INTERNATIONAL MARITIME ORGANIZATION

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7th session
Agenda item 16

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REPORT TO THE MARITIME SAFETY COMMITTEE

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LIST OF ANNEXES

1 GENERAL

1.1 The Sub-Committee on Ship Design and Construction (SDC), chaired by Mr. K. Hunter (United Kingdom), held its seventh session from 3 to 7 February 2020. The Vice-Chair, Mrs. T. Stemre (Norway), was also present.

1.2 The session was attended by delegations from Member States, an Associate Member of IMO and observers from intergovernmental and non-governmental organizations in consultative status, as listed in document SDC 7/INF.1.

Opening address

1.3 The Secretary-General welcomed participants and delivered his opening address, the full text of which can be downloaded from the IMO website at the following link:
www.imo.org/en/MediaCentre/SecretaryGeneral/Secretary-GeneralsSpeechesToMeetings/

Chair's remarks

1.4 In responding, the Chair thanked the Secretary-General for his words of guidance and encouragement and assured him that his advice and requests would be given every consideration in the deliberations of the Sub-Committee.

Adoption of the agenda and related matters

1.5 The Sub-Committee adopted the agenda (SDC 7/1) and agreed to be guided in its work, in general, by the annotations contained in document SDC 7/1/1 (Secretariat) and the arrangements in document SDC 7/1/2 (Chair).

2 DECISIONS OF OTHER IMO BODIES

2.1 The Sub-Committee noted the decisions and comments pertaining to its work made by MSC 101, CCC 6 and NCSR 7, as reported in document SDC 7/2 (Secretariat) and in paragraphs 2.2 to 2.5 below, and took them into account in its deliberations when dealing with the relevant agenda items.

2.2 In particular, the Sub-Committee noted that MSC 101, with regard to the development of goal-based regulations and instruments, had approved amendments to the *Generic guidelines for developing IMO goal-based standards* (MSC.1/Circ.1394/Rev.1). The amended Generic Guidelines were issued as MSC.1/Circ.1394/Rev.2.

2.3 The Sub-Committee also noted that MSC 101 had approved a revision to the *Organization and method of work of the Maritime Safety Committee and the Marine Environment Protection Committee and their subsidiary bodies* (MSC-MEPC.1/Circ.5/Rev.1 and Corr.1).

Revised versions of resolutions

2.4 The Sub-Committee further noted that NCSR 6 had requested the Committee to consider that amendments to guidelines and recommendations adopted by MSC resolutions could be adopted in the future, if appropriate, as revised versions of such resolutions (NCSR 6/23, paragraphs 15.15.3 and 23.1.23, and MSC 101/24, paragraph 11.22).

2.5 Subsequently, MSC 101, after consideration of the aforementioned request:

.1 agreed that amendments to guidelines and recommendations adopted by MSC resolutions could be adopted in the future, if appropriate, as revised versions of such resolutions, maintaining the same number, with the extension "/Rev…" added;

.2 instructed subsidiary bodies to take this decision into account, as appropriate, when amending MSC resolutions in the future; and

.3 invited MEPC, TCC, FAL and LEG Committees to note this decision and to consider taking a similar approach in respect of resolutions under their purview, as appropriate.

3 AMENDMENTS TO THE EXPLANATORY NOTES TO SOLAS CHAPTER II-1 SUBDIVISION AND DAMAGE STABILITY REGULATIONS (RESOLUTION MSC.429(98))

GENERAL

3.1 The Sub-Committee recalled that SDC 6 had finalized draft amendments to SOLAS chapter II-1 to ensure consistency between parts B-2 to B-4 and parts B to B-1 of SOLAS chapter II-1 with regard to watertight integrity and that MSC 101 had approved the draft amendments with a view to adoption at MSC 102 (MSC 101/24, paragraphs 12.10 to 12.12).

3.2 The Sub-Committee also recalled that, following the finalization of the draft amendments to SOLAS chapter II-1, SDC 6 had agreed to consequently amend the associated provisions in the *Revised Explanatory Notes to the SOLAS chapter II-1 subdivision and damage stability regulations* (resolution MSC.429(98)) and had tasked the Correspondence Group on Subdivision and Damage Stability (SDS Correspondence Group) to further develop the draft amendments to the Explanatory Notes and to submit its report to this session (SDC 6/13, paragraph 4.23).

3.3 Consequently, MSC 101 had agreed, as requested by SDC 6, to change the output title from "Review SOLAS chapter II-1, parts B-2 to B-4, to ensure consistency with parts B and B-1 with regard to watertight integrity" to "Amendments to the Explanatory Notes to SOLAS chapter II-1 subdivision and damage stability regulations (resolution MSC.429(98))".

3.4 The Sub-Committee further recalled that SDC 6 had considered the updated IACS Unified Interpretation SC156 on "Doors in watertight bulkheads of cargo and passenger ships" (UI SC 156/Rev.1), which required consequential amendments to the related provisions in MSC.1/Circ.1464, which had been replaced by MSC.1/Circ.1572, and had subsequently tasked the SDS Correspondence Group to amend MSC.1/Circ.1572, but only with respect to the SOLAS requirements, as amended by resolution MSC.421(98) (SDC 6/13, paragraph 9.12).

REPORT OF THE SDS CORRESPONDENCE GROUP

3.5 The Sub-Committee considered the report of the SDS Correspondence Group (SDC 7/3), which contained draft amendments to the *Revised Explanatory Notes to the SOLAS chapter II-1 subdivision and damage stability regulations* (resolution MSC.429(98)) and draft amendments to section 3 of *Unified Interpretations of SOLAS chapter II-1 and XII, of the technical provisions for means of access for inspections (resolution MSC.158(78)) and of the*

Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers (resolution MSC.188(79)) (MSC.1/Circ.1572).

Revised Explanatory Notes to the SOLAS chapter II-1 subdivision and damage stability regulations (resolution MSC.429(98))

3.6 The Sub-Committee had for its consideration the following documents related to the SDS Correspondence Group's report:

.1 SDC 7/3/1 (IACS), seeking clarification on the requirements for semi-watertight doors above the bulkhead deck that become intermittently immersed (fully or partly) at angles of heel in the required range of positive stability beyond the equilibrium position, in particular with respect to conflicting requirements for such remotely controlled sliding semi-watertight doors that are also required to meet the fire protection requirements of SOLAS regulation II-2/9.4.1.1; and

.2 SDC 7/3/2 (IACS), seeking clarification on the provisions on the prevention of progressive flooding in the *Revised Explanatory Notes to the SOLAS chapter II-1 subdivision and damage stability regulations* (resolution MSC.429(98)) for SOLAS regulations II-1/7.7 and II-1/7-1 with respect to the formulation "of the same order as their stiffening structure" for pipes and valves and their separation distance to the bulkhead or deck and proposing to use a separation distance of 450 mm instead.

3.7 In considering the above documents, the Sub-Committee noted the following views:

.1 with respect to internal watertight integrity of passenger ships above the bulkhead deck:

.1 semi-watertight doors are excluded from the fire door requirements in SOLAS regulation II-2/9.4.1.1.5; and

.2 semi-watertight doors are not excluded from the fire door requirements in SOLAS regulation II-2/9.4.1.1.5 as they are necessary for the fire integrity on ships;

.2 with respect to determining what constitutes "separation is of the same order" in the Revised Explanatory Notes regarding SOLAS regulations II-1/7 and II-1/7-1.1:

.1 in order for progressive flooding not to be considered, a clear separation distance for pipes and valves from the bulkheads needed to be defined;

.2 during the development of the Explanatory Notes in resolution MSC.281(85) and the Revised Explanatory Notes in resolution MSC.429(98), a prescriptive separation distance was not considered appropriate and the current proposal to base the separation distance on fire protection criteria was unsuitable; and

.3 the stiffening of the associated structure is different from ship to ship and needs to be taken into account in the determination of the separation distance.

3.8 In considering the above documents and the action requested in paragraph 22 of the report of the SDS Correspondence Group with respect to the draft amendments to the Revised Explanatory Notes, the Sub-Committee approved the report in general and agreed to refer the above documents to the Working Group on Subdivision and Damage Stability (SDS Working Group) for further discussion, with a view to finalization of the draft amendments to the Revised Explanatory Notes.

3.9 The Sub-Committee also considered a proposal by the observer from IACS for clarification with respect to the Explanatory Note to SOLAS regulation II-1/13.4, following the draft amendments approved at MSC 101 to SOLAS regulations II-1/13.9 and II-1/13.4, which would, as currently drafted, permit up to eight watertight doors in the bulkheads of a ship with two engine-rooms.

3.10 Having considered the above comment and having agreed that up to eight watertight doors in the bulkheads of a ship with two engine-rooms may not have been intended at the time of drafting the Explanatory Notes, the Sub-Committee agreed to refer the matter to the SDS Working Group for further consideration.

3.11 Following the decision of MSC 101 that amendments to guidelines and recommendations adopted by MSC resolutions could be adopted in the future, if appropriate, as revised versions of such resolutions (see paragraph 2.5), the Sub-Committee agreed to instruct the SDS Working Group to prepare the consolidated draft Revised Explanatory Notes and the associated draft MSC resolution, with a view to adoption by MSC 102 as resolution MSC.429(98)/Rev.1.

Unified Interpretations of provisions related to doors in watertight bulkheads of passenger ships and cargo ships (MSC.1/Circ.1572, section 3)

3.12 The Sub-Committee considered annex 2 to the report of the SDS Correspondence Group, containing draft amendments to section 3 of MSC.1/Circ.1572 related to doors in watertight bulkheads of passenger and cargo ships, and having agreed to the draft amendments in general, requested the SDS Working Group to amend section 3 accordingly.

3.13 Following consideration of the discussion within the SDS Correspondence Group on the current lack of guidance for SOLAS regulation II-1/22.3 related to opening of watertight doors on cargo ships during navigation, the Sub-Committee agreed to instruct the SDS Working Group to consider the need for developing guidance for SOLAS regulation II-1/22.3 and advise it accordingly.

ESTABLISHMENT OF THE SDS WORKING GROUP

3.14 Having considered the above matters, the Sub-Committee established the SDS Working Group and instructed it, taking into account the comments and decisions made in plenary, to:

.1 finalize the draft consolidated Revised Explanatory Notes (resolution MSC 429(98)) and the associated draft MSC resolution, with a view to adoption by MSC 102 as resolution MSC.429(98)/Rev.1, based on the annex to document SDC 7/3 and taking into account documents SDC 7/3/1 and SDC 7/3/2;

.2 finalize the draft amendments to section 3 of MSC.1/Circ.1572 on watertight door requirements in SOLAS chapter II-1, part B-1, based on annex 2 to document SDC 7/3; and

.3 advise whether there was a need to develop guidance for SOLAS regulation II-1/22.3 related to opening of watertight doors during navigation.

REPORT OF THE SDS WORKING GROUP

3.15 Having considered the relevant part of the report of the SDS Working Group (SDC 7/WP.4), the Sub-Committee took action as outlined in paragraphs 3.16 to 3.25.

Amendments to the Revised Explanatory Notes

3.16 In considering the Group's discussion on the clarification sought in document SDC 7/3/1 (IACS) with regard to the Explanatory Notes for SOLAS regulation II-1/17.1 and whether semi-watertight sliding doors above the bulkhead deck were subject to the fire integrity provisions in SOLAS chapter II-2, the Sub-Committee agreed with the Group that such doors were considered power-operated watertight doors and excluded from the fire integrity provisions in SOLAS regulation II-2/9.4.1.1.5 and, in addition, also excluded from the requirements in SOLAS regulation II-2/9.4.1.1.8 concerning hose ports.

3.17 With regard to the Explanatory Notes for draft SOLAS regulation II-1/17.3 (MSC 101/24/Add.1, annex 25) for doors in internal watertight subdivision arrangements above the bulkhead deck, the Sub-Committee agreed with the Group's view that an appropriate requirement for these doors, which must be capable of preventing the passage of water when intermittently immersed in the required range of positive stability, was a watertight standard for a minimum 1 m head of water which was considered sufficient and would provide a consistent standard for the approval of these doors.

3.18 In addition to the above, the Sub-Committee agreed with the clarification in the Explanatory Notes 2 and 3 that, given these doors were located above the bulkhead deck, they must comply with a combination of watertight and fire protection requirements. In this context, the Sub-Committee noted that the Group had agreed that these doors were required to comply with the fire protection requirements in SOLAS chapter II-2 and that, because these doors were not watertight doors that complied with the requirements in regulation II-1/13, the exclusions for watertight doors in chapter II-2 did not apply.

3.19 The Sub-Committee noted that the Group, with respect to determining what constituted "separation is of the same order" in the Revised Explanatory Notes regarding SOLAS regulations II-1/7 and II-1/7-1.1, had agreed to add a provision in the Explanatory Notes for SOLAS regulations II-1/7.7, 7-1.1.1 and 7-1.1.2 stating that in no case should the separation distance on either side of the bulkhead or deck be more than 450 mm, measured from the valve's near flange.

3.20 With regard to the comment raised that the Explanatory Note for regulation II-1/13.4 could potentially permit up to eight watertight doors in the bulkheads of a ship with two engine-rooms, separated by a longitudinal bulkhead (see paragraph 3.10), the Sub-Committee noted that, although conceptually possible, the Group did not consider this potential arrangement to be very realistic and therefore had agreed that no action was necessary.

3.21 Following the discussion, the Sub-Committee agreed to the draft Revised Explanatory Notes to SOLAS chapter II-1 subdivision and damage stability regulations and the associated draft MSC resolution, to be issued as resolution MSC.429(98)/Rev.1, as set out in annex 1, for submission to MSC 102 for adoption, in conjunction with the adoption of the draft amendments to the SOLAS chapter II-1 subdivision and damage stability regulations (MSC 101/24, annex 25).

Unified Interpretations of provisions related to doors in watertight bulkheads of passenger ships and cargo ships (MSC.1/Circ.1572)

3.22 In considering the draft amendments to section 3 of the annex to MSC.1/Circ.1572 pertaining to watertight door requirements in SOLAS chapter II-1, the Sub-Committee agreed to the draft amendments to section 3 of MSC.1/Circ.1572 and the associated MSC circular, as set out in annex 2, for submission to MSC 102 for approval.

3.23 In connection with the above, the Sub-Committee noted the Group's view that MSC.1/Circ.1572 would need to be reviewed and updated when the SOLAS chapter II-1 amendments entered into force on 1 January 2024.

Consideration of the need to develop guidance for SOLAS regulation II-1/22.3

3.24 The Sub-Committee endorsed the Group's conclusion that there was no need to develop guidance with respect to stability survivability on cargo ships for SOLAS regulation II-1/22.3 related to the opening of watertight doors during navigation, and noted that the Group had included a new Explanatory Note for regulation II-1/22.3, which stated that, for cargo ships, authorizations were left to the discretion of the Administration.

