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GENERIC GUIDELINES FOR DEVELOPING IMO GOAL-BASED STANDARDS

1 The Maritime Safety Committee, at its eighty-ninth session (11 to 20 May 2011), with a view to providing the process for the development, verification, implementation and monitoring of goal-based standards (GBS) to support regulatory development within IMO, approved the *Generic guidelines for developing IMO goal-based standards (*MSC.1/Circ.1394).

2 Taking into account the application of the Generic Guidelines during the development of IMO goal-based regulations, the Maritime Safety Committee, at its ninety-fifth session (3 to 12 June 2015) approved the revised Generic Guidelines (MSC.1/Circ.1394/Rev.1). Subsequently, the Committee approved further revisions to the Generic Guidelines at its 101st session (5 to 14 June 2019). The text of the revised Generic Guidelines is set out in the annex.

3 Member Governments are invited to use the annexed Generic Guidelines and to bring them to the attention of all parties concerned.

4 The present circular supersedes MSC.1/Circ.1394/Rev.1.

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ANNEX

GENERIC GUIDELINES FOR DEVELOPING IMO GOAL-BASED STANDARDS

Purpose

1 These Guidelines describe the process for the development, verification, implementation and monitoring of goal-based standards (GBS) to support regulatory development within IMO. GBS establish "rules for rules".

2 These Guidelines are generic and where they use phrases such as "required level of safety", this does not imply any preference for a specific technical approach.

Definitions and terminology

3 ***A goal-based standards framework*** consists of goal-based standards and the associated detailed requirements of rules and regulations for ships (see figure 1). An example of a structure of goal-based regulations is included in the appendix 1.

4 ***Accident*** is an unintended event involving fatality, injury, ship loss or damage, other property loss, damage or environmental damage.

5 ***Goal-based standards*** are high-level standards and procedures that are to be met through regulations, rules and standards for ships. GBS are comprised of at least one goal, functional requirement(s) associated with that goal, and verification of conformity that rules/regulations meet the functional requirements including goals.

6 ***Risk*** is the combination of the frequency and the severity of the consequence.

7 ***Rule/regulation commentary*** is an explanation of what functional requirement(s) is (are) intended to be covered by the rule/regulation (section or chapter), and how it is intended to be covered, including a synopsis of the analysis performed to prove that the rules/regulations conform to the functional requirements the rules/regulations intend to cover.

8 ***Safety*** is the absence of unacceptable levels of risk.

Basic principles

9 IMO goal-based standards are:

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

.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.

Goals (Tier I)

10 Goals are high-level objectives to be met. A goal should address the issue(s) of concern and reflect the required level of safety.

