see paragraph 12):

Ships are to be designed and constructed for a specified design life to be safe and environmentally friendly, when properly operated and maintained under the specified operating and environmental conditions, in intact and specified damage conditions, throughout their life.

.1 Safe and environmentally friendly means the ship shall have adequate strength, integrity and stability to minimize the risk of loss of the ship or pollution to the marine environment due to structural failure, including collapse, resulting in flooding or loss of watertight integrity.

.2 Environmentally friendly also includes the ship being constructed of materials for environmentally acceptable recycling.

.3 Safety also includes the ship's structure being arranged to provide for safe access, escape, inspection and proper maintenance.

.4 Specified operating and environmental conditions are defined by the intended operating area for the ship throughout its life and cover the conditions, including intermediate conditions, arising from cargo and ballast operations in port, waterways and at sea.

.5 Specified design life is the nominal period that the ship is assumed to be exposed to operating and/or environmental conditions and/or the corrosive environment and is used for selecting appropriate ship design parameters. However, the ship's actual service life may be longer or shorter depending on the actual operating conditions and maintenance of the ship throughout its life cycle.

Functional requirements (Tier II)

11 MSC 81 also approved the following Tier II functional requirements (MSC 81/25, paragraph 6.15), applicable to new bulk carriers and oil tankers in unrestricted navigation, which were further amended at MSC 82 (MSC 82/24, paragraphs 5.11, 5.24 and 5.25), likewise subject to any necessary adjustments resulting from the completion of Tier III (Verification of compliance), work on which is still on-going (see paragraph 12):

.1 DESIGN

II.1 Design life
II.2 Environmental conditions
II.3 Structural strength
II.4 Fatigue life

II.5 Residual strength
II.6 Protection against corrosion
II.6.1 Coating life
II.6.2 Corrosion addition
II.7 Structural redundancy
II.8 Watertight and weathertight integrity
II.9 Human element considerations
II.10 Design transparency

.2 CONSTRUCTION

II.11 Construction quality procedures
II.12 Survey

.3 IN-SERVICE CONSIDERATIONS

II.13 Survey and maintenance
II.14 Structural accessibility

.4 RECYCLING CONSIDERATIONS

II.15 Recycling

A detailed description of the functional requirements is set out in annex 1.

Verification of compliance (Tier III)

12 The general purpose of Tier III is the verification that the technical requirements in Tier IV comply with the functional requirements in Tier II. The Tier III verification framework includes the appropriate acceptance criteria and the information and documentation requirements for the verification process. Work on Tier III is on-going (see paragraphs 17 and 18) and might necessitate further adjustments to the Tier I goals (see paragraph 10) and Tier II functional requirements (see paragraph 11).

13 Acknowledging that Tier IV may consist of IMO requirements, Administration standards and classification society rules, the Committee discussed whether Tier III should address verification of all those requirements. It concluded that, at this juncture, IMO would only deal with the verification of classification society rules, recalling that one of the original objectives of developing GBS for new ship construction was to provide Administrations with an oversight of the rules applied by classification societies for the design and construction of new ships (MSC 81/25, paragraph 6.17). A flowchart of the framework for the verification of classification society rules, prepared by the GBS Working Group (MSC 81/WP.7, annex 3), is set out in annex 3.

14 MSC 81 noted in this connection that the GBS Working group had agreed that any decision by IMO concerning the outcome of the verification does not pre-empt the decision or action by an Administration with respect to the status of a classification society acting as a recognized organization on behalf of that Administration, although the group had also agreed that a classification society should not be authorized as a recognized organization for the purpose of ship structure standards unless its rules met the goal-based standards (MSC 81/25, paragraph 6.20).

15 In considering who should carry out the verification, the Committee noted that its GBS Working Group had recommended that the verification authority to review the information and documentation provided by a classification society and to prepare recommendations for the consideration of the Committee should be a group of experts, selected and appointed from a pool of independent experts by the Secretary-General (MSC 81/25, paragraph 6.24). Funding options for such a group of experts are expected to be further considered at this session (MSC 83/5/4).

16 Concerning the issue of liability by IMO with regard to decisions of the future group of experts, relating to verification, the Committee noted that, if a function is consistent with the objective and purpose of the Organization and its Convention, the Organization is immune from legal process. If a function of the Organization, like the work of an expert group under the auspices of the Committee, is covered by a mandatory instrument, e.g. the SOLAS Convention, no liability issues would arise (MSC 81/25, paragraph 6.22).