Completion of the work on the output

3.25 The Sub-Committee invited the Committee to note that the work on this output had been completed.

4 SAFETY MEASURES FOR NON-SOLAS SHIPS OPERATING IN POLAR WATERS

General

4.1 The Sub-Committee recalled that MSC 100 had endorsed an updated road map (MSC 100/WP.9, annex 2) outlining, inter alia, the work to be undertaken by SDC 6 and SDC 7 on matters related to safety measures for non-SOLAS ships operating in polar waters.

4.2 The Sub-Committee also recalled that MSC 101 had agreed to include this output in the provisional agenda for NCSR 7 to, inter alia, consider how best to enhance the safety of non-SOLAS ships, including possible development of amendments to SOLAS and/or the Polar Code, and to advise the Committee accordingly, taking into account the outcome of the Ministerial Conference on Fishing Vessel Safety and Illegal, Unreported and Unregulated Fishing (MSC 101/24, paragraph 7.6), held in Torremolinos, Spain, from 21 to 23 October 2019 (A 31/10/3).

4.3 The Sub-Committee noted that the Assembly, at its thirty-first session, had adopted resolution A.1137(31) on *Interim safety measures for ships not certified under the SOLAS Convention operating in polar waters* urging Member States, on a voluntary basis, to implement the safety measures of the Polar Code, as far as practicable, for ships not certified under SOLAS operating in polar waters, including fishing vessels of 24 m in length and over and pleasure yachts of 300 gross tonnage and above not engaged in trade.

Report of the Correspondence Group

4.4 The Sub-Committee considered the report of the Correspondence Group on Safety Measures for Non-SOLAS Ships Operating in Polar Waters (SDC 7/4), containing draft Guidelines for safety measures for fishing vessels of 24 m in length and over operating in polar waters (Fishing Vessel Guidelines) (SDC 7/4, annex 1) and draft Guidelines for pleasure yachts of 300 gross tonnage and above not engaged in trade operating in polar waters (Pleasure Yachts Guidelines) (SDC 7/4, annex 2).

4.5 The Sub-Committee also had for its consideration the following documents:

.1 SDC 7/4/1 (Norway), commenting on the report of the Correspondence Group and outlining concerns regarding, inter alia, alignment with the 2012 Cape Town Agreement, the appropriateness of the draft provisions on damage stability and life-saving equipment and the inclusion of training and manning in the draft Fishing Vessel Guidelines, and on the maximum expected time of rescue in both sets of draft guidelines; and

.2 SDC 7/4/2 (FOEI et al.), commenting on the report of the Correspondence Group and suggesting, with respect to the draft Fishing Vessel Guidelines, using the same performance standards as in the 2012 Cape Town Agreement and expanding the scope of the recommended surveys for fishing vessels and, with respect to the draft Pleasure Yachts Guidelines, including a chapter on radiocommunications and procedures for maintaining life support and vessel integrity in the event of prolonged entrapment by ice.

4.6 In considering the above documents, the Sub-Committee noted the following views on the draft Fishing Vessel Guidelines:

.1 with respect to references to, and alignment with, the 2012 Cape Town Agreement:

.1 any references to the Agreement were inappropriate as it had not yet entered into force;

.2 references by name to the Agreement could be made so as to provide the context for the development of the draft guidelines, including their close alignment with the Agreement, taking into account that no direct reference to specific provisions therein should be included in the Guidelines;

.3 MSC 99 had instructed the Sub-Committee to align the Fishing Vessel Guidelines with the Agreement; and

.4 while the damaged stability calculation in the 2012 Cape Town Agreement would apply to fishing vessels of 100 m in length and over, the draft Guidelines were intended to be applied to fishing vessels of 24 m in length and over, which was considered challenging for existing fishing vessels;

.2 with respect to training requirements for fishers:

.1 all training of fishers should be considered under one single instrument, the STCW-F Convention;

.2 while specific training requirements should be considered by the HTW Sub-Committee, the draft Fishing Vessel Guidelines should include some high-level provisions on training of fishers in polar waters; and

.3 the HTW Sub-Committee had already agreed to finalize the comprehensive review of the 1995 STCW-F Convention at HTW 8 and, therefore, consideration of training related to operation in polar waters would have to be considered at a later stage.

4.7 The Sub-Committee also noted the following views on the draft Pleasure Yachts Guidelines:

.1 a definition for "pleasure yachts not engaged in trade" should not be included in the draft guidelines as national legislation often defined the term differently and there was a general understanding of the term which was used in SOLAS without a definition; and

.2 the extent of the regulatory gap should be considered for pleasure yachts of 300 gross tonnage and above, but less than 500 gross tonnage, engaged in trade, as well as for cargo ships of 300 gross tonnage and above but less than 500 gross tonnage.

4.8 Taking into account the above views, the Sub-Committee considered the actions requested in paragraph 51 of the report of the Correspondence Group (SDC 7/4) and, having approved the report in general, made the following decisions:

.1 with respect to the draft Fishing Vessel Guidelines:

.1 alignment with the provisions of the 2012 Cape Town Agreement should be achieved without directly referencing provisions therein, taking into account the non-mandatory status of the draft Guidelines;

.2 text from the 2012 Cape Town Agreement could be used within the Guidelines where such text was appropriate, provided it was expressed in a recommendatory language, taking into account the need to avoid any conflicts between the new draft Guidelines and the Agreement; and

.3 the training and manning provisions of the draft Guidelines should be forwarded to HTW 7 for consideration, bearing in mind that there was not sufficient time to consider any input during the current comprehensive revision of the 1995 STCW-F Convention, which was expected to be completed at HTW 8; and

.2 with respect to the draft Pleasure Yachts Guidelines, not to include a definition for the term "pleasure yacht not engaged in trade".

Establishment of the Working Group

4.9 Following discussion, the Sub-Committee established the Working Group on Safety Measures for Non-SOLAS Ships Operating in Polar Waters and instructed it, taking into account the documents submitted for consideration at this session and the comments and decisions made in plenary, to:

.1 consider the unresolved drafting proposals in both sets of guidelines, noting that alternative text options and text for possible deletion were shown in square brackets and proposed new text was shown underlined;

.2 as a matter of priority, further develop, with the aim of finalizing, the draft guidelines for fishing vessels of 24 m in length and over operating in polar waters, based on annex 1 to document SDC 7/4, and the associated draft MSC circular;

.3 consider the extent of the regulatory gap for pleasure yachts of 300 gross tonnage and above, but less than 500 gross tonnage, engaged in trade, i.e. commercial yachts and cargo ships of 300 gross tonnage and above but less than 500 gross tonnage and whether the scope of the current output needed to be extended;

.4 depending on the consideration of sub-paragraph .3 above, further develop, with the aim of finalizing, the draft guidelines for pleasure yachts not engaged in trade operating in polar waters, based on annex 2 to document SDC 7/4, and the associated draft MSC circular;

.5 if time permitted, consider whether any consequential amendments were needed to the *Guide for cold water survival* (MSC.1/Circ.1185/Rev.1) and advise the Sub-Committee on how best to proceed; and

.6 consider the need to re-establish the Correspondence Group on Safety Measures for Non-SOLAS Ships Operating in Polar Waters and, if so, prepare terms of reference for the Group.

Report of the Working Group

4.10 Having considered the report of the Working Group on Safety Measures for Non-SOLAS Ships Operating in Polar Waters (SDC 7/WP.5), the Sub-Committee took action as outlined below.

Guidelines for fishing vessels of 24 m in length and over operating in polar waters

4.11 With regard to the training provisions in paragraph 11.5 of the draft guidelines, the Sub-Committee noted that the Group had recalled the ongoing work by the HTW Sub-Committee on the comprehensive review of the 1995 STCW-F Convention and, therefore, agreed to invite HTW 7 to comment on paragraph 11.5 with regard to the correctness of the terminology used and to identify any conflicts between the text and existing IMO instruments, with a view to advising MSC 103 directly.

4.12 Subsequently, the Sub-Committee agreed to the draft Guidelines for fishing vessels of 24 m in length and over operating in polar waters and the associated draft MSC circular, as set out in annex 3, taking into account any comments on paragraph 11.5 from HTW 7, with a view to submission to MSC 103 for approval.

Guidelines for pleasure yachts of 300 gross tonnage and above not engaged in trade operating in polar waters

4.13 The Sub-Committee agreed to the draft Guidelines for pleasure yachts of 300 gross tonnage and above not engaged in trade operating in polar waters and the associated draft MSC circular, as set out in annex 4, for submission to MSC 103 for approval.

Need to develop guidelines for cargo ships below 500 gross tonnage operating in polar waters

4.14 Having noted that the development of guidelines for fishing vessels and pleasure yachts not engaged in trade operating in polar waters had been completed, as directed by the Committee (MSC 99/22, paragraph 7.15.2), the Sub-Committee noted that neither SOLAS nor the draft Guidelines prepared by the Working Group covered pleasure yachts of 300 gross tonnage and above and less than 500 gross tonnage engaged in trade (i.e. commercial yachts) and cargo ships of 300 gross tonnage and above and less than 500 gross tonnage and, therefore, invited MSC 102 to consider whether safety guidelines should also be developed for those ships operating in polar waters, which were currently not addressed in any IMO instrument.

Consequential amendments to the Guide for cold water survival (MSC.1/Circ.1185/Rev.1)

4.15 The Sub-Committee endorsed the view of the Group that there was currently no need for consequential amendments to the *Guide for cold water survival*; however, if required, guidance for survival on ice and in remote cold areas could be developed at a future stage by the relevant Sub-Committee.

Finalization of the work

4.16 The Sub-Committee decided to place this output on the provisional agenda for SDC 8 for consideration of matters related to the safety of pleasure yachts engaged in trade and the safety of cargo ships less than 500 gross tonnage, taking into account the outcome of MSC 102 (see paragraphs 4.14 and 4.16 above).

5 FINALIZATION OF SECOND GENERATION INTACT STABILITY CRITERIA

GENERAL

5.1 The Sub-Committee recalled that SDC 6 had agreed to consolidate the three separate draft Interim Guidelines on second generation intact stability criteria (i.e. on vulnerability criteria; on specification of direct stability assessment procedures; and on preparation of operational limitations and operational guidance) into a single set to include all five stability failure modes, with a view to finalization at SDC 7.

5.2 The Sub-Committee also recalled that SDC 5 had agreed that the draft Explanatory Notes for all five stability failure modes, based on annex 19 to document SDC 5/INF.4 (Japan), should be finalized by the Correspondence Group on Intact Stability after completion of the complete draft package of levels 1 and 2 vulnerability criteria, for consideration at SDC 8 (SDC 6/13, paragraph 5.22).

DRAFT INTERIM GUIDELINES FOR THE SECOND GENERATION INTACT STABILITY CRITERIA

Report of the Intact Stability Correspondence Group

5.3 The Sub-Committee considered part 1 of the report of the Intact Stability Correspondence Group (SDC 7/5), containing the draft Interim guidelines on second generation intact stability criteria (Interim Guidelines) for the intact stability assessment of ship dynamics in waves as a consolidated draft instrument comprising three sets of interim guidelines, namely guidelines on vulnerability criteria; for direct stability failure assessment; and for operational measures.

5.4 The Sub-Committee also had for its consideration the following documents related to the draft Interim Guidelines:

.1 SDC 7/5/3 (Japan), commenting on the draft Interim Guidelines and objecting to the deletion proposed by some members of the Correspondence Group of the verification of stability failure modes in the direct stability assessment, as well as the deletion of the simplified operational guidance based on level 2 assessment for parametric rolling and the calm water resistance in the formula for surf-riding level 2 vulnerability criteria; and

.2 SDC 7/5/2 (China), reporting on an applicability study carried out by China on the weakness criteria for existing ships, based on the draft Interim Guidelines with further information contained in documents SDC 7/INF.6, SDC 7/INF.7, SDC 7/INF.8, SDC 7/INF.9 and SDC 7/INF.10.

5.5 In connection with the above, the Sub-Committee noted the information provided in the following documents:

.1 SDC 7/INF.4 (Japan), providing additional sample calculations of excessive acceleration failure mode in full and ballast conditions of 37 ships of different types which showed that only 33% of the sample ships passed the current vulnerability criteria for full and ballast loading conditions, while the remaining 67% of ships would require either direct stability assessment or operational limitations;

.2 SDC 7/INF.6 (China), containing the results of a study applying the parametric roll vulnerability criteria on an offshore research vessel (ORV) with extended low weather deck (LWD) in a time domain simulation, which indicates that the effect of the deck-in-water phenomenon is substantial and the results that had been obtained so far showed that the parametric roll vulnerability criteria are not applicable to ships with extended low weather deck;

.3 SDC 7/INF.7 (China), containing an associated analysis of different calculation methods for roll restoring force in waves;

.4 SDC 7/INF.8 (China), containing the results of applying the surge-heave-pitch-roll coupled 4 degree of freedom (DOF) mathematical model, which confirmed the appropriate estimate for pure loss of stability in stern quartering waves;

.5 SDC 7/INF.9 (China), containing the results of applying the surf-riding/broaching criteria which showed that some displacement type vessels using waterjet propulsion cannot meet the level 1 criteria requirement for which an alternative assessment method was proposed; and

.6 SDC 7/INF.10 (China), containing the validation for the calculation of large amplitude roll damping using CFD.

5.6 The Sub-Committee expressed its appreciation to the delegations of China and Japan for the research carried out so far and encouraged the submission of further research results on the application of Interim guidelines on second generation intact stability criteria to the Sub-Committee for consideration.

5.7 In considering the proposals set out in annex 3 to the report of the Correspondence Group, the Sub-Committee decided that such proposals were best suited to be taken as part of any future revisions of the Interim Guidelines, after practical experience had been gained and, subsequently, decided to retain the text as set out in annex 1 to document SDC 7/5.

5.8 In considering the above documents and the action requested in paragraph 27 of part 1 of the report of the Correspondence Group, the Sub-Committee confirmed its determination to finalize the draft Interim Guidelines at this session so as to ensure that they could be trialled to gain practical experience in their application and to enable possible future revisions.

5.9 Subsequently, the Sub-Committee approved part 1 of the report and agreed, in principle, to the restructured draft Interim Guidelines and the associated draft MSC circular.

DRAFT EXPLANATORY NOTES FOR THE SECOND GENERATION INTACT STABILITY CRITERIA

5.10 The Sub-Committee considered part 2 of the report of the Correspondence Group (SDC 7/5/1), reflecting the discussion on the draft Explanatory notes on the interim guidelines on second generation intact stability criteria (Explanatory Notes).