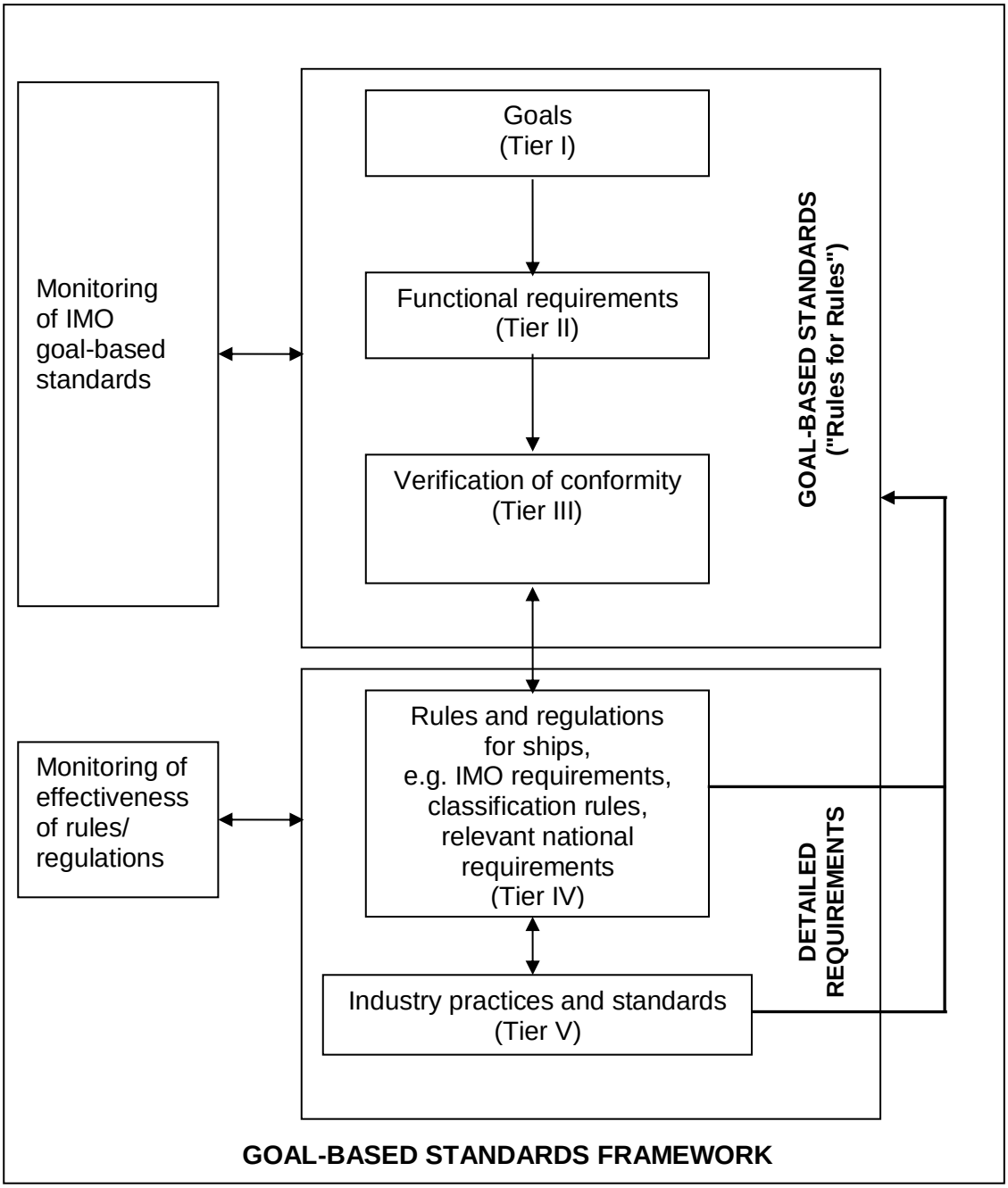

Figure 1
Goal-based standards framework

Functional requirements (Tier II)

11 Functional requirements provide the criteria to be complied with in order to meet the goals. Once a goal has been set, functional requirements should therefore be developed.

12 In order to fulfil the basic objectives of Goal-Based Standards functional requirements should comply with the following:

.1 functional requirements should cover all areas necessary to meet the goal;

.2 functional requirements should address all relevant hazards;

.3 functional requirements should provide the criteria for compliance with the goal, i.e. the criteria against which regulations and rules are justified/verified by Tier III (Verification of conformity);

.4 functional requirements should be independent from technical realization for leaving space for further technological development; and

.5 clearly describe what function has to be achieved.

In order to comply with .1 and .2 of the list above, functional requirements should be based on an identification and ranking of hazards for the area under consideration. Functional requirements may be developed in hierarchical order considering different layers starting from a generic level and be supported by functional requirements prescribing more precisely the function required.

13 Functional requirements should be formulated considering the following three elements:

.1 description: a specific and short explanation of the required function;

.2 rationale: assignment of hazards to be mitigated by the function under consideration; and

.3 expected performance: description of the necessary function in quantitative terms; where this is impracticable, the expected performance may be expressed in verifiable qualitative terms. This description should cover all aspect necessary for verifying compliance and the conditions under which these have to be reached.