Verification pilot project

17 MSC 81 agreed that carrying out a verification pilot project using the IACS Common Structural Rules for oil tankers and bulk carriers (CSR) would be advantageous to help uncover issues that had not been discussed and resolved previously and also to determine what, if any, changes were needed (MSC 81/25, paragraph 6.36). It was emphasized that the purpose of the pilot project was not the detailed consideration of the CSR but the assessment of the adequacy of the Tier III requirements and the identification of weaknesses in the GBS verification process.

18 Consequently, MSC 82 approved a plan for the pilot project on trial application of the Tier III verification process using the IACS CSR (MSC 82/24, annex 15), to be carried out by a Pilot Panel with the objective of conducting a trial application of Tier III of the GBS for oil tankers and bulk carriers with the intention of validating the Tier III verification framework, identifying shortcomings and making proposals for improvement. The Pilot Panel started work in January 2007 and its report (MSC 83/5/1) is expected to be considered at this session.

Ship Construction File (SCF)

19 In the context of the consideration of GBS, the development of a Ship Construction File, which should contain drawings and information on materials/construction of the hull, machinery and equipment relevant to the operation, maintenance and repair of the ship and should remain with it through changes of ownership, classification and flag, was principally agreed at MSC 79 (MSC 79/23, paragraph 6.6.8) and further discussed over the next few sessions, taking into account a relevant proposal by Japan (MSC 81/6/5).

20 At MSC 82 (MSC 82/WP.5, annex 2), the GBS Working Group prepared the final version of the SCF, which is set out in annex 2, and agreed that the SCF should become an independent mandatory requirement under SOLAS chapter II-1 (MSC 82/24, paragraph 5.28). The Committee instructed the Correspondence Group on GBS for oil tankers and bulk carriers to prepare relevant draft SOLAS amendments, which are expected to be discussed at this session (MSC 83/5/2).

Incorporation of GBS in mandatory IMO instruments

21 MSC 81 agreed that Tier I should be prepared in the form of amendments to SOLAS chapter II-1, with Tiers II and III included in a separate Code or a resolution, to be made mandatory under the SOLAS amendments to be developed, whereby the Tier III process details as well as the Tier III verification guidelines could be footnoted, so that they could easily be

amended if necessary (MSC 81/25, paragraph 6.35). Relevant draft SOLAS amendments, as prepared by the Correspondence Group on GBS for oil tankers and bulk carriers (MSC 83/5/2), are expected to be discussed at this session.

SAFETY LEVEL APPROACH

22 MSC 81 had extensive and wide ranging discussions on the safety level approach with a view to identifying what needed to be done in order to develop GBS using the safety level approach and agreed that this should include the development of a risk model and of goal-based standards guidelines; the determination of the current safety level and of the relationship between different design measures, e.g., structure, stability, manoeuvrability, fire protection, etc.; examination and reconsideration of the five-tier system and, if needed, appropriate adaptation to develop a structure suitable for the safety level approach; examination and, if appropriate, modification of Tier I and Tier II as developed for oil tankers and bulk carriers for use in the safety level approach; and consideration of the relationship between overall failure of the ship and the contribution of individual failure modes (MSC 81/25, paragraph 6.38).

23 MSC 82 (MSC 82/WP.5, annex 4), agreed on a provisional long-term work plan for the development of GBS based on the safety level approach, set out in annex 4, and included priority items in the terms of reference for the Correspondence Group on the Safety Level Approach, including determination of the current safety level in a holistic high-level manner, further consideration of the linkage between FSA and GBS and further development of goal-based standard guidelines for the safety level approach. The report of the group (MSC 83/5/3) is expected to be considered at this session.

LINKAGE BETWEEN FORMAL SAFETY ASSESSMENT (FSA) AND GBS

24 The Committee discussed the linkage between FSA and GBS on several occasions. MSC 79 agreed that the two subjects should be kept separate for the time being and also that the matter should be further discussed by the FSA Working Group (MSC 79/23, paragraph 6.13).

25 At MSC 80 (MSC 80/24, paragraphs 7.19 and 7.20), the FSA Working Group had an extensive discussion regarding the linkage and agreed that the FSA process, in general, could be used to:

.1 conduct holistic assessments (e.g., ship types, whole system reviews, etc.) with a view to establishing the level of risk and set goals accordingly;

.2 identify and/or formulate high-level goals and functional requirements;

.3 support high-level goals to determine associated hazards and develop appropriate risk control options;

.4 assess specific issues (e.g., focus on diesel engine fires) to determine associated hazards and associated risks and develop appropriate risk control options;

.5 identify inherent safety levels in existing standards and, from that, make explicit the inherent risk acceptance criteria;

.6 verify compliance of regulations (e.g., classification society rules) with high-level goals and functional requirements; and

.7 find gaps in functional requirements.