5.11 In this context, the Sub-Committee noted with appreciation the information provided in the following documents, containing, inter alia, the draft consolidated text of the Explanatory Notes:

.1 SDC 7/INF.2 (Japan), containing the draft table of contents, draft chapter 1 (Introduction and framework of the second generation intact stability criteria) and draft chapter 2 (Explanatory notes on the guideline for vulnerability criteria) of the Explanatory Notes;

.2 SDC 7/INF.2/Add.1 (Japan), containing draft chapter 3 (Explanatory notes on the guidelines for direct stability assessment) of the Explanatory Notes;

.3 SDC 7/INF.2/Add.2 (Japan), containing draft chapter 4 (Explanatory notes on the guidelines for operational measures) of the Explanatory Notes;

.4 SDC 7/INF.2/Add.3 (Japan), containing a description, sample application and validation of the split-time method, also known as the motion perturbation method (MPM), for extrapolation in the context of direct stability assessment (DSA); and

.5 SDC 7/INF.3 (United States), containing, inter alia, worked examples that can be used directly in the preparation of the Explanatory Notes.

5.12 In considering the above documents and the action requested in paragraph 17 of part 2 of the report of the Correspondence Group, the Sub-Committee approved part 2 of the report in general and instructed the Drafting Group to further develop the Explanatory Notes.

ESTABLISHMENT OF THE DRAFTING GROUP

5.13 Following consideration, the Sub-Committee established the Drafting Group on Intact Stability and instructed it, taking into account the comments made and decisions taken in plenary, to:

.1 finalize the draft Interim guidelines on second generation intact stability criteria, based on annex 1 and taking into account annex 2 to document SDC 7/5, as well as documents SDC 7/5/2 and SDC 7/5/3;

.2 if time permitted, further develop the draft Explanatory notes on the second generation intact stability criteria, based on document SDC 7/INF.2 and addenda, taking into account documents SDC 7/5/1 and SDC 7/INF.3; and

.3 prepare terms of reference for the intersessional Correspondence Group on Intact Stability for the further development of the Explanatory notes on the second generation intact stability criteria.

REPORT OF THE DRAFTING GROUP

5.14 Having considered the report of the Drafting Group (SDC 7/WP.6), the Sub-Committee took action as outlined below.

Draft Interim guidelines for the second generation intact stability criteria

5.15 The Sub-Committee noted that the Group had completed the development of the draft Interim guidelines for the second generation intact stability criteria (Interim Guidelines) and, in order to retain the flexibility of amending the associated Explanatory Notes on the second generation intact stability criteria, had agreed to remove all the footnotes and references thereto.

5.16 With regard to the future review of the Interim Guidelines, the Sub-Committee noted that the Group had agreed that there should be no restriction on amending the Interim Guidelines when the need arose and after adequate experience had been gained; and that providing feedback to the Organization on the experience gained in implementing the Interim Guidelines should be encouraged.

5.17 Subsequently, the Sub-Committee agreed to the draft Interim guidelines on the second generation intact stability criteria and the associated draft MSC circular, as set out in annex 5, for submission to MSC 102 with a view to approval.

Draft Explanatory notes on the second generation intact stability criteria

5.18 With regard to the development of the Explanatory Notes, the Sub-Committee endorsed the Group's recommendation to develop them using a similar structure and manner for paragraphs/sections as in the draft Interim Guidelines, to facilitate their use.

5.19 Following the Group's recommendation, the Sub-Committee endorsed the development of the draft Explanatory Notes as a standalone circular, rather than combining them with the draft Interim Guidelines, in order to facilitate their amendment at a later stage.

Re-establishment of the Intact Stability Correspondence Group

5.20 In order to progress the work intersessionally, the Sub-Committee re-established the Correspondence Group on Intact Stability, under the coordination of Japan,* and instructed it, based on the comments and decisions made at SDC 7, to:

.1 further develop the draft Explanatory notes on the second generation intact stability criteria, based on the respective annexes to documents SDC 7/INF.2 and addenda and SDC 7/INF.3, taking into account document SDC 7/5/1, with a view to finalization at SDC 8;

.2 structure the draft text in a similar manner to the paragraphs/sections of the draft Interim guidelines on the second generation intact stability criteria for ease of use;

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.3 prepare an associated draft MSC circular for the draft Explanatory Notes; and

.4 submit a report to SDC 8.

Change of the title of the output

5.21 Following the completion of the draft Interim guidelines on second generation intact stability criteria, the Sub-Committee noted that the only outstanding work was the development of the associated Explanatory Notes and therefore invited the Committee to change the title of the existing output to "Development of Explanatory notes on second generation intact stability criteria" (see paragraphs 13.4 and 13.5 and annexes 12 and 13).

Extension of the target completion year

5.22 In light of the above decisions, the Sub-Committee invited the Committee to extend the target completion year for this output to 2021 (see paragraph 13.4 and annex 12).

6 MANDATORY INSTRUMENT AND/OR PROVISIONS ADDRESSING SAFETY STANDARDS FOR THE CARRIAGE OF MORE THAN 12 INDUSTRIAL PERSONNEL ON BOARD VESSELS ENGAGED ON INTERNATIONAL VOYAGES

GENERAL

6.1 The Sub-Committee recalled that SDC 6 had re-established the Correspondence Group on Industrial Personnel (IP) with terms of reference as set out in paragraph 6.29 to document SDC 6/13 and had instructed the Group to submit its report to this session.

6.2 The Sub-Committee also recalled that SDC 6 had tasked the IP Correspondence Group with further developing the draft IP Code (SDC 6/13, paragraph 6.29) while the further development of the draft new SOLAS chapter XV was deferred, pending the Committee's clarification on the application requirements (SDC 6/13, paragraph 6.12).

6.3 The Sub-Committee further recalled that the draft IP Code used a goal-based approach and, therefore, built on a tiered structure consisting of goals, functional requirements and underlying regulations, in accordance with the *Generic guidelines for developing IMO goal-based standards* (MSC.1/Circ.1394/Rev.2).

6.4 With regard to the outcome of MSC 101, the Sub-Committee noted that the Committee had confirmed the decision of MSC 99 to use an aggregated number of persons, comprising of passengers, special personnel and industrial personnel, as the qualifying criterion for the application of the IP Code (MSC 101/24, paragraph 12.17).

6.5 The Sub-Committee also noted that MSC 101 had further agreed that the proposals contained in document MSC 101/12/1, in particular in paragraphs 11 and 12, as well as in document MSC 101/12/6, should be used as the basis for formulating the application provisions of the draft new SOLAS chapter XV and the draft IP Code and that both documents should also be considered when formulating the training requirements for industrial personnel and special personnel on ships subject to the IP Code, with a view to advising the Committee as appropriate (MSC 101/24, paragraphs 12.17 and 12.18).

PART 2 OF THE REPORT OF THE IP WORKING GROUP ESTABLISHED AT SDC 6

6.6 Having considered part 2 of the report of the IP Working Group established at SDC 6 (SDC 7/6), the Sub-Committee, bearing in mind that the IP Correspondence Group had already considered the matters outlined in the report during its deliberations, approved part 2 of the report in general.

REPORT OF THE IP CORRESPONDENCE GROUP

Draft International Code of Safety for Ships Carrying Industrial Personnel

6.7 The Sub-Committee considered the report of the IP Correspondence Group (SDC 7/6/1) containing the draft International Code of Safety for Ships Carrying Industrial Personnel (IP Code).

6.8 The Sub-Committee also had for its consideration the following documents:

.1 SDC 7/6/2 (China), containing various proposals to amend the draft IP Code, in particular related to personnel transfer arrangement safety, requirements for life-saving appliances and issues related to the carriage of dangerous goods;

.2 SDC 7/6/3 (Norway and the United States), containing a proposal for amending regulation IV/8.4, setting out safety measures in addition to those currently proposed for ships carrying dangerous liquid chemicals in bulk and all other ships carrying dangerous or flammable liquid cargo in bulk;

.3 SDC 7/6/4 (Vanuatu and ICS), containing, inter alia, a proposal to include grandfathering provisions for ships where Administrations have applied the Interim Recommendations; and

.4 SDC 7/6/5 (Vanuatu), commenting on, and providing alternative proposals for part III of, the draft IP Code in relation to the current provision for the master to establish medical fitness of IP, the possibility that personnel transfer arrangements may not be part of the ship and that verification of the suitability of the design of the personnel transfer arrangement for a ship or a facility, other than the ship transporting or accommodating industrial personnel, may not be possible.

6.9 In considering the above documents, the Sub-Committee noted the following views:

.1 with respect to the development of grandfathering provisions:

.1 the draft new SOLAS chapter XV and the draft IP Code should contain provisions with respect to ships where Administrations had applied the *Interim recommendations on the safe carriage of more than 12 industrial personnel on board vessels engaged on international voyages* (resolution MSC.418(97)), following the endorsement by SDC 5 that some kind of grandfathering should be considered at a later stage (SDC 5/15, paragraph 7.6.3);

.2 the applicability requirements of SOLAS chapter XV and the IP Code needed to be unambiguous and it should be considered that, by allowing the continuation of ships certified in accordance with resolution MSC.418(97) in lieu of the new IP Code, two different safety standards for ships carrying industrial personnel could be introduced;

.2 with respect to training and certification of industrial personnel:

.1 industrial personnel should be familiar with and receive training similar to that required for onshore personnel for the handling of dangerous goods under national regulations of a Member State;

.2 if the terms "training" and "instruction" for industrial personnel were to be considered by the HTW Sub-Committee, then their experts might not be able to provide advice as the STCW Code did not define the difference between these terms;

.3 with respect to life-saving appliances on board ships subject to the IP Code:

.1 a threshold value, based on the number of industrial personnel on board, should not be used to determine the required launching time of all survival craft for ship abandonment and the alignment with the SPS Code should be retained;

.2 ships might carry a large number of industrial personnel and exempting them from the provisions in SOLAS chapter III and the LSA Code could pose problems; the IP Code should, therefore, contain a certain threshold number of industrial personnel where the same approach was taken as for passenger ships;

.3 the requirements to launch the full complement of persons and equipment within a period of 30 min, in accordance with SOLAS regulation III/21.1.3, should be considered for ships carrying more than 240 industrial personnel as they would meet the subdivision and damage stability requirements for passenger ships;

.4 with respect to the master's role in verifying industrial personnel's medical fitness and training:

.1 the responsibility for confirming the level of training, medical and physical fitness should rest with the company employing industrial personnel and not the ship, to avoid additional administrative burden to the master;

.2 the master retained ultimate responsibility for the persons on board, including the determination of compliance of industrial personnel with the provisions of the IP Code, which could not be delegated to a subcontractor;

.3 the verification of the appropriate certification of industrial personnel could be part of the safety management system of the ship and relieved the master of the need to verify a large number of IP documentation; and

.4 the simple verification of certificates of crew members by the master had been a long-established practice and could be extended, without major administrative burden, to industrial personnel.

6.10 Having considered the above views, the Sub-Committee instructed the IP Working Group to take them into account when finalizing the draft SOLAS chapter XV and the draft IP Code.

Action requested of the Sub-Committee

6.11 Having considered the action requested in paragraph 22 of the report of the IP Correspondence Group, the Sub-Committee approved the report in general and took the following decisions:

.1 HTW 7 should only be requested to provide advice and input on matters pertaining to training and related issues under its remit with respect to industrial personnel if the Sub-Committee had specific questions that could be directed to the HTW Sub-Committee; and

.2 PPR 7 should be informed of the changes to the IP Code provisions and, given its further development, that there was no requirement for the PPR Sub-Committee to respond to the request made by SDC 6 to PPR 7 (SDC 6/13, paragraph 6.24).

ESTABLISHMENT OF THE IP WORKING GROUP

6.12 Following discussion and recalling the relevant decision of MSC 101, the Sub-Committee established the Working Group on Carriage of More than 12 Industrial Personnel (IP) on Board Vessels Engaged on International Voyages and instructed it, taking into account the documents submitted and the comments and decisions made in plenary, to:

.1 finalize the draft new SOLAS chapter XV, based on annex 1 to document SDC 6/6/1, incorporating the proposal in document MSC 101/12/1, taking into account document MSC 101/12/6, as well as the decision of MSC 101 to use an aggregated number for the application of the IP Code;

.2 finalize parts I to IV of the draft IP Code, based on the annex to document SDC 7/6/1 and taking into account documents MSC 101/12/1 and MSC 101/12/6 with regard to training requirements for industrial personnel and special personnel on ships subject to the IP Code, with a view to preparing advice for the Committee's consideration, as appropriate;

.3 if time permitted, continue to develop part V of the draft IP Code, based on the annex to document SDC 7/6/1;

.4 prepare part III of the check/monitoring sheet for the process of amending the (SOLAS) Convention, using the form contained in annex 2 to MSC.1/Circ.1500/Rev.1 annex 2;

.5 consider the input needed from the PPR Sub-Committee in relation to the carriage of dangerous chemicals with regard to the development of the IP Code at this session (SDC 6/13, paragraph 6.25);

.6 draft specific requests for input and advice from CCC 7, bearing in mind that CCC 6 concurred with paragraph 3.1.8.4 of the draft IP Code, as set out in annex 2 to document SDC 6/WP.4;

.7 consider the need for input from the HTW Sub-Committee with regard to training and certification of industrial personnel and, if necessary, prepare specific requests for advice from HTW 7;

.8 consider whether it was necessary to re-establish the correspondence group and, if so, prepare terms of reference for consideration by the Sub-Committee; and

.9 if necessary, continue working through the week and submit part 2 of the report as soon as possible after the session to SDC 8, so that it could be taken into account by the Correspondence Group on Carriage of More than 12 Industrial Personnel on Board Vessels Engaged on International Voyages, if re-established.

REPORT OF THE IP WORKING GROUP

6.13 Having considered part 1 of the report of the IP Working Group (SDC 7/WP.3), the Sub-Committee took action as outlined below.

Application of the new SOLAS chapter to existing ships

6.14 When considering the scope of application of the draft new SOLAS chapter XV the Sub-Committee noted that the Group had identified the following cases to be addressed for application of the new SOLAS chapter to existing ships:

.1 ships currently transporting industrial personnel in accordance with the provisions of the *Interim Recommendations on the safe carriage of more than 12 industrial personnel on board vessels engaged on international voyages* (resolution MSC.418(97)); and

.2 ships constructed before the date of entry into force of the new chapter that may start carrying industrial personnel after the date of entry into force of the new chapter.

6.15 In this context, the Sub-Committee recalled operative paragraph 2 of resolution MSC.418(97), which invited Member States to apply the Interim Recommendations to existing ships "until such time that the mandatory instrument for the carriage of industrial personnel enters into force". The Sub-Committee, recognizing that the application to ships currently transporting industrial personnel in accordance with the Interim Recommendations was a policy matter falling under the purview of the Committee, invited MSC to reaffirm, or otherwise, the decision of MSC 97 regarding the application of the new SOLAS chapter XV to ships certified in accordance with the Interim recommendations and take action as appropriate.