The hierarchical set from generic to specific functional requirements in conjunction should consider the elements listed above. These elements of functional requirements should be formulated in a way avoiding any reference to existing technical solutions, e.g. by considering examples. Furthermore, functional requirements should provide the background for regulations and rules and therefore the relation between both functional requirements and associated regulations/rules should be unambiguous.

14 An example of the hierarchical structure of functional requirements, as well as examples for the formulation of functional requirements are found in appendix 2 of these Guidelines. Appendix 3 provides an example of the process for developing functional requirements.

15 Figure 2 illustrates a simplified example of how goal-based functional requirements for ship structure could be derived.

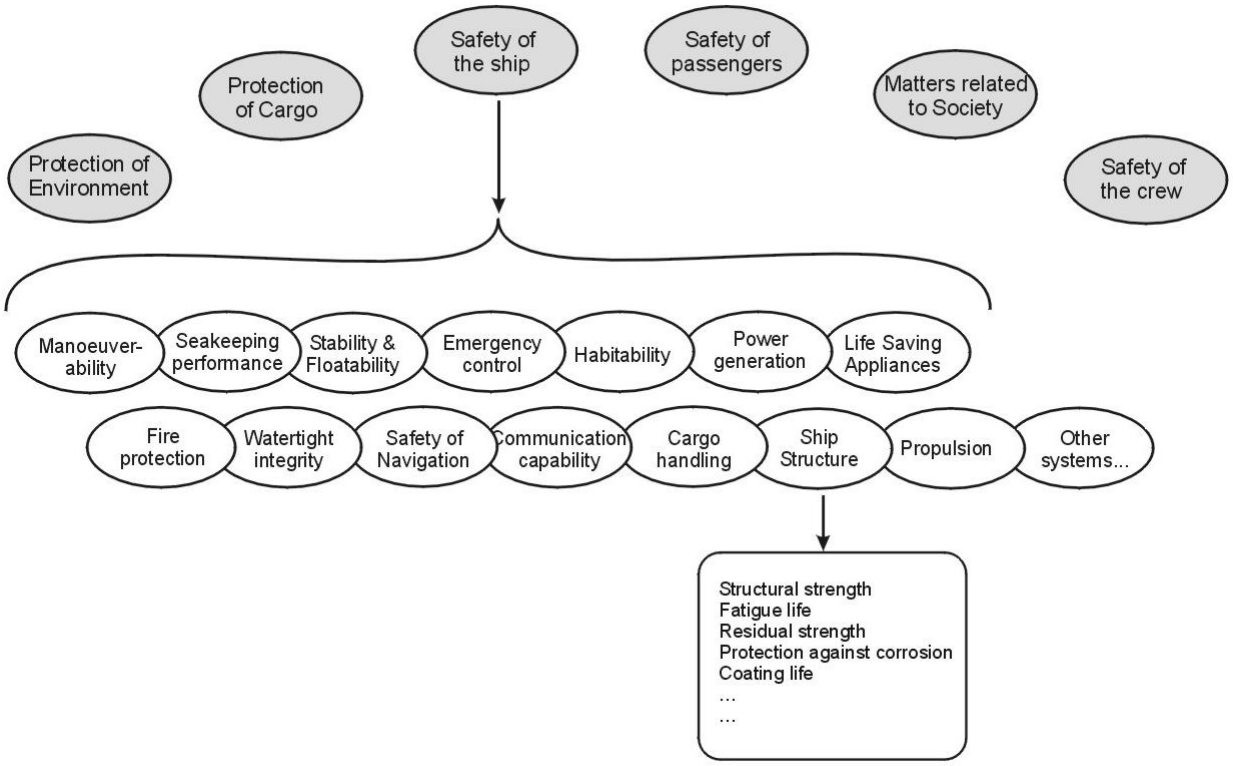

Figure 2
Simplified example of how goal-based functional requirements for ship structure could be derived

Verification of conformity (Tier III)

16 Verification of conformity provides the instruments necessary for demonstrating and verifying that the associated rules and regulations for ships conform to the goals and functional requirements. The verification process should be focused on conformity with the functional requirements. The verification process should be transparent and result in a consistent outcome irrespective of the evaluator.