26 The group was also of the view that the first three FSA steps (identification of hazards, risk analysis, risk control options)* are suitable for the development of high-level goals (Tier I) and functional requirements (Tier II) of GBS. Equally, the last three steps (risk control options, cost benefit assessment, recommendations for decision-making) could feed into Tiers IV and V of GBS, by helping to select between alternative technical or regulatory solutions to specific problems.

27 MSC 82 (MSC 82/24, paragraph 5.40) included consideration of the linkage between FSA and GBS, identifying which elements are relevant for both, and, in particular, considering risk acceptance criteria based on the Committee's work on FSA, in the terms of reference of the Correspondence Group on the Safety Level Approach, the report of which (MSC 83/5/3) is expected to be considered at this session.

ACTION REQUESTED OF THE COMMITTEE

28 The Committee is invited to note the above information and take action as appropriate.

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* Refer to the Guidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process (MSC/Circ.1023 – MEPC/Circ.392).

ANNEX 1

TIER II FUNCTIONAL REQUIREMENTS

(Applicable to new oil tankers and bulk carriers in unrestricted navigation*)

DESIGN

II.1 Design life

The specified design life is not to be less than 25 years.

II.2 Environmental conditions

Ships should be designed in accordance with North Atlantic environmental conditions and relevant long-term sea state scatter diagrams.

II.3 Structural strength

Ships should be designed with suitable safety margins:

.1 to withstand, at net scantlings**, in the intact condition, the environmental conditions anticipated for the ship's design life and the loading conditions appropriate for them, which should include full homogeneous and alternate loads, partial loads, multi-port and ballast voyage, and ballast management condition loads and occasional overruns/overloads during loading/unloading operations, as applicable to the class designation; and

.2 appropriate for all design parameters whose calculation involves a degree of uncertainty, including loads, structural modelling, fatigue, corrosion, material imperfections, construction workmanship errors, buckling and residual strength.

The structural strength should be assessed against excessive deflection and failure modes, including but not limited to buckling, yielding and fatigue. Ultimate strength calculations should include ultimate hull girder capacity and ultimate strength of plates and stiffeners. The ship's structural members should be of a design that is compatible with the purpose of the space and ensures a degree of structural continuity. The structural members of ships should be designed to facilitate load/discharge for all contemplated cargoes to avoid damage by loading/discharging equipment which may compromise the safety of the structure.

II.4 Fatigue life

The design fatigue life should not be less than the ship's design life and should be based on the environmental conditions in II.2.

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* Unrestricted navigation means that the ship is not subject to any geographical restrictions (i.e. any oceans, any seasons) except as limited by the ship's capability for operation in ice.

** The net scantlings should provide the structural strength required to sustain the design loads, assuming the structure in intact condition and excluding any addition for corrosion.

II.5 Residual strength

Ships should be designed to have sufficient strength to withstand the wave and internal loads in specified damaged conditions such as collision, grounding or flooding. Residual strength calculations should take into account the ultimate reserve capacity of the hull girder, including permanent deformation and post-buckling behaviour. Actual foreseeable scenarios should be investigated in this regard as far as is reasonably practicable.

II.6 Protection against corrosion

Measures are to be applied to ensure that net scantlings required to meet structural strength provisions are maintained throughout the specified design life. Measures include, but are not limited to, coatings, corrosion additions, cathodic protection, impressed current systems, etc.

II.6.1 Coating life

Coatings should be applied and maintained in accordance with manufacturers' specifications concerning surface preparation, coating selection, application and maintenance. Where coating is required to be applied, the design coating life is to be specified. The actual coating life may be longer or shorter than the design coating life, depending on the actual conditions and maintenance of the ship. Coatings should be selected as a function of the intended use of the compartment, materials and application of other corrosion prevention systems, e.g. cathodic protection or other alternatives.

II.6.2 Corrosion addition

The corrosion addition should be added to the net scantling and should be adequate for the specified design life. The corrosion addition should be determined on the basis of exposure to corrosive agents such as water, cargo or corrosive atmosphere, or mechanical wear, and whether the structure is protected by corrosion prevention systems, e.g. coating, cathodic protection or by alternative means. The design corrosion rates (mm/year) should be evaluated in accordance with statistical information established from service experience and/or accelerated model tests. The actual corrosion rate may be greater or smaller than the design corrosion rate, depending on the actual conditions and maintenance of the ship.