6.16 Consequently, the Sub-Committee noted that the Group had placed the definitions of the terms "ship constructed" and "at similar stage of construction" (draft SOLAS regulations XV/1.4 and 1.5), which were directly related to the application to ships currently transporting industrial personnel, in square brackets, pending the Committee's decision on draft regulation XV/3.2 (see paragraph 6.15).

6.17 With regard to the application to ships constructed before the date of entry into force of the new chapter of SOLAS that intended to start carrying industrial personnel after the new chapter entered into force (paragraph 16.14.2), the Sub-Committee agreed that both new and existing ships should be certified for the carriage of industrial personnel in accordance with the new SOLAS chapter XV and, consequently, the new IP Code.

Two-phase approach for the work on this output

6.18 The Sub-Committee agreed, in principle, to the draft new SOLAS chapter XV (SDC 7/WP.3, annex 2) and a two-phase approach for the work on this output whereby, in case the draft provisions for high-speed craft carrying industrial personnel could not be finalized in time for entry into force on 1 January 2024, the draft SOLAS chapter XV and the draft IP Code would be finalized by SDC 8 for ships certified under SOLAS chapter I, requiring later amendments to SOLAS chapter XV and the IP Code when the provisions for high-speed craft were finalized (i.e. the second phase for craft certified in accordance with SOLAS chapter X).

6.19 Following the above decision, and taking into account that the primary goal was to develop a complete package of mandatory instruments for the carriage of industrial personnel in time for entry into force in 2024, the Sub-Committee invited the Committee to endorse its decision that in case the work on matters related to high-speed craft was not finalized at SDC 8, the draft new SOLAS chapter XV and the draft IP Code would be finalized for ships certified under SOLAS chapter I, with a view to approval at MSC 104, and the second-phase would deal with development of provisions for craft certified in accordance with SOLAS chapter X.

Training requirements for industrial personnel

6.20 With respect to the need for advice from the HTW Sub-Committee on training requirements for industrial personnel, who are not subject to the STCW Convention and Code, the Sub-Committee endorsed the Group's agreement that there was no need for any specific input from the HTW Sub-Committee and requested HTW 7 to note the draft IP Code and its provisions for training of industrial personnel therein, under its agenda item 2 on "Decisions of other IMO bodies".

Carriage of dangerous goods

6.21 The Sub-Committee agreed with the Group's recommendation to refer the draft amendments to the goals, functional requirements and regulations for the carriage of dangerous goods in the draft IP Code, taking into account the discussion in the Group (SDC 7/WP.3, paragraphs 18 to 20 and annex 3), to:

.1 CCC 7 to note; and
.2 ESPH 26 for agreement.

Re-establishment of the IP Correspondence Group

6.22 In order to progress the work on this output intersessionally, the Sub-Committee re-established the Correspondence Group on Carriage of More than 12 Industrial Personnel on Board Vessels Engaged on International Voyages, under the coordination of Norway,* and instructed it, taking into account documents SDC 5/INF.2 and SDC 7/WP.3 and part 2 of the IP Working Group's report from SDC 7,** to:

.1 further develop the draft IP Code with a view to finalization;

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.2 further consider the draft new SOLAS chapter XV on matters related to high-speed craft, based on annex 1 to document SDC 7/WP.3;

.3 further consider the draft part V (Additional regulations for ships certified in accordance with SOLAS chapter X) of the draft IP Code; and

.4 submit a report to SDC 8.

Extension of the target completion year

6.23 In light of the above decisions, MSC 102 was invited to extend the target completion year for this output to 2021 (see paragraphs 13.4 and 13.5 and annexes 12 and 13).

7 DEVELOPMENT OF AMENDMENTS TO SOLAS CHAPTER II-1 TO INCLUDE REQUIREMENTS FOR WATER LEVEL DETECTORS ON NON-BULK CARRIER CARGO SHIPS WITH MULTIPLE CARGO HOLDS

General

7.1 The Sub-Committee recalled that MSC 100 had considered document MSC 100/17/2 (United States), proposing to expand the applicability of the requirements of SOLAS regulation II-1/25 for cargo hold water level detectors by developing a new SOLAS regulation applying to cargo ships with multiple cargo holds, and had agreed to include a new output on "Development of amendments to SOLAS chapter-II-1 to include requirements for water level detectors on non-bulk carrier cargo ships with multiple cargo holds" in its post-biennial agenda, with two sessions needed to complete the item.

7.2 The Sub-Committee also recalled that MSC 100 had further agreed, in accordance with MSC.1/Circ.1481 and MSC.1/Circ.1500, that:

.1 the amendments to be developed should apply to new cargo ships with multiple cargo holds other than bulk carriers;

.2 the instrument to be amended was SOLAS chapter II-1; and

.3 the amendments to be developed should enter into force on 1 January 2024, provided that they were adopted before 1 July 2022.

7.3 The Sub-Committee considered document SDC 7/7 (United States), proposing to expand the applicability of SOLAS regulation II-1/25, which was currently applicable to single hold cargo ships, to include cargo ships with multiple cargo holds by means of a new SOLAS regulation II-1/25-1.

7.4 The Sub-Committee also had for its consideration document SDC 7/7/1 (China), questioning the need to require cargo hold water level detectors for cargo ships with multiple cargo holds, stating that no cost-effectiveness analysis for the installation of cargo hold water level detectors was provided and research carried out by China had found that 100% of the sample ships did not have cargo hold water level detectors and that bilge alarms on such ships were believed to be sufficient to detect any water ingress. Hence, the installation of cargo hold water level detectors for cargo ships with multiple cargo holds other than bulk carriers should be based on a risk assessment of damage stability requirements in SOLAS chapter II-1.

7.5 In considering the above documents, the Sub-Committee noted the following views:

.1 the proposed draft SOLAS regulation II-1/25-1 deviated from the related SOLAS regulation II-1/25 as it did not include damage stability provisions;

.2 as drafted, the application of the draft SOLAS regulation II-1/25-1 would also apply to tankers, which would not benefit from added safety by installing water level detectors and, therefore, tankers should not be included;

.3 the proposed draft SOLAS regulation II-1/25-1 should be supported, in principle, as it represented an improvement in safety;

.4 the scope of the new regulation needed to be clearly stated with respect to the ship types to which it applied; and

.5 the requirement for water level detectors required further analysis and should only be applied to non-bulk carrier cargo ships carrying certain cargoes.

7.6 Having considered the above views and given the general support for the installation of water level detectors on non-bulk carrier cargo ships with multiple cargo holds and the added safety benefit associated with it, the Sub-Committee decided to develop the draft new SOLAS regulation II-1/25-1, based on the annex to document SDC 7/7.

Instructions to the SDS Working Group

7.7 Following discussion, the Sub-Committee instructed the SDS Working Group, established under agenda item 3, taking into account comments and decisions made in plenary, to finalize the draft new SOLAS regulation II-1/25-1 on water level detectors on multiple hold cargo ships other than bulk carriers, based on the annex to document SDC 7/7.

Report of the SDS Working Group

7.8 Having considered the relevant part of the SDS Working Group's report (SDC 7/WP.4), the Sub-Committee took action as outlined below.

7.9 The Sub-Committee noted that the Group had agreed that the draft new SOLAS regulation II-1/25-1 should not apply to tankers, but that it was a reasonable safety enhancement that should apply irrespective of whether the ship complied with a damage stability requirement or its hull arrangements.

7.10 Following discussion, the Sub-Committee agreed to the new SOLAS regulation II-1/25-1 on water level detectors on multiple hold cargo ships other than bulk carriers and tankers, as set out in annex 6, for submission to MSC 102 for approval, with a view to subsequent adoption.

7.11 With regard to the corresponding check/monitoring sheet for the draft new SOLAS regulation, in accordance with MSC.1/Circ.1500/Rev.1, the Sub-Committee requested the Secretariat to complete Part III of the sheet, together with the records for regulatory development, as part of the final approval process by the Committee.

7.12 The delegation of Belgium, while generally supportive of the installation of water ingress alarms for the enhancement of safety, as proposed in the draft new SOLAS regulation, expressed concern about a possible side effect with respect to bilge alarms that were commonly installed on cargo ships not carrying bulk cargoes, which would not be sufficient after entry into force of new SOLAS regulation II-1/25-1.

7.13 The Sub-Committee, in considering the Group's observation with regard to single hold cargo ships and the potential need to review SOLAS regulation II-1/25 in the future in order to consider water level detector requirements for ships that complied with damage stability requirements, invited interested Member States and international organizations to submit proposals to the Committee for a new output in accordance with the Committees' procedures (MSC-MEPC.1/Circ.5/Rev.1 and Corr.1).

8 MANDATORY APPLICATION OF THE PERFORMANCE STANDARD FOR PROTECTIVE COATINGS FOR VOID SPACES ON BULK CARRIERS AND OIL TANKERS

Background

8.1 The Sub-Committee recalled that MSC 76 (2 to 13 December 2002) had included an item on "Performance standards for protective coatings" in the work programme of the DE Sub-Committee, with a target completion year of 2004 (MSC 76/23, paragraph 20.41.2).

8.2 The Sub-Committee also recalled that MSC 80 had agreed to expand the scope of the item to also cover void spaces into which seawater normally did not enter (MSC 80/24, paragraphs 14.10 and 14.13). Consequently, DE 49 had agreed to consider a draft Performance standard for protective coatings of void spaces of all types of ships, considering as a priority oil tankers and bulk carriers, and to, inter alia, identify and define those void spaces to which a different standard could apply for other types of ships (DE 50/27, paragraph 4.3).

8.3 The Sub-Committee further recalled that MSC 82 had adopted the *Performance standard for protective coatings for dedicated seawater ballast tanks in all types of ships and of double-side skin spaces of bulk carriers* (resolution MSC.215(82)), which had become effective on 1 July 2008 upon entry into force of the associated amendments to SOLAS regulations II-1/3-2 and XII/6, adopted by resolution MSC.216(82).

8.4 The Sub-Committee further recalled that, subsequently, MSC 83 had adopted the *Performance standard for protective coatings for void spaces on bulk carriers and oil tankers* (resolution MSC.244(83)) and had agreed that it would consider making the Performance standard mandatory through the development of relevant SOLAS amendments, in the longer term, after experience had been gained with its application (MSC 83/28, paragraph 9.7).

8.5 The Sub-Committee also recalled that SDC 6, following a proposal by the Chair to consider the outputs that had been on the post-biennial agenda of the Committee since MSC 76 (December 2002), and in order to make a decision as to how to progress the work, had agreed to include them in the provisional agenda of SDC 7.

Discussion on how best to proceed

8.6 The Sub-Committee noted that, since the adoption of resolution MSC.244(83), no feedback on the experience gained with the application of the Performance Standard had been reported and the output on "Mandatory application of the performance standard for protective coatings for void spaces on bulk carriers and oil tankers" had been kept on the post-biennial agenda of the Committee.

8.7 The Sub-Committee also noted that no documents had been submitted under the agenda item to this session.

8.8 The Sub-Committee further noted the correlation with agenda item 9 on "Performance standard for protective coatings for void spaces on all types of ships" and, in considering how to proceed with these two interrelated outputs and bearing in mind that, in accordance with paragraph 5.12 of the Committees' procedures (MSC-MEPC.1/Circ.5/Rev.1 and Corr.1), sub-committees should seek the advice of the committees in the case of outputs for which no submissions had been received for two consecutive sessions, agreed to invite Member States and international organizations to submit concrete proposals on this matter to SDC 8.

8.9 In considering a way forward, the Sub-Committee noted information provided by the delegation of China, which had conducted an investigation into the matter and concluded that no information had been received for over 30 years with respect to any coating failures, and that the mandatory application of resolution MSC.244(83) would result in an increased cost for shipbuilding. The analysis also revealed that some of the current provisions might not be sufficient and, therefore, did not support the mandatory application of the Performance Standard at this time.

8.10 In considering the comments made, the Sub-Committee agreed to consider the matter further at SDC 8 on the understanding that, if no proposals were submitted, the Sub-Committee would invite the Committee to consider the deletion of output OW 31 (Mandatory application of the Performance standard for protective coatings for void spaces on bulk carriers and oil tankers).

9 PERFORMANCE STANDARD FOR PROTECTIVE COATINGS FOR VOID SPACES ON ALL TYPES OF SHIPS

9.1 The Sub-Committee recalled the background information provided for agenda item 8 (see paragraphs 8.1 to 8.5) and noted that no documents had been submitted under this agenda item to this session.

9.2 Recalling the correlation with agenda item 8, and considering how to proceed with these two interrelated outputs and bearing in mind that, in accordance with paragraph 5.12 of the Committees' procedures (MSC-MEPC.1/Circ.5/Rev.1 and Corr.1), sub-committees should seek the advice of the committees in the case of outputs for which no submissions had been received for two consecutive sessions, the Sub-Committee invited Member States and international organizations to submit relevant proposals to SDC 8.

9.3 Recalling also its earlier decision with respect to agenda item 8 (see paragraphs 8.6 to 8.10), the Sub-Committee agreed that, in the event that no proposals were submitted to SDC 8, it would invite the Committee to consider the deletion of this output (OW 32).

10 AMENDMENTS TO THE 2011 ESP CODE

Background

10.1 The Sub-Committee recalled that MSC 101 had adopted, after a comprehensive revision, amendments to the 2011 ESP Code (resolution MSC.461(101)), which were expected to enter into force on 1 January 2021, in accordance with the provisions of SOLAS article VIII.

Provisions for Remote Inspection Techniques (RITs)

10.2 Having considered document SDC 7/10 (IACS), proposing draft amendments to the 2011 ESP Code to allow the use of remote inspection techniques (RITs), such as remotely operated vehicles (ROVs) and real-time sensing devices that are carried by drones in the survey of existing ships as an alternative to a close-up survey, the Sub-Committee noted the following views:

.1 the use of RITs was generally supported as it provided a means for the safe inspection and survey of those parts of the ship which posed a safety risk to the surveyor, in particular, in confined spaces;

.2 innovative technologies for use by surveyors were supported but amendments were needed to ensure that RITs could meet the objectives of a close-up survey rather than being an alternative;

.3 while the use of RITs for close-up surveys was supported in general, their use should be limited to bulk carriers and oil tankers until their third special survey and should not be used when:

  .1 there was an existing record or indication of abnormal deterioration or damage to structure or to items to be inspected;

  .2 there were existing recommendations for repairs or conditions affecting the class of the ship;

  .3 during the course of the RIT survey, defects were found such as damage or deterioration that required attention; and

  .4 the coating condition of the tank/hold was rated as less than "Good" by the surveyor, with the exception of sections of cargo oil tanks that were not coated (i.e. stainless steel cargo tanks);

.4 the draft amendments to the 2011 ESP Code did not provide a substantial framework for the use of these emerging technologies and the issue should be brought to the attention of the III Sub-Committee;

.5 the use of RIT for surveys under the ESP Code was a purely technical matter that fell under the remit of this Sub-Committee and, therefore, there was no need to involve the III Sub-Committee, bearing in mind that a qualified surveyor would use such technologies only when appropriate;

.6 as the 2011 ESP Code referred to both Administrations and recognized organizations under the single term "Administration", the implications of the term "Administration" in the current draft regulation needed to be carefully considered; and

.7 a wider, more holistic view on inspections and surveys of ships should be pursued in order to avoid duplication of work within the Organization where similar approaches for the use of remote inspection/survey technologies may be considered under other instruments.