17 Verification of conformity should establish the method and criteria to be applied during the verification process, and should consider the following elements:

.1 identification of the functional requirement(s) that are being addressed by the rules/regulations;

.2 extent to which the rules/regulations cover the functional requirements and contribute towards meeting the goal(s);

.3 rule/regulation commentary;

.4 technical documentation, which may include:

.1 mechanism of how the rules/regulations meet the functional requirements (operational, technical, design, etc.);

.2 explanation, including technical background information, of the way the rule/regulation was formulated/drafted; and

.3 methodology used to derive the rule/regulation along with supporting rationale/justification;

.5 quality assurance procedures applied throughout rule/regulation development process; and

.6 methods for obtaining feedback on the effectiveness of the rules/regulations and for promoting continuous improvement.

18 Verification of conformity should:

.1 be based on techniques varying from first principle models to historic data;

.2 be based on analyses using proven and established technology;

.3 be based on defined clear qualitative and quantitative criteria with a preference of quantitative values; and

.4 check whether currently known modes and causes of failure are covered;

.5 be verified by independent auditors and/or appropriate IMO organs, as decided by IMO.

19 The developer of the rules/regulations under consideration is responsible for performing an analysis that the rules/regulations conform to the functional requirements the rules/regulations intend to cover.

Rules and regulations for ships (Tier IV)

20 Rules and regulations for ships are 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 in order to meet the goals and functional requirements. These detailed requirements become a part of a GBS framework when they have been verified as conforming to the GBS.

Industry practices and standards (Tier V)

21 Industry standards, codes of practice and safety and quality systems for shipbuilding, ship operation, maintenance, training, manning, etc., may be referenced in the rules/regulations. The responsibility for justifying the suitability of such industry standards and practices, when referenced in a rule set, rests with the rule/regulation submitter. This justification should be provided during the verification of conformity process.

Monitoring

22 Monitoring is a method of evaluating the effectiveness of goals (Tier I), functional requirements (Tier II), rules and regulations (Tier IV) and standards/practices (Tier V) as well as attempting to identify risks not addressed in the initial rules/regulations development. In order to verify that the risk of shipping is kept as low as reasonably practicable, the GBS framework should be continuously monitored and systematically analysed. The degree of detail for the data recording depends on the item to be monitored.

23 As illustrated by figure 1 of these Guidelines, two monitoring processes are distinguished:

.1 the monitoring of the effectiveness of single rules/regulations; and

.2 the monitoring of the effectiveness of the goals (Tier I) and the functional requirements (Tier II).

24 The monitoring system to be established should address (listed without any prioritization):

.1 safety of passengers;

.2 matters related to society;

.3 occupational safety and health of seafarers;

.4 safety of ship;

.5 protection of environment; and

.6 protection of cargo.

25 For both processes monitoring should consider, but not be limited to, historical data, such as casualty reports, in-service experience, accident investigation, incident reports, near miss reports, new scientific research results as published in the industry, as well as risk analysis.

26 Monitoring responsibilities should be assigned with respect to monitoring tasks as follows:

.1 Tier I:

.1 Monitoring (including data collection): IMO

.2 Analysis: IMO

.3 Evaluation: Committees

.2 Tier II:

.1 Monitoring (including data collection): Sub-Committees

.2 Analysis: Sub-Committees

.3 Evaluation: Sub-Committees

.3 Tier IV:

.1 Rules: monitoring (including data collection) and analysis by rule maker, evaluation by rule maker, supervision by IMO

.2 Requirements: monitoring and analysis by IMO/Sub-Committees, evaluation by IMO/Sub-Committees, rule-maker.

27 The organization(s) responsible for the monitoring and analysis is (are) also responsible for the development and update of the reporting format.