II.7 Structural redundancy

Ships should be of redundant design and construction so that localized damage of any one structural member will not lead to immediate consequential failure of other structural elements leading to loss of structural and watertight integrity of the ship.

II.8 Watertight and weathertight integrity

Ships should be designed to have adequate watertight and weathertight integrity for the intended service of the ship and adequate strength and redundancy of the associated securing devices of hull openings.

II.9 Human element considerations

Ships should be designed and built using ergonomic design principles to ensure safety during operations, inspection and maintenance of ship's structures. These considerations should include

stairs, vertical ladders, ramps, walkways and standing platforms used for permanent means of access, the work environment and inspection and maintenance considerations.

II.10 Design transparency

Ships should be designed under a reliable, controlled and transparent process made accessible to the extent necessary to confirm the safety of the new as-built ship, with due consideration to intellectual property rights. Readily available documentation should include the main goal-based parameters and all relevant design parameters that may limit the operation of the ship.

CONSTRUCTION

II.11 Construction quality procedures

Ships should be built in accordance with controlled and transparent quality production standards with due regard to intellectual property rights. The ship construction quality procedures should include, but not be limited to, specifications for material, manufacturing, alignment, assembling, joining and welding procedures, surface preparation and coating.

II.12 Survey

A survey plan should be developed for the construction phase of the ship, taking into account the ship type and design. The survey plan should contain a set of requirements, including specifying the extent and scope of the construction survey(s) and identifying areas that need special attention during the survey(s), to ensure compliance of construction with mandatory ship construction standards.

IN-SERVICE CONSIDERATIONS

II.13 Survey and maintenance

Ships should be designed and constructed to facilitate ease of survey and maintenance, in particular avoiding the creation of spaces too confined to allow for adequate survey and maintenance activities. The survey plan in II.12 should also identify areas that need special attention during surveys throughout the ship's life and in particular all necessary in-service survey and maintenance that was assumed when selecting ship design parameters.

II.14 Structural accessibility

The ship should be designed, constructed and equipped to provide adequate means of access to all internal structures to facilitate overall and close-up inspections and thickness measurements.

RECYCLING CONSIDERATIONS

II.15 Recycling

Ships should be designed and constructed of materials for environmentally acceptable recycling without compromising the safety and operational efficiency of the ship.

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ANNEX 2

SHIP CONSTRUCTION FILE (SCF)

The Ship Construction File (SCF) shall include the following information.
(Details of the information below might be included directly or by reference to other documents.)

Tier II items		Explicit information to be recorded
DESIGN		
1	Design Life	Assumed design life.
2	Environmental conditions	Assumed environmental conditions.
3	Structural strength	Calculating conditions and results; Operational restrictions due to structural strength; Assumed loading conditions; Scantlings (net); Scantlings (gross).
4	Fatigue life	Calculating conditions and results.
5	Residual strength	Assumed conditions.
6	Protection against corrosion	Coated areas and other measures for corrosion protection; Coating specification and selected anti corrosion measures.
6.1	Coating life	Target coating life.
6.2	Corrosion addition	Corrosion addition and wastage allowance.
7	Structural redundancy	Assumed conditions.
8	Watertight and weathertight integrity	Key factors for watertight and weathertight integrity.
9	Human element	List of ergonomic design principles applied to ship structure design to enhance safety during operations, inspections and maintenance of ships.
10	Design transparency	List of alternate methods used to demonstrate equivalency to the rules.
CONSTRUCTION		
11	Construction quality procedures	Applied construction quality standard.
12	Survey	Survey regime applied during construction.

IN-SERVICE CONSIDERATIONS		
13	Survey and maintenance	List of maintenance plans specific to the structure of the ship; Areas where higher attention to structural fatigue and corrosion are called.
14	Structural accessibility	Ship Structure Access Manual (SOLAS regulation II-1/3-6) covering both cargo and other areas.
RECYCLING CONSIDERATIONS		
15	Recycling	Identification of all materials that were used in construction and may need special handling due to environmental and safety concerns.