10.3 Having considered the above views, the Sub-Committee decided that, while the use of RITs for surveys under the 2011 ESP Code had been generally supported, the matter required a broader consideration by the Organization, which might consider taking a holistic approach in regulating RITs, including those that might be considered under other instruments.

10.4 Consequently, the Sub-Committee invited interested Member States and international organizations to submit proposals on the matter to the Sub-Committee for consideration.

10.5 In this connection, the observer from IACS stated that its member organizations would welcome any contributions from Member States and observers for the development of a proposal to regulate the use of RITs and that it was not IACS' intention to lower the requirements of the 2011 ESP Code by allowing these techniques to replace surveyors' work but to ensure that surveyors had the freedom to use RITs when appropriate.

Thickness measurements at the first renewal survey of double hull oil tankers

10.6 The Sub-Committee considered document SDC 7/10/1 (IACS) proposing, after an analysis carried out by IACS had showed that the coating wastage was minimal (SDC 7/INF.5), to amend annex 2 of part A of annex B of the 2011 ESP Code, as amended by resolution MSC.461(101), whereby it would be sufficient to consider only suspect areas for thickness measurements at the first renewal survey of double hull oil tankers.

10.7 In this respect, the Sub-Committee noted with appreciation the information contained in document SDC 7/INF.5 (IACS) providing the data collected from 157 oil tankers, as referred to in document SDC 7/10/1.

10.8 After a brief discussion, the Sub-Committee agreed to draft amendments to the 2011 ESP Code, as set out in annex 7, for submission to MSC 102 with a view to approval and subsequent adoption.

11 UNIFIED INTERPRETATION TO PROVISIONS OF IMO SAFETY, SECURITY, AND ENVIRONMENT-RELATED CONVENTIONS

Background

11.1 The Sub-Committee recalled that this was a continuous item on the biennial agenda and that the Assembly, at its twenty-eighth session, had expanded the output to include all proposed unified interpretations to provisions of IMO safety, security, and environment-related conventions, so that any newly developed or updated draft unified interpretation could be submitted for the consideration of the Sub-Committee, with a view to developing an appropriate IMO interpretation.

Unified interpretation on service tank arrangements

11.2 The Sub-Committee recalled that MSC 101, having considered the discussions at SDC 6 on the proposed unified interpretation (UI) of service tank arrangements, together with documents MSC 101/8/1 and SDC 6/9/4 (IACS), could not reach consensus on the matter and had instructed SDC 7 to further consider the development of a unified interpretation of SOLAS regulation II-1/26.11. In this regard, the Committee had invited interested Member States and international organizations to submit relevant comments and proposals to SDC 7, taking into account the discussions in the Working Group on Fuel Oil Safety (MSC 101/WP.10, paragraphs 34 to 37).

11.3 The Sub-Committee noted that no documents on this issue had been submitted to this session.

11.4 In the ensuing discussion, the observer from IACS informed the Sub-Committee that IACS had submitted revision 4 of UI SC123 on service tank arrangements in the annex to document SDC 6/9/4 and, after having carefully considered the discussions at both SDC 6 and MSC 101, IACS members had decided to withdraw revision 4 of the UI.

11.5 The observer from IACS also informed the Sub-Committee that revision 3 of IACS UI SC123 remained effective after 1 January 2020 and that IACS was working on the new revision 4 of the UI, aimed at clarifying that fuels with different sulphur contents were not considered as different types of fuels with respect to SOLAS safety requirements. He advised the Sub-Committee that IACS would submit revision 4 to a future session.

11.6 Consequently, the Sub-Committee invited interested Member States and international organizations to join the work of IACS in developing revision 4 of UI SC123 on Machinery Installations – Service Tank Arrangements Reg. II-1/26.11 and agreed to inform MSC 102 accordingly.

Unified interpretation of regulation 25(3) of the International Convention on Load Lines, 1966, as modified by the 1988 Protocol relating thereto (1988 LL Protocol)

11.7 The Sub-Committee considered document SDC 7/11 (China), proposing a unified interpretation of regulation 25(3) of the International Convention on Load Lines, 1966, as modified by the Protocol of 1988 relating thereto (1988 LL Protocol), regarding the setting of courses of guard rails for the protection of crew, in order to fill the gap for the term "superstructure" in the Convention, in particular to require three courses for guard rails (instead of only two) for modern designs of large ship open deck superstructures.

11.8 In the ensuing discussion, the Sub-Committee noted the following views:

.1 the issue raised in the document was valid as insufficiently arranged guard rails had been contributing factors of accidents in bad weather where seafarers had gone overboard;

.2 the gap identified in document SDC 7/11 for the modern design of large ships existed, but this matter should be addressed as an amendment to the 1988 LL Protocol and not by a unified interpretation; and

.3 the text, as drafted, would not apply to ships of less than 150 m in length and, therefore, the safety of seafarers on board such ships would not be covered.

11.9 Having considered the proposed draft UI to the 1988 LL Protocol, the Sub-Committee, while confirming that this was an important safety matter and that a regulatory gap existed with respect to the arrangement of guard rails on large ship open deck superstructures, agreed that a unified interpretation would not be an appropriate solution and, therefore, invited China, interested Member States and international organizations to submit a new output proposal to the Committee in accordance with the Committees' procedures (MSC-MEPC.1/Circ.5/Rev.1).

12 REVIEW OF MANDATORY REQUIREMENTS IN THE SOLAS, MARPOL AND LOAD LINES CONVENTIONS AND THE IBC AND IGC CODES REGARDING WATERTIGHT DOORS ON CARGO SHIPS

General

12.1 The Sub-Committee recalled that MSC 101 had considered document MSC 101/21/16 (Liberia et al.), proposing the review of mandatory requirements in the SOLAS, MARPOL and Load Lines Conventions and the IBC and IGC Codes regarding watertight doors on cargo ships, addressing inconsistencies, and had agreed to include in the biennial agenda of the Sub-Committee for 2020-2021 and the provisional agenda for SDC 7 an output on "Review of mandatory requirements in the SOLAS, MARPOL and Load Lines Conventions and the IBC and IGC Codes regarding watertight doors on cargo ships", with a target completion year of 2021 (MSC 101/24, paragraph 21.25); and had also agreed to involve MEPC, as requested by MEPC 74, with regard to the instruments under the purview of MEPC.

12.2 The Sub-Committee also recalled that MSC 101 had further agreed that, in accordance with MSC.1/Circ.1481 and MSC.1/Circ.1500/Rev.1:

.1 the amendments to be developed should apply to new ships;

.2 the instruments to be amended were SOLAS, MARPOL and the Load Lines Conventions and the IBC and IGC Codes (dependent on the outcome of the review); and

.3 the amendments to be developed should enter into force on 1 January 2024, provided that they were adopted before 1 July 2022.

12.3 The Sub-Committee had for its consideration the following documents:

.1 SDC 7/12 (Liberia et al.), proposing to align the requirements with respect to doors in watertight bulkheads among different IMO instruments with that of the SOLAS Convention by amending Annex I of MARPOL, the 1966 Load Lines Convention (1966 LL Convention), as well as the IBC and IGC Codes by explicitly excluding "hinged watertight doors that are normally closed at sea" when considering openings through which progressive flooding or downflooding may take place; and

.2 SDC 7/12/1 (China), proposing amendments to Annex I of MARPOL, the 1966 LL Convention and the IBC and IGC Codes with respect to permitting hinged watertight doors as an alternative to remotely operated sliding doors, provided that they are required "to be kept permanently closed" at sea, have the same level of watertight integrity and are equipped with a sound alarm device.

12.4 In considering the above documents, the Sub-Committee noted the following views:

.1 watertight doors may be of hinged-type, but serious concerns remained with respect to the human factor and failure to close all watertight doors which compromised the watertight integrity during flooding;

.2 if watertight doors of hinged-type were used, they should be of single action-type and require indication of their status locally and on the bridge ("closed"/"open"); and

.3 the definitions for "normally closed" and "permanently closed", as contained in MSC.1/Circ.1572, needed to be considered when formulating requirements for watertight doors in different instruments.

12.5 Taking into account the above views, the Sub-Committee agreed to consider the documents submitted for the development of requirements for hinged watertight doors.

Instructions to the SDS Working Group

12.6 Following discussion, the Sub-Committee instructed the SDS Working Group established under agenda item 3, taking into account comments made and decisions taken in plenary, to finalize draft amendments to:

.1 regulation 27(13)(a) of the 1988 LL Protocol;
.2 paragraph 2.9.2.1 of the IBC Code;
.3 paragraph 2.7.1.1 of the IGC Code; and
.4 regulation 28.3.1 of MARPOL Annex I,

taking into account the text proposals in documents SDC 7/12 and SDC 7/12/1.

Report of the SDS Working Group

12.7 Having considered the relevant part of the SDS Working Group's report (SDC 7/WP.4), the Sub-Committee took action as outlined below.

12.8 The Sub-Committee noted that the Group, in considering the requirements in SOLAS regulation II-1/13-1.3, which allowed hinged watertight doors if normally closed at sea, had noted that they were limited to "access doors" and that such limitation should be included in the amendment text.

12.9 The Sub-Committee also noted that, in the absence of a clear understanding of the term "access doors" and due to time constraints, the Group could not consider this matter further.

12.10 The delegation of Australia raised concerns about the current draft amendments to MARPOL Annex I, the 1988 LL Protocol and the IBC and IGC Codes, as contained in annex 4 of document SDC 7/WP.4, highlighting that the current draft text only required hinged watertight doors that were "normally closed at sea" to be of quick-acting or single-action type, but that this provision should be extended to watertight doors that were "permanently closed" at sea and that Australia, therefore, intended to convey this concern to MSC 102 and MEPC 76.

12.11 Subsequently, the Sub-Committee agreed to the draft amendments to:

.1 MARPOL Annex I, set out in annex 8;
.2 the 1988 LL Protocol, set out in annex 9;
.3 the IBC Code, set out in annex 10; and
.4 the IGC Code, set out in annex 11,

for submission to MSC 102 and MEPC 76, as appropriate, for approval with a view to subsequent adoption for entry into force on 1 January 2024 for new ships only.

12.12 If approved by MSC 102, the Committee is invited to request MEPC 76 to consider and approve the draft amendments to the IBC Code, as set out in annex 10, with a view to subsequent adoption.

12.13 With regard to the envisaged application of the amendments to the four instruments (see paragraph 12.11), the Sub-Committee agreed to invite the Committee to note that it expected no impact of the draft amendments on existing ships and, therefore, the Committees could consider applying the amendments to all ships on the date of entry into force.

13 BIENNIAL STATUS REPORT AND PROVISIONAL AGENDA FOR SDC 8

Guidelines for use of fibre reinforced plastic (FRP) within ship structures

13.2 The Sub-Committee noted that it had currently only one output on the post-biennial agenda of the Committee on "Guidelines for use of Fibre Reinforced Plastics (FRP) within ship structures". In this context, the Sub-Committee recalled that MSC 98 had approved MSC.1/Circ.1574 on *Interim guidelines for use of fibre reinforced plastic (FRP) elements within ship structures: Fire safety issues* and had endorsed the view that 4 years would be a suitable period for Administrations to gather experience in the application of the Interim guidelines, with a view to reviewing them. Therefore, the output on "Guidelines for use of fibre reinforced plastic (FRP) within ship structures" was placed on the Committee's post-biennial agenda (MSC 98/23, paragraph 10.22).

13.3 The Sub-Committee also noted that MSC.1/Circ.1574 called upon Member States and international organizations to submit information, observations, comments and recommendations based on the practical experience gained through the application of the above Interim Guidelines to the Sub-Committee under the agenda item "Any other business" and that the 4-year review period of the experience gained in the application of the Interim guidelines would end in 2021.

Biennial status report for the 2020-2021 biennium

13.4 Taking into account the progress made at this session, the Sub-Committee prepared its biennial status report (SDC 7/WP.2, annex 1), as set out in annex 12, for consideration by MSC 102.

Proposed provisional agenda for SDC 8

13.5 Taking into account the progress made at this session, the Sub-Committee prepared the proposed provisional agenda for SDC 8 (SDC 7/WP.2, annex 2), as set out in annex 13, for consideration by MSC 102.

Correspondence groups established at this session

13.6 The Sub-Committee established correspondence groups on the following subjects, due to report to SDC 8:

.1 finalization of Explanatory Notes to the interim guidelines on second generation intact stability criteria* (see paragraph 5.20); and

.2 carriage of more than 12 industrial personnel on board vessels engaged on international voyages (see paragraph 6.22).

Arrangements for the next session

13.7 The Sub-Committee agreed to establish at its next session working and drafting groups on the following subjects:

.1 Safety measures for non-SOLAS ships operating in polar waters (agenda item 3);**

* Renaming the output, subject to approval by MSC 102.

** Refers to the proposed provisional agenda set out in annex 13.

.2 Carriage of more than 12 industrial personnel on board vessels engaged on international voyages (agenda item 4);

.3 Development of Explanatory notes to the interim guidelines on second generation intact stability criteria (agenda item 5); and

.4 Amendments to the 2011 ESP Code (agenda item 6),

whereby the Chair, taking into account the submissions received on the respective subjects, would advise the Sub-Committee before SDC 8 on the final selection of such groups.

Date of the next session

13.8 The Sub-Committee noted that its eighth session had been tentatively scheduled to take place from 25 to 29 January 2021.

14 ELECTION OF CHAIR AND VICE-CHAIR FOR 2021

14.1 In accordance with the Rules of Procedure of the Maritime Safety Committee, the Sub-Committee unanimously elected Mrs. T. Stemre (Norway) as Chair and Mr. J. Sirkar (United States) as Vice-Chair, both for 2021.

Expressions of appreciation

14.2 The Sub-Committee expressed sincere thanks and appreciation to Mr. Kevin Hunter of the United Kingdom for his excellent services to the SLF and SDC Sub-Committees over many years and, in particular, in his capacity as Chair of this Sub-Committee since SDC 3.