APPENDIX 1

AN EXAMPLE OF A STRUCTURE OF GOAL-BASED REGULATIONS

Preamble

1 The International Code of …

2 This Code has been developed …

3 Reference to relationship to other relevant codes/standards

General

…

Introduction

This part of the Code contains the …

Definitions

For the purpose of the Code, unless expressly provided otherwise, the terms used have the meanings defined in the following paragraphs. Terms used, but not defined in the Code, are to be interpreted as they are defined in the relevant Conventions.

Application

…

Goals

The goal of this Code is to …

Functional requirements

In order to achieve its goal, this Code embodies …

Regulation A-1

Goals

The goal of this regulation is to provide …

Functional requirements

To achieve the above-mentioned goals, the following functional requirements …:

.1 providing …;

.2 providing …;

Regulations/requirements

…

Regulation A-2

Goals

The goal of this regulation is to provide …

Functional requirements

To achieve the above-mentioned goals, the following functional requirements …:

.1 providing …;

.2 providing …;

Regulations/requirements

…

Regulation A-3

Goals

The goal of this regulation is to provide …

etc.

APPENDIX 2

EXAMPLES OF THE FORMULATION OF FUNCTIONAL REQUIREMENTS

This appendix provides examples for functional requirements, one for hierarchical layered structure and one high-level only, both in compliance with these Guidelines. These examples may be further developed, in particular with respect to quantitative expected performance.

Area: SOLAS chapter III

Example for layers of functional requirements

High-level generic functional requirements

.1 Information: provide necessary information of conditions both within and surrounding the ship during an emergency.

.2 Communication: ensure necessary means of communicating emergency and distress, communication to SAR organizations and indication of the ship's position.

.3 Escape: provide means of safe escape to the assembly/muster stations.

.4 Evacuation from ships: provide a safe means of evacuation for passengers and/or crew from the assembly/muster stations to a survival craft and ensure safety of their lives at sea.

Specific functional requirements

Description	**Rationale**	**Expected performance**
Safe Place Provide a safe place protecting all people (crew + passengers) from a ship in distress until rescue	Fire & explosion and loss of floatability of vessel endanger persons on board and require a place for survival until rescue	- Safe even if vessel sinks - Safe in case of fire on vessel - Protection for anticipated time of rescue (set by regulator?)
Protect Against Environment Provide means to protect people in distress against (extreme) environmental conditions	High/low temperature, strong wind, animals etc. can endanger people by the hazards of hypothermia, heat stroke etc.	- A habitable environment is provided protecting people against anticipated temperatures, wind, sun radiation, …
Prevent Drowning Provide means to enable survival in water until rescue	Persons in water are endangered by drowning and hypothermia.	Means are provided to - prevent drowning of persons (unconscious, awake) in water

Description	Rationale	Expected performance
		- enable/support rescue from water?
Survival at sea Provide means for survival at sea	Persons in distress are endangered by starvation, dying of thirst or injuries. Persons on board are endangered by consequences of injuries.	Means are provided to - sufficiently supply people with water - sufficiently supply people with calories - allow first medical aid for injuries - all provided for anticipated time of rescue

Area: SOLAS chapter II-2

High-level generic functional requirements

Description	Rationale	Expected performance
Containment and extinction of any fire in the space of origin	Fire & explosion endanger persons on board. Mitigate the possibility of spread of fire	- Contain fire in fire zone of origin for given time - Contain fire by passive and/or active means - Provide means to extinguish fire

APPENDIX 3

EXAMPLE OF THE PROCESS FOR DEVELOPING FUNCTIONAL REQUIREMENTS

General

1 This appendix provides an example of the process for developing functional requirements with detailed explanation.

2 The development of functional requirements is the next stage in the process of the development of goal-based standards, following the establishment of the goal.

3 The development of functional requirements comprises three steps:

.1 identification, ranking and selection of relevant hazards;

.2 developing risk mitigating functions and expected performance; and

.3 formulation of functional requirements including description, rationale and expected performance.