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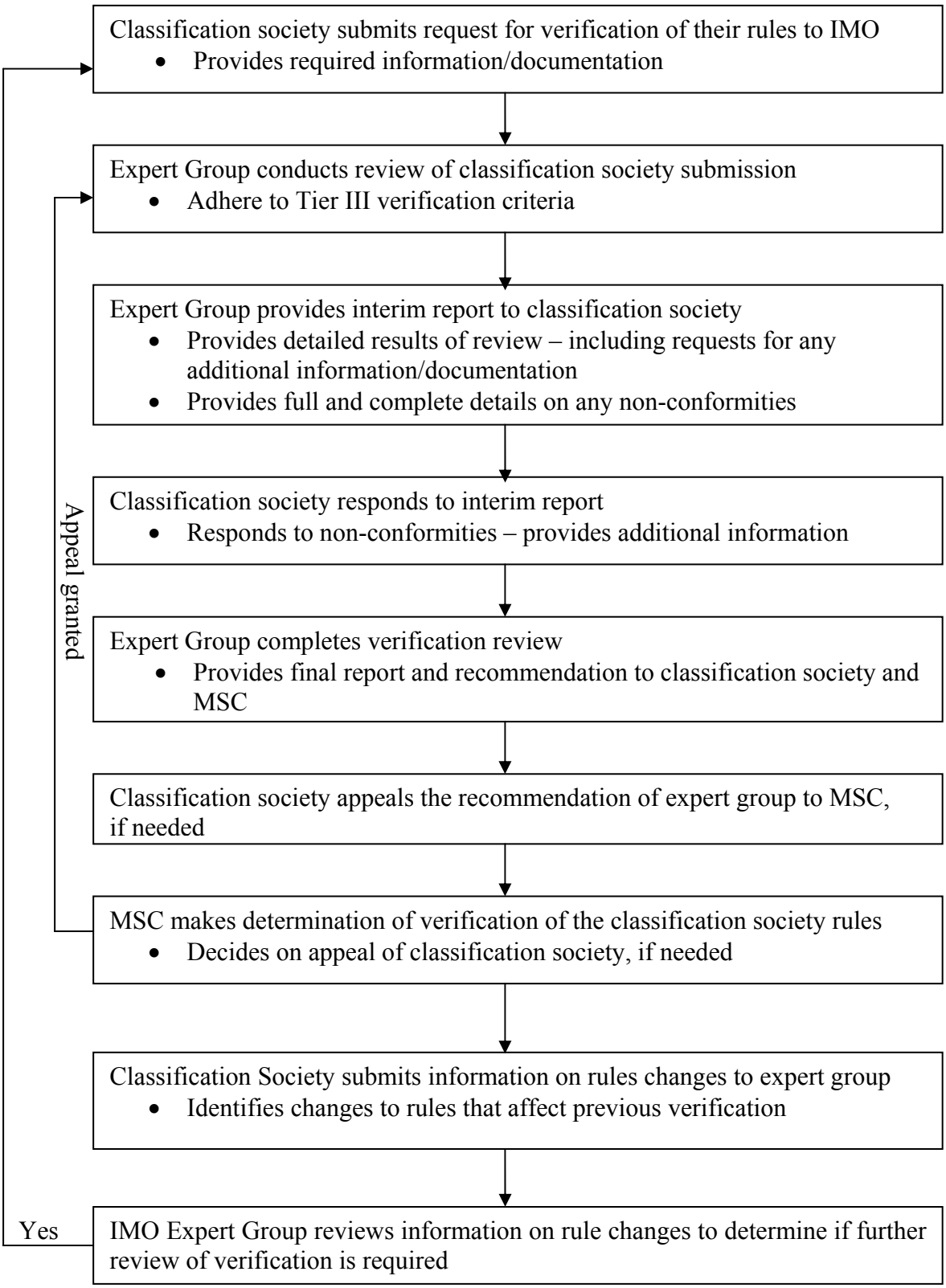
ANNEX 3

VERIFICATION FRAMEWORK – CLASSIFICATION SOCIETY RULES



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ANNEX 4

PROVISIONAL LONG-TERM WORK PLAN FOR THE SAFETY LEVEL APPROACH

1 Determination of the current safety level in a holistic high-level manner divided by ship types in order to develop Tier I goals.

2 Consideration of the outcome of MSC's work on FSA, in particular concerning risk acceptance criteria, and including existing FSA studies, for use in the development of the safety level approach.

3 Consideration of the tier structure so far agreed for GBS for oil tankers and bulk carriers for use in the safety level approach, using document MSC 81/6/14 as the basis and taking into account the proposals in documents MSC 81/6/8 and MSC 82/5/5.

4 Examination and broadening of the Tier II functional requirements as developed for oil tankers and bulk carriers to other issues for use in the safety level approach.

5 Examination of risk models to consider the contribution from different design measures, e.g., structure, stability, manoeuvrability, fire protection, etc., and from human element and organizational structures.

6 Development of goal-based standard guidelines for the safety level approach, taking into account document MSC 82/5/8, including development of a common terminology, taking into account documents MSC 76/INF.3 and MSC 81/6/14.

7 Consideration of the Tier III verification process.

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