14.3 The Sub-Committee also expressed sincere thanks and appreciation to Mrs. Turid Stemre of Norway for her excellent services to the SLF and SDC Sub-Committees over many years and, in particular, in her capacity as Vice-Chair of this Sub-Committee since SDC 3.

15 ANY OTHER BUSINESS

Amendments to the Guidelines for safe access to tanker bows (resolution MSC.62(67)) with regard to foot-stops

15.1 The Sub-Committee had for its consideration document SDC 7/15 (IACS), proposing to amend the *Guidelines for safe access to tanker bows* (resolution MSC.62(67)) with respect to foot-stops in order to replicate the respective mandatory provision on foot-stops in regulations 25-1(2)(e) and (f) of the 1966 LL Convention, adopted by resolution MSC.143(77), i.e. after approval of resolution MSC.62(67).

15.2 Following discussion, the Sub-Committee agreed to draft amendments to the *Guidelines for safe access to tanker bows* (resolution MSC.62(67)) and the associated draft MSC resolution, as set out in annex 14, for adoption by MSC 102 as a minor correction in accordance with paragraph 3.2(vi) of document C/ES.27/D, for dissemination as resolution MSC.62(67)/Rev.1.

Minor correction to the 1988 LL Protocol

15.3 The Sub-Committee considered document SDC 7/15/1 (United States and IACS), proposing a minor editorial correction to regulation 22(1)(g) of the 1988 LL Protocol, as amended, by deleting the reference to "inlets" therein, which the sponsors considered to be an editorial error.

15.4 Following discussion, the Sub-Committee agreed to the draft amendments to the 1988 LL Protocol, as set out in annex 15, for approval by MSC 102 with a view to subsequent adoption, as a minor correction in accordance with paragraph 3.2(vi) of document C/ES.27/D.

Clarification on the minimum width of the double-side skin construction of general dry cargo ships of less than 150 m in length which occasionally carry dry cargoes in bulk

15.5 Having considered document SDC 7/15/2 (IACS), seeking clarification on the application of the minimum width of double-side skin construction to general dry cargo ships which are less than 150 m in length, and which occasionally carry dry cargoes in bulk, the Sub-Committee noted the following views:

.1 the minimum width of double-side skin construction on general dry cargo ships which are less than 150 m in length, and which occasionally carry dry cargoes in bulk, is not clear and requires clarification;

.2 with regard to sub-paragraph .1 above, any clarification should be based on a technical assessment for determining the minimum width needed to ensure the structural strength of the ship;

.3 a minimum width for general dry cargo ships which are less than 150 m in length and over 100 m, which occasionally carry dry cargoes in bulk, should not be specified; and

.4 the requirements for the minimum width should be applied for ships of 150 m and over only, in line with the interpretation set out in paragraph 6 of document SDC 7/15/2.

15.6 The Sub-Committee agreed, in principle, that the application for the minimum width should be applied to ships of 150 m and over, but that the proposed amendments to the *Clarification of the term "bulk carrier" and guidance for application of regulations in SOLAS to ships which occasionally carry dry cargoes in bulk and are not determined as bulk carriers in accordance with regulation XII/1.1 and chapter II-1* (resolution MSC.277(85)) could not be considered as minor corrections in accordance with paragraph 3.2(vi) of document C/ES.27/D. Therefore, a new output proposal would be required and Member States and international organizations were invited to submit a new output proposal to the Committee in accordance with the Committees' procedures (MSC-MEPC.1/Circ.5/Rev.1), to which IACS was invited to contribute.

Guidelines for wing-in-ground craft

15.7 The Sub-Committee recalled that MSC 101, in considering the proposal by SDC 6 to update outdated references in the *Guidelines for wing-in-ground craft* (MSC.1/Circ.1592), had noted that the updated references, in particular to the LSA Code, did not match the provisions in the WIG Guidelines which had been drafted on the basis of SOLAS regulations that were no longer applicable to conventional SOLAS ships; and that other sections of the Guidelines might also contain outdated references and provisions. Consequently, the Committee had referred the revised Guidelines back to SDC 7 and instructed it to consider the matter further under the agenda item "Any other business", with a view to advising MSC 102 on a proposed way forward (MSC 101/24, paragraph 12.25).

15.8 In this connection, the Sub-Committee considered document SDC 7/15/3 (Russian Federation), proposing to conduct a comprehensive analysis of the existing instruments on WIG craft with a view to updating outdated references therein and to recommend to MSC 102 to consider the continuation of the work on WIG craft, with the inclusion of a new output in the agenda of the Sub-Committee.

15.9 Following discussion, the Sub-Committee invited Member States and international organizations to liaise with the Russian Federation in support of a new output proposal to the Committee, in accordance with the Committees' procedures (MSC-MEPC.1/Circ.5/Rev.1), to conduct a comprehensive review of the *Guidelines for wing-in-ground craft* (MSC.1/Circ.1592). The Committee was invited to note the above decision.

Expression of appreciation

15.10 The Sub-Committee expressed its appreciation to the following delegates, who had recently retired or were about to do so, for their invaluable contribution to its work and wished them a long and happy retirement:

- Mr. Rob Griffiths (CLIA) (on retirement)
- Mr. Kevin Hunter (United Kingdom) (on retirement)
- Mr. James Person (United States) (on retirement)
- Mr. Paul Sadler (IACS) (on retirement)

16 ACTION REQUESTED OF THE COMMITTEES

16.1 The Maritime Safety Committee, at its 102nd session, is invited to:

.1 adopt the draft Revised Explanatory Notes to SOLAS chapter II-1 subdivision and damage stability regulations and the associated draft MSC resolution, to be disseminated as resolution MSC.429(98)/Rev.1 (paragraph 3.21 and annex 1);

.2 approve the draft MSC circular on Amendments to section 3 of MSC.1/Circ.1572 (paragraph 3.22 and annex 2);

.3 note that HTW 7 was invited to comment on paragraph 11.5 of the draft Guidelines for fishing vessels of 24 m in length and over operating in polar waters with regard to the correctness of the terminology used and to identify any conflicts of the text with existing IMO instruments, with a view to advising MSC 103 directly when considering the above draft Guidelines for approval (paragraph 4.11);

.4 consider whether safety guidelines should be developed for pleasure yachts of 300 gross tonnage and above and less than 500 gross tonnage engaged in trade (i.e. commercial yachts) and for cargo ships of 300 gross tonnage and above and less than 500 gross tonnage, operating in polar waters, and take action as appropriate (paragraphs 4.14 and 4.16);

.5 approve the draft Interim guidelines for the second generation intact stability criteria and the associated draft MSC circular (paragraph 5.17 and annex 5);

.6 consider the application of the draft SOLAS chapter XV for existing ships certified to the *Interim Recommendations on the safe carriage of more than 12 industrial personnel on board vessels engaged on international* *voyages* (resolution MSC.418(97), taking into account that the aforementioned interim recommendations should be applied until such time as the mandatory regulations come into force, and take action as appropriate (paragraphs 6.15 and 6.16);

.7 agree that the draft new SOLAS chapter XV will apply to new and existing ships if such ships intend to carry industrial personnel on or after the date of entry into force date of the new chapter (paragraph 6.17);

.8 endorse the Sub-Committee's decision on the two-phase approach for the work whereby, in case the draft provisions for high-speed craft carrying industrial personnel cannot be finalized in time for entry into force on 1 January 2024, the draft new SOLAS chapter XV and the draft IP Code would be completed at SDC 8 for ships certified under SOLAS chapter I, and the second phase would deal with development of provisions for craft certified in accordance with SOLAS chapter X (paragraphs 6.18 and 6.19);

.9 note that HTW 7 was invited to note the outcome of matters related to training of industrial personnel and that CCC 7 was invited to note, and ESPH 26 to review, the draft amendments related to the carriage of dangerous goods in the draft IP Code and to advise SDC 8, as appropriate (paragraphs 6.20 and 6.21);

.10 approve draft SOLAS regulation II-1/25-1 on Water level detectors on multiple hold cargo ships other than bulk carriers and tankers, with a view to subsequent adoption, taking into account the check/monitoring sheet and records for regulatory development (paragraphs 7.10 and 7.11 and annex 6);

.11 approve the draft amendments to the 2011 ESP Code, with a view to subsequent adoption at MSC 103 (paragraph 10.8 and annex 7);

.12 note that IACS has withdrawn its proposed unified interpretation on service tank arrangements for further consideration and that interested Member States and international organizations were invited to join IACS in its work on this matter (paragraphs 11.2 to 11.6);

.13 with regard to the draft amendments for watertight doors on cargo ships:

.1 note that MEPC 76 has been invited to approve draft amendments to MARPOL Annex I (paragraph 12.11.1 and annex 8)

.2 approve the draft amendments to the 1988 LL Protocol (paragraph 12.11.2 and annex 9);

.3 approve the draft amendments to the IBC Code, subject to concurrent approval by MEPC 76 (paragraphs 12.11.3 and 12.12 and annex 10); and

.4 approve the draft amendments to the IGC Code (paragraph 12.11.4 and annex 11),

with a view to subsequent adoption for entry into force by 1 January 2024;

.14 note that the above amendments will have no impact on existing ships and, therefore, the Committees could apply them to all ships (paragraph 12.13);

.15 approve the biennial status report of the Sub-Committee (paragraph 13.4 and annex 12);

.16 approve the proposed provisional agenda for SDC 8 (paragraph 13.5 and annex 13);

.17 adopt the draft MSC resolution on Guidelines for safe access to tanker bows (resolution MSC.62(67)/Rev.1), taking into account the Sub-Committee's view that the proposed amendments could be treated as a minor correction in accordance with paragraph 3.2(vi) of document C/ES.27/D (paragraph 15.2 and annex 14);

.18 approve the draft amendments to the 1988 LL Protocol, taking into account the Sub-Committee's view that the proposed amendments could be treated as minor corrections in accordance with C/ES.27/D, paragraph 3.2(vi), with a view to subsequent adoption at MSC 103 (paragraph 15.4 and annex 15);

.19 note that the Sub-Committee considered the outdated references in the *Guidelines for wing-in-ground (WIG) craft* (MSC.1/Circ.1592) and invited interested Member States and international organizations to liaise with the Russian Federation in support of the submission of a new output proposal to the Committee, for a comprehensive analysis of the WIG Guidelines (paragraph 15.9); and

.20 approve the report in general.

16.2 The Marine Environment Protection Committee, at its seventy-sixth session, is invited to:

.1 approve the draft amendments to MARPOL Annex I with a view to adoption, subject to concurrent approval by MSC 102 (paragraph 12.11.1 and annex 8);

.2 approve the draft amendments to the IBC Code, with a view to subsequent adoption for entry into force by 1 January 2024 (paragraphs 12.11.3 and 12.12 and annex 10); and

.3 note that the above amendments will have no impact on existing ships and, therefore, the Committees could apply them to all ships (paragraph 12.13).

16.3 The Maritime Safety Committee, at its 103rd session, is invited to:

.1 approve the draft Guidelines for fishing vessels of 24 m in length and over operating in polar waters and the associated draft MSC circular, taking into account any comments on paragraph 11.5 from HTW 7 (paragraph 4.11 and annex 3);

.2 approve the draft Guidelines for pleasure yachts of 300 gross tonnage and above not engaged in trade operating in polar waters and the associated draft MSC circular (paragraph 4.15 and annex 4);

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ANNEX 1

DRAFT RESOLUTION MSC.429(98)/REV.1

REVISED EXPLANATORY NOTES TO THE SOLAS CHAPTER II-1 SUBDIVISION AND DAMAGE STABILITY REGULATIONS

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the function of the Committee,

RECALLING ALSO that, by resolution MSC.216(82), it adopted the regulations on subdivision and damage stability as contained in SOLAS chapter II-1 which are based on the probabilistic concept, using the probability of survival after collision as a measure of ships' safety in a damaged condition,

NOTING that, at its ~~the~~ eighty-second session, it approved Interim Explanatory Notes to the SOLAS chapter II-1 subdivision and damage stability regulations (MSC.1/Circ.1226), to assist Administrations in the uniform interpretation and application of the aforementioned subdivision and damage stability regulations,

NOTING ALSO that, at its ~~the~~ eighty-fifth session, it adopted the *Explanatory Notes to the SOLAS chapter II-1 subdivision and damage stability regulations* (resolution MSC.281(85)),

NOTING FURTHER that, by resolution MSC.421(98), it adopted amendments to regulations on subdivision and damage stability, as contained in SOLAS chapter II-1, and in conjunction with the adoption of the aforementioned amendments, adopted the Revised Explanatory Notes to the SOLAS chapter II-1 subdivision and damage stability regulations, by resolution MSC.429(98),

NOTING ~~FURTHER~~ that, by resolution [MSC...(102)], it adopted additional amendments to regulations on subdivision and damage stability, as contained in SOLAS chapter II-1,

RECOGNIZING that the consolidated Revised Explanatory Notes should be adopted in conjunction with the adoption of the aforementioned amendments to subdivision and damage stability regulations (resolution ~~MSC.421(98)~~ [MSC...(102)]),

RECOGNIZING ALSO that the appropriate application of the Revised Explanatory Notes is essential for ensuring the uniform application of the SOLAS chapter II-1 subdivision and damage stability regulations,

HAVING CONSIDERED, at its ~~ninety-eighth~~ [102nd] session, the recommendations made by the Sub-Committee on Ship Design and Construction, at its ~~fourth~~ seventh session,

1 ADOPTS the consolidated Revised Explanatory Notes to the SOLAS chapter II-1 subdivision and damage stability regulations set out in the annex to the present resolution;

2 URGES Contracting Governments and all parties concerned to utilize the consolidated Revised Explanatory Notes when applying the SOLAS chapter II-1 subdivision and damage stability regulations adopted by resolution MSC.216(82), as amended;

3 INVITES Contracting Governments to note that these consolidated Revised Explanatory Notes should ~~take effect on ships as defined in SOLAS regulation II-1/1.1.1, as adopted by resolution MSC.421(98)~~ take effect on [1 January 2024] and should apply to ships as defined in SOLAS regulation II-1/1.1.1.1;

4 REVOKES resolution MSC.429(98).

ANNEX

REVISED EXPLANATORY NOTES TO THE SOLAS CHAPTER II-1 SUBDIVISION AND DAMAGE STABILITY REGULATIONS

Contents

PART A

INTRODUCTION

1 The harmonized SOLAS regulations on subdivision and damage stability, as contained in SOLAS chapter II-1, are based on a probabilistic concept which uses the probability of survival after collision as a measure of ships' safety in a damaged condition. This probability is referred to as the "attained subdivision index *A*" in the regulations. It can be considered an objective measure of ships' safety and, ideally, there would be no need to supplement this index by any deterministic requirements.

2 The philosophy behind the probabilistic concept is that two different ships with the same attained index are of equal safety and, therefore, there is no need for special treatment of specific parts of the ship, even if they are able to survive different damages. The only areas which are given special attention in the regulations are the forward and bottom regions, which are dealt with by special subdivision rules provided for cases of ramming and grounding.