4 The hazard identification and ranking, and subsequent selection of relevant hazards are regarded as the prerequisite for developing any functional requirements. Hazards are all situations having the potential to threaten human life, health, property or the environment. A hazard identification can be performed in various ways, e.g. system or process based, and can be conducted with different degrees of detail, usually leading to different degrees of detail of the risk mitigating functions developed subsequently. Methods and further guidance on hazard identification are provided in *the Revised guidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process* (FSA Guidelines) (MSC-MEPC.2/Circ.12/Rev.2).

5 Hazards selected as relevant will subsequently be used to develop risk mitigating functions. Missing hazards and functions could potentially lead to gaps in Tier IV (Rules and regulation) and Tier V (Industry practices and standards) provisions thereby failing to meet the Tier I (Goals).

6 For each of the risk mitigating functions, expected performance(s) will be developed that specifies the effectiveness to be achieved. These will provide the criteria for verifying compliance with the goal, should be part of the functional requirements and should be expressed as precisely as possible. When quantifying an expected performance, it is recommended to consider other standards (for example, *Functional requirements and performance standards for the assessment of evacuation guidance systems* (MSC/Circ.1167)) and readily available scientific results, and, in case of existing IMO provisions, the performance explicitly and implicitly contained in them.

7 It is regarded as necessary to specify under which conditions the expected performance should be met (e.g. the expected performance of equipment was developed for a specific temperature range). Where these conditions are relevant for a group of risk mitigating functions (or all) it is recommended to summarise them in chapeau text.

8 The final step in the formulation of functional requirements is to incorporate the rationale, the risk mitigating functions and the expected performance.

9 The example below is for illustrative purposes only.

Example: How to develop functional requirements

The following example is using life-saving appliances and arrangements.

Tier I (Goals)

In the context of this example the "goal" could be defined as:
To save and maintain human life during and after an emergency

In order to scope the hazard identification, the goal has been interpreted as follows:

.1 *Save and maintain … during and after* is interpreted that the functional requirements should address the time starting with the emergency and ending with reaching a safe haven;

.2 *Human life* refers to all persons on board ship;

.3 *Emergencies* are situations resulting from incidents or accidents, such as collision, contact, fire and explosion, grounding, foundering or a person falling overboard, etc.;

.4 …

Further, the goal is not limited to specific operational, environmental or weather conditions.

Hazard identification

All hazards should be identified and assessed for the issue under consideration or, if such a list is already available, carefully reviewed.

In this example, there are two high-level hazards for consideration:

.1 persons on board are forced to leave the ship because it is not a safe place anymore (for instance due to fire, explosion, sinking); or

.2 person(s) over board.

For supporting identification of related hazards, the following generic high-level event sequence is specified for sub-paragraph .1 above:

.1 accident
.2 evaluation of situation (is the ship still a safe place?)
.3 alarm
.4 escape (from the ship to a place for abandonment)
.5 abandonment
.6 survival at sea
.7 safe haven

Of these, only the events "evaluation of situation", "alarm", "abandonment" and "survival at sea" are related to current IMO provisions on life-saving and will be considered further.

For each of these events related detailed hazards can be identified[1], for instance:

Evaluation of situation

- lack of information
- inaccurate information
- too slow evaluation
- wrong evaluation
- …

- Alarm

  - not heeded
  - not noticed
  - not understood
  - ...

- Abandonment (all operations for clearing away from abandoned ship)

  - no safe place for persons
  - not timely reaching a safe place
  - arrangements are not adequate/operable
  - accidents
  - …

- Survival at sea (preservation of life until rescue)

  - hypothermia
  - hyperthermia
  - sunstroke
  - lack of medical treatment
  - toxic atmosphere, low oxygen
  - loss of vital functions (due to lack of supplies, lack of activity…)
  - failure/accident involving the safe place (sinking, capsizing, fire, explosion…)
  - not timely rescued
  - …

Depending on the objectives, a more detailed investigation may be performed, e.g. considering the different phases of abandonment like preparation of means, embarkation etc.

This step should be finalized by ranking and selecting the relevant hazards characterizing the safety and therefore need to be considered for the development of functional requirements, expected performance and related regulations.

[1] This list is purely illustrative and does not claim to be exhaustive.

It is noted that:

.1 each hazard may be mitigated by more than one function and vice versa; and

.2 some of these mitigating functions are not part of IMO regulations on life-saving appliances, e.g. escape from the ship, transmission of distress alerts and are, therefore, not further considered.

Development of risk mitigating functions

Based on this list of hazards, mitigating functions are, for instance:

Detailed hazards	Mitigating functions
Evaluation of situation	
Lack of information	• Information characterizing ship condition • Means of providing information • Training and drill
Inaccurate information	• Training and drill • Means providing information
Too slow evaluation	• Training and drill • Means accelerating evaluation
Wrong evaluation	• Training and drill • Evaluation support (system)
Abandonment	
No safe place for persons	• Mustering/assembly area prior to abandonment • Safe place (e.g. survival craft) • Activate means of refuge for persons (communication with safe place) • Protect against damages (accidental, environmental) • Alternative way/spare capacity (of means) • Spare parts (for means) • Inspection and maintenance
Not reaching a safe place in a timely manner	• Survival craft/safe place carried on board • Easy to use/prepare • Training and drill • Propulsion/manoeuvrability
Abandonment arrangements not adequate/operable	• Adequate for ship • Adequate for area of operation • Operable in adverse condition
Accident during abandonment	• Training and drill • Adequate embarkation • Failure-tolerant design • Protect persons during abandonment

Survival at sea	
Hypothermia	• Protect against low temperature (adequate temperature) • Protect against rain/moisture/wind
Hyperthermia	• Protect against high temperature (adequate temperature)
Sunstroke	• Shadow
Lack of medical treatment	• Medication
Toxic atmosphere	• Keep concentration of toxic gases low • Sufficient oxygen
Loss of vital functions	• Water supply • Food supply • Allow activity for stimulating vital functions
Failure/accident involving safe place (sinking, capsizing, fire, explosion, grounding …)	• Stability, seaworthiness • Damage stability • Propulsion/manoeuvrability • Spare parts • Prevent the occurrence of fire and explosion (SOLAS chapter II-2) • Training and drill
Not rescued in a timely manner	• Alerting ships, aircraft and shore • Guide ships and aircraft to location • Support detection (audible, visual)

This list contains risk mitigating functions affecting several hazards, e.g. training and drill. Furthermore, some of the risk mitigating functions may be merged to a higher-level function.

Based on the list above the following risk mitigating functions are developed:

- equipment to be in a state of readiness for immediate use;
- training and drills to ensure that all persons are familiar with the equipment and processes;
- emergency management system;
- provide means for abandonment (e.g. survival craft, other ship, helicopter); and
- provide means for the safety and survivability of all persons after abandonment.

Functional requirements

To meet the safety goal, life-saving appliances and arrangements need to provide a certain performance. These performance requirements provide the criteria for verifying compliance with the goal and should be part of the functional requirements.

The development of functional requirements including expected performance is demonstrated in the following for one selected risk mitigating function:

Provide means for the safety and survivability of all persons after abandonment

With related expected performance[2]:

- Habitable environment:
  - provisions to keep body core temperature between x and y°C
  - protect against climate and environment (sun, wind, rain, snow)
  - non-toxic atmosphere (no toxic gases from operation, CO < x, CO_2 < x, O_2 > x)
- Keep vital functions alive:
  - supplies (water, calories)
  - space for activity (min. space per person)
  - allow for excretion (sanitation)
- Medication for standard/known diseases/first aid
- Propulsion/manoeuvrability
- Seakeeping and stability

Tier IV (Rules and regulation)

For illustration, the following Tier IV (Rules and regulation) requirements could apply:

In order to comply with the expected performance of functional requirement "keep vital functions alive" the following Tier IV regulation applies:

- Provide "x" litres/person of potable water and "x" calories/person of emergency food for the number of persons on board and a maximum expected time of rescue to be "x" days

- The distribution of persons shall be no more than "x" persons/m^2.

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[2] Placeholders are used for quantitative values.