3 Only a few deterministic elements, which were necessary to make the concept practicable, have been included. It was also necessary to include a deterministic "minor damage" on top of the probabilistic regulations for passenger ships to avoid ships being designed with what might be perceived as unacceptably vulnerable spots in some part of their length.

4 It is easily recognized that there are many factors that will affect the final consequences of hull damage to a ship. These factors are random and their influence is different for ships with different characteristics. For example, it would seem obvious that in ships of similar size carrying different amounts of cargo, damages of similar extents may lead to different results because of differences in the range of permeability and draught during service. The mass and velocity of the ramming ship is obviously another random variable.

5 Owing to this, the effect of a three-dimensional damage to a ship with given watertight subdivision depends on the following circumstances:

.1 which particular space or group of adjacent spaces is flooded;

.2 the draught, trim and intact metacentric height at the time of damage;

.3 the permeability of affected spaces at the time of damage;

.4 the sea state at the time of damage; and

.5 other factors such as possible heeling moments owing to unsymmetrical weights.

6 Some of these circumstances are interdependent and the relationship between them and their effects may vary in different cases. Additionally, the effect of hull strength on penetration will obviously have some effect on the results for a given ship. Since the location and size of the damage is random, it is not possible to state which part of the ship becomes flooded. However, the probability of flooding a given space can be determined if the probability of occurrence of certain damages is known from experience, that is, damage statistics. The probability of flooding a space is then equal to the probability of occurrence of all such damages which just open the considered space to the sea.

7 For these reasons and because of mathematical complexity as well as insufficient data, it would not be practicable to make an exact or direct assessment of their effect on the probability that a particular ship will survive a random damage if it occurs. However, accepting some approximations or qualitative judgments, a logical treatment may be achieved by using the probability approach as the basis for a comparative method for the assessment and regulation of ship safety.

8 It may be demonstrated by means of probability theory that the probability of ship survival should be calculated as the sum of probabilities of its survival after flooding each single compartment, each group of two, three, etc., adjacent compartments multiplied, respectively, by the probabilities of occurrence of such damages leading to the flooding of the corresponding compartment or group of compartments.

9 If the probability of occurrence for each of the damage scenarios the ship could be subjected to is calculated and then combined with the probability of surviving each of these damages with the ship loaded in the most probable loading conditions, we can determine the attained index *A* as a measure for the ship's ability to sustain a collision damage.

10 It follows that the probability that a ship will remain afloat without sinking or capsizing as a result of an arbitrary collision in a given longitudinal position can be broken down to:

.1 the probability that the longitudinal centre of damage occurs in just the region of the ship under consideration;

.2 the probability that this damage has a longitudinal extent that only includes spaces between the transverse watertight bulkheads found in this region;

.3 the probability that the damage has a vertical extent that will flood only the spaces below a given horizontal boundary, such as a watertight deck;

.4 the probability that the damage has a transverse penetration not greater than the distance to a given longitudinal boundary; and

.5 the probability that the watertight integrity and the stability throughout the flooding sequence is sufficient to avoid capsizing or sinking.

11 The first three of these factors are solely dependent on the watertight arrangement of the ship, while the last two depend on the ship's shape. The last factor also depends on the actual loading condition. By grouping these probabilities, calculations of the probability of survival, or attained index *A*, have been formulated to include the following probabilities:

.1 the probability of flooding each single compartment and each possible group of two or more adjacent compartments; and

.2 the probability that the stability after flooding a compartment or a group of two or more adjacent compartments will be sufficient to prevent capsizing or dangerous heeling due to loss of stability or to heeling moments in intermediate or final stages of flooding.

12 This concept allows a rule requirement to be applied by requiring a minimum value of *A* for a particular ship. This minimum value is referred to as the "required subdivision index *R*" in the present regulations and can be made dependent on ship size, number of passengers or other factors legislators might consider important.

13 Evidence of compliance with the rules then simply becomes:

$$A \geq R$$

13.1 As explained above, the attained subdivision index *A* is determined by a formula for the entire probability as the sum of the products for each compartment or group of compartments of the probability that a space is flooded, multiplied by the probability that the ship will not capsize or sink due to flooding of the considered space. In other words, the general formula for the attained index can be given in the form:

$$A = \Sigma p_i s_i$$

13.2 Subscript "*i*" represents the damage zone (group of compartments) under consideration within the watertight subdivision of the ship. The subdivision is viewed in the longitudinal direction, starting with the aftmost zone/compartment.

13.3 The value of "p_i" represents the probability that only the zone "*i*" under consideration will be flooded, disregarding any horizontal subdivision, but taking transverse subdivision into account. Longitudinal subdivision within the zone will result in additional flooding scenarios, each with its own probability of occurrence.

13.4 The value of "s_i" represents the probability of survival after flooding the zone "*i*" under consideration.

14 Although the ideas outlined above are very simple, their practical application in an exact manner would give rise to several difficulties if a mathematically perfect method was to be developed. As pointed out above, an extensive but still incomplete description of the damage will include its longitudinal and vertical location as well as its longitudinal, vertical and transverse extent. Apart from the difficulties in handling such a five-dimensional random variable, it is impossible to determine its probability distribution very accurately with the presently available damage statistics. Similar limitations are true for the variables and physical relationships involved in the calculation of the probability that a ship will not capsize or sink during intermediate stages or in the final stage of flooding.

15 A close approximation of the available statistics would result in extremely numerous and complicated computations. In order to make the concept practicable, extensive simplifications are necessary. Although it is not possible to calculate the exact probability of survival on such a simplified basis, it has still been possible to develop a useful comparative measure of the merits of the longitudinal, transverse and horizontal subdivision of a ship.

PART B

GUIDANCE ON INDIVIDUAL SOLAS CHAPTER II-1 SUBDIVISION AND DAMAGE STABILITY REGULATIONS

REGULATION 1 – APPLICATION

Regulation 1.3

1 If a passenger ship built before 1 January 2009 undergoes alterations or modifications of major character, it may still remain under the damage stability regulations applicable to ships built before 1 January 2009.

2 If a passenger ship constructed on or after 1 January 2009 but before the applicable dates in regulation 1.1.1.1* undergoes alterations or modifications of major character that don't impact the watertight subdivision of the ship, or only have a minor impact, it may still remain under the damage stability regulations that were applicable when it was constructed. However, if alterations or modifications of major character significantly impact the watertight subdivision of the ship, it should comply with the damage stability regulations in part B-1 applicable when the alterations or modifications of major character are carried out unless the Administration determines that this is not reasonable and practicable, in which case the attained subdivision index *A* should be raised above the original construction required subdivision index *R* as much as practical.

3 Application of MSC.1/Circ.1246 is limited to cargo ships constructed before 1 January 2009.

4 A cargo ship constructed on or after 1 January 2009 of less than 80 m in length that is later lengthened beyond that limit should fully comply with the damage stability regulations according to its type and length.

5 If a passenger ship that has been in domestic service only and never issued a SOLAS Passenger Ship Safety Certificate is converted to international service, for purposes of the stability requirements in parts B, B-1, B-2, B-3 and B-4 it should be treated as a passenger ship constructed on the date on which such a conversion commences.

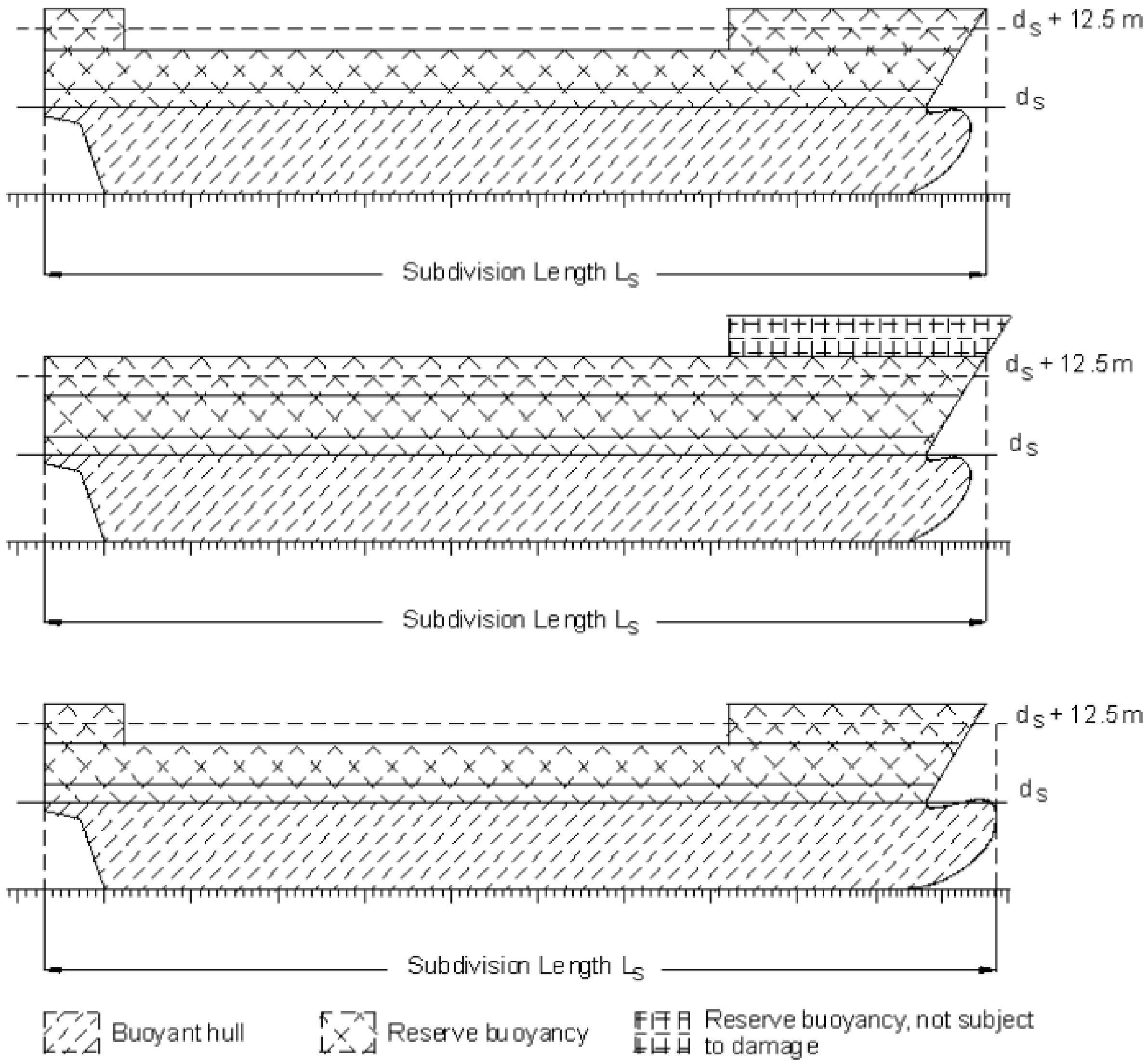
REGULATION 2 – DEFINITIONS

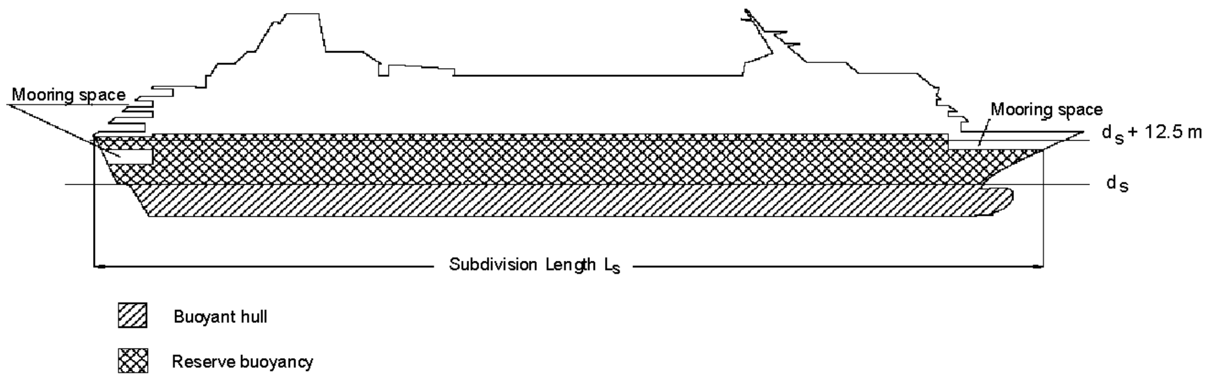
Regulation 2.1

Subdivision length (L_s) – Different examples of L_s showing the buoyant hull and the reserve buoyancy are provided in the figures below. The limiting deck for the reserve buoyancy may be partially watertight.

The maximum possible vertical extent of damage above the baseline is d_s + 12.5 metres.

* References to regulations in this guidance are to regulations of SOLAS chapter II-1, unless expressly provided otherwise.





Regulation 2.6

Freeboard deck – See explanatory notes for regulation 13-1 for the treatment of a stepped freeboard deck with regard to watertightness and construction requirements.

Regulation 2.11

Light service draught (d_l) – The light service draught (d_l) corresponds, in general, to the ballast arrival condition with 10% consumables for cargo ships. For passenger ships it corresponds, in general, to the arrival condition with 10% consumables, a full complement of passengers and crew and their effects, and ballast as necessary for stability and trim. Any temporary ballast water exchange conditions for compliance with the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 or any non-service conditions, such as dry-docking, should not be taken as d_l.

Regulation 2.19

Bulkhead deck – See explanatory notes for regulation 13 for the treatment of a stepped bulkhead deck with regard to watertightness and construction requirements.

REGULATION 4 – GENERAL

Regulation 4.5

See explanatory notes for regulation 7-2.2, for information and guidance related to these provisions.

REGULATION 5 – INTACT STABILITY

Regulation 5.2

1 For the purpose of this regulation, a sister ship means a cargo ship built by the same shipyard from the same plans.

2 For any new sister ship with known differences from the lead sister ship that do not exceed the lightship displacement and longitudinal centre of gravity deviation limits specified in regulation 5.2, a detailed weights and centres of gravity calculation to adjust the lead sister ship's lightship properties should be carried out. These adjusted lead sister ship lightship properties are then used for comparison to the new sister ship's lightweight survey results. However, in cases when the known differences from the lead sister ship exceed lightship displacement or longitudinal centre of gravity deviation limits specified in regulation 5.2, the ship should be inclined.

3 When the lightweight survey results do not exceed the specified deviation limits, the lightship displacement and the longitudinal and transverse centres of gravity obtained from the lightweight survey should be used in conjunction with the higher of either the lead sister ship's vertical centre of gravity or the calculated, adjusted value.

4 Regulation 5.2 may be applied to the SPS Code ships certified to carry less than 240 persons.

Regulation 5.4

1 When alterations are made to a ship in service that result in calculable differences in the lightship properties, a detailed weights and centres of gravity calculation to adjust the lightship properties should be carried out. If the adjusted lightship displacement or longitudinal centre of gravity, when compared to the approved values, exceeds one of the deviation limits specified in regulation 5.5, the ship should be re-inclined. In addition, if the adjusted lightship vertical centre of gravity, when compared to the approved value,

exceeds 1%, the ship should be re-inclined. The lightship transverse centre of gravity is not subject to a deviation limit.

2 When a ship does not exceed the deviation limits specified in explanatory note 1 above, amended stability information should be provided to the master using the new calculated lightship properties if any of the following deviations from the approved values are exceeded:

.1 1% of the lightship displacement; or

.2 0.5% of L for the longitudinal centre of gravity; or

.3 0.5% of the vertical centre of gravity.

However, in cases when these deviation limits are not exceeded, it is not necessary to amend the stability information supplied to the master.

3 When multiple alterations are made to a ship in service over a period of time and each alternation is within the deviation limits specified above, the cumulative total changes to the lightship properties from the most recent inclining also should not exceed the deviation limits specified above or the ship should be re-inclined.

Regulation 5.5

When the lightweight survey results do not exceed the specified deviation limits, the lightship displacement and the longitudinal and transverse centres of gravity obtained from the lightweight survey should be used in conjunction with the vertical centre of gravity derived from the most recent inclining in all subsequent stability information supplied to the master.

REGULATION 5-1 – STABILITY INFORMATION TO BE SUPPLIED TO THE MASTER

Regulation 5-1.3

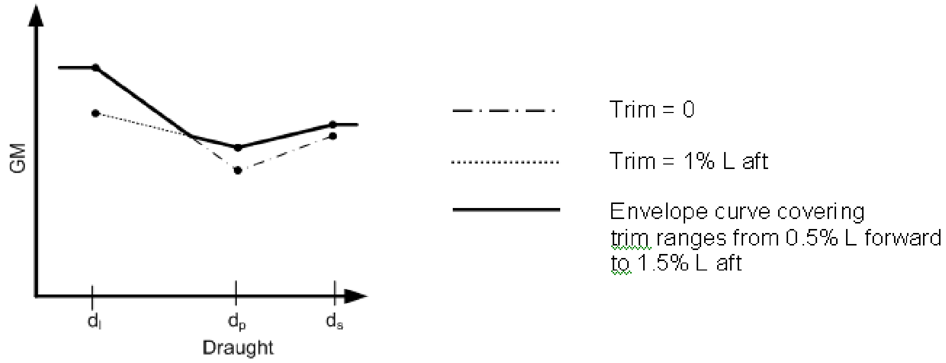
The requirement that applied trim values shall coincide in all stability information intended for use on board, is intended to address initial stability calculations as well as those that may be necessary during the service life of the ship.

Regulation 5-1.4 (see also regulation 7.2)

1 Linear interpolation of the limiting values between the draughts d_s, d_p and d_l is only applicable to minimum *GM* values. If it is intended to develop curves of maximum permissible *KG*, a sufficient number of KM_T values for intermediate draughts should be calculated to ensure that the resulting maximum *KG* curves correspond with a linear variation of *GM*. When light service draught is not with the same trim as other draughts, KM_T for draughts between partial and light service draught should be calculated for trims interpolated between trim at partial draught and trim at light service draught.

2 In cases where the operational trim range is intended to exceed ±0.5% of *L*, the original *GM* limit line should be designed in the usual manner with the deepest subdivision draught and partial subdivision draught calculated at level trim and estimated service trim used for the light service draught. Then additional sets of *GM* limit lines should be constructed on the basis of the operational range of trims which is covered by loading conditions for each of the three draughts d_s, d_p and d_l ensuring that intervals of 1% *L* are not exceeded. The sets of *GM* limit lines are combined to give a single envelope limiting *GM* curve. The effective trim range of the curve should be clearly stated.

3 If multiple *GM* limiting curves are obtained from damage stability calculations of differing trims in accordance with regulation 7, an envelope curve covering all calculated trim values should be developed. Calculations covering different trim values should be carried out in steps not exceeding 1% of *L*. The whole range including intermediate trims should be covered by the damage stability calculations. Refer to the example showing an envelope curve obtained from calculations of 0 trim and 1% of *L*.

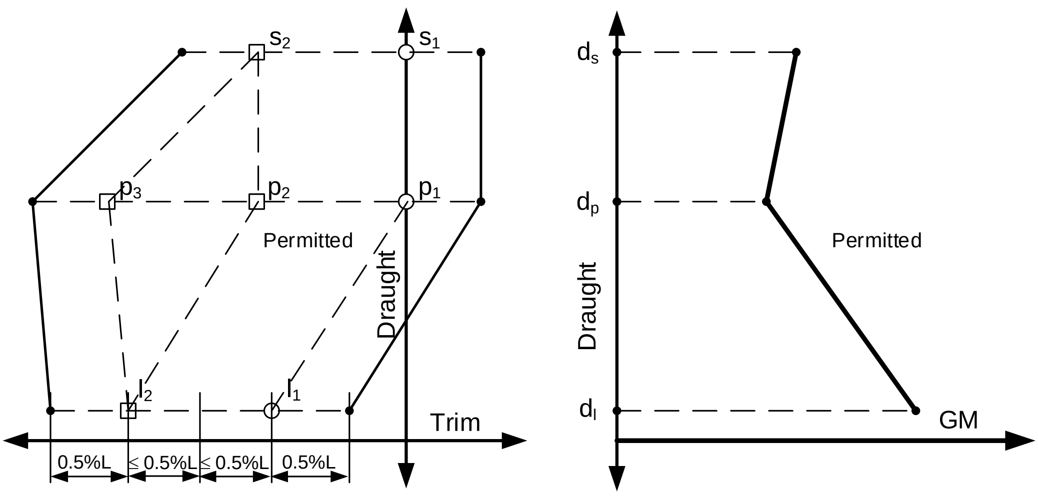


4 Temporary loading conditions may occur with a draught less than the light service draught d_l due to ballast water exchange requirements, etc. In these cases, for draughts below d_l, the *GM* limit value at d_l is to be used.

5 Ships may be permitted to sail at draughts above the deepest subdivision draught d_s according to the International Convention on Load Lines, e.g. using the tropical freeboard. In these cases, for draughts above d_s the *GM* limit value at d_s is to be used.

Regulation 5-1.5

There could be cases where it is desirable to expand the trim range, for instance around d_p. This approach is based on the principle that it is not necessary that the same number of trims be used when the *GM* is the same throughout a draught and when the steps between trims do not exceed 1% of *L*. In these cases there will be three *A* values based on draughts s_1, p_1, l_1 and s_2, p_2, l_2 and s_2, p_3, l_2. The lowest value of each partial index A_s, A_p and A_l across these trims should be used in the summation of the attained subdivision index *A*.



Trim limit diagram **GM limit curve**

Regulation 5-1.6

This provision is intended to address cases where an Administration approves an alternative means of verification.

REGULATION 6 – REQUIRED SUBDIVISION INDEX *R*

Regulation 6.1

To demonstrate compliance with these provisions, see the Guidelines for the preparation of subdivision and damage stability calculations, set out in the appendix, regarding the presentation of damage stability calculation results.

REGULATION 7 – ATTAINED SUBDIVISION INDEX *A*

Regulation 7.1

1 The probability of surviving after collision damage to the ship's hull is expressed by the index *A*. Producing an index *A* requires calculation of various damage scenarios defined by the extent of damage and the initial loading conditions of the ship before damage. Three loading conditions should be considered and the result weighted as follows:

$$A = 0.4A_s + 0.4A_p + 0.2A_l$$

where the indices *s*, *p* and *l* represent the three loading conditions and the factor to be multiplied to the index indicates how the index *A* from each loading condition is weighted.

2 The method of calculating *A* for a loading condition is expressed by the formula:

$$A_c = \sum_{i=1}^{i=t} p_i [v_i s_i]$$

2.1 The index *c* represents one of the three loading conditions, the index *i* represents each investigated damage or group of damages and *t* is the number of damages to be investigated to calculate A_c for the particular loading condition.

2.2 To obtain a maximum index *A* for a given subdivision, *t* has to be equal to *T*, the total number of damages.

3 In practice, the damage combinations to be considered are limited either by significantly reduced contributions to *A* (i.e. flooding of substantially larger volumes) or by exceeding the maximum possible damage length.

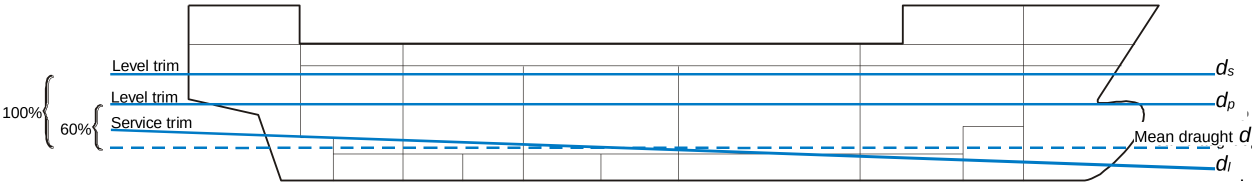
4 The index *A* is divided into partial factors as follows:

p_i The *p* factor is solely dependent on the geometry of the watertight arrangement of the ship.

v_i The *v* factor is dependent on the geometry of the watertight arrangement (decks) of the ship and the draught of the initial loading condition. It represents the probability that the spaces above the horizontal subdivision will not be flooded.

s_i The s factor is dependent on the calculated survivability of the ship after the considered damage for a specific initial condition.

5 Three initial loading conditions should be used for calculating each index *A.* The loading conditions are defined by their mean draught *d,* trim and *GM (*or *KG).* The mean draught and trim are illustrated in the figure below.



6 The *GM* (or *KG*) values for the three loading conditions could, as a first attempt, be taken from the intact stability *GM* (or *KG*) limit curve. If the required index *R* is not obtained, the *GM* (or *KG*) values may be increased (or reduced), implying that the intact loading conditions from the intact stability book must now meet the *GM* (or *KG*) limit curve from the damage stability calculations derived by linear interpolation between the three *GM*s.

7 For a series of new passenger or cargo ships built from the same plans each of which have the same draughts d_s, d_p and d_l as well as the same *GM* and trim limits, the attained subdivision index *A* calculated for the lead ship may be used for the other ships. In addition, small differences in the draught d_l (and the subsequent change in the draught d_p) are acceptable if they are due to small differences in the lightship characteristics that do not exceed the deviation limits specified in regulation 5.2. For cases where these conditions are not met, a new attained subdivision index *A* should be calculated.

"Built from the same plans" means that the watertight and weathertight aspects of the hull, bulkheads, decks, openings and other parts of a ship that impact the attained subdivision index *A* calculation remain exactly the same.

8 For a passenger or cargo ship in service which undergoes alterations that materially affect the stability information supplied to the master and require it to be re-inclined in accordance with regulation 5.4, a new attained subdivision index *A* should be calculated. However, for alteration cases where a re-inclining is not required and the alterations do not change the watertight and weathertight arrangements of the ship that impact the attained subdivision index *A*, if d_s and the *GM* and trim limits remain the same then a new attained subdivision index *A* is not required.

9 For passenger ships subject to lightweight surveys every 5 years, if the lightweight survey results are within the limits specified in regulation 5.5, and d_s and the *GM* and trim limits remain the same, a new attained subdivision index *A* is not required. However, if the lightweight survey results exceed either limit specified in regulation 5.5, a new attained subdivision index *A* should be calculated.

10 For any new passenger or cargo ship for which the deviation in lightship characteristics between the preliminary and the as built values are within the limits specified in regulation 5.2 and d_s is unchanged, then the preliminary attained subdivision index *A* calculation may be approved as the final attained subdivision index *A* calculation. However, for cases where these conditions are not met, then a new attained subdivision index *A* should be calculated.

Regulation 7.2

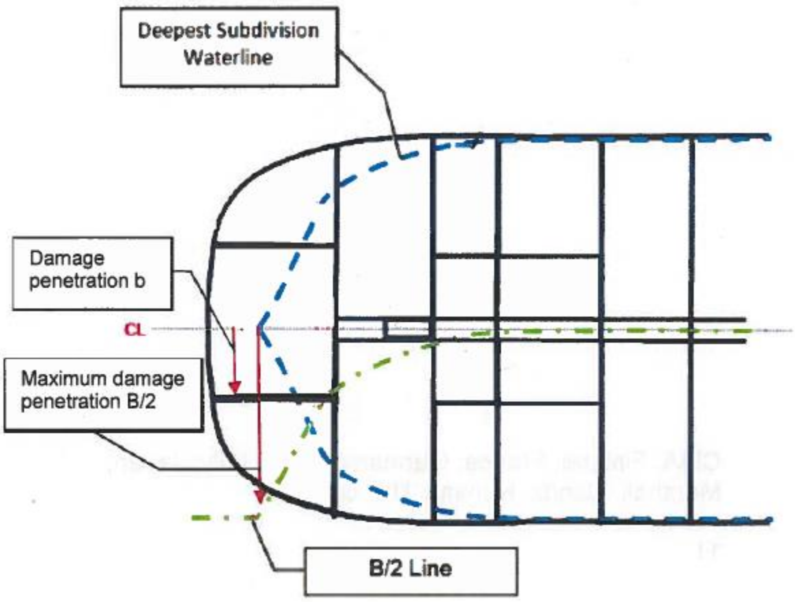
When additional calculations of *A* are performed for different trims, for a given set of calculations the difference between trim values for d_s, d_p and d_l may not exceed 1% *L*.

Regulation 7.5

1 With the same intent as wing tanks, the summation of the attained index *A* should reflect effects caused by all watertight bulkheads and flooding boundaries within the damaged zone. It is not correct to assume damage only to one half of the ship's breadth *B* and ignore changes in subdivision that would reflect lesser contributions.

2 In the forward and aft ends of the ship where the sectional breadth is less than the ship's breadth *B*, transverse damage penetration can extend beyond the centreline bulkhead. This application of the transverse extent of damage is consistent with the methodology to account for the localized statistics which are normalized on the greatest moulded breadth *B* rather than the local breadth.

3 Where, at the extreme ends of the ship, the subdivision exceeds the waterline at the deepest subdivision draught, the damage penetration *b* or *B*/2 is to be taken from centre line. The figure below illustrates the shape of the *B*/2 line.



4 Where longitudinal corrugated bulkheads are fitted in wing compartments or on the centreline, they may be treated as equivalent plane bulkheads provided the corrugation depth is of the same order as the stiffening structure. The same principle may also be applied to transverse corrugated bulkheads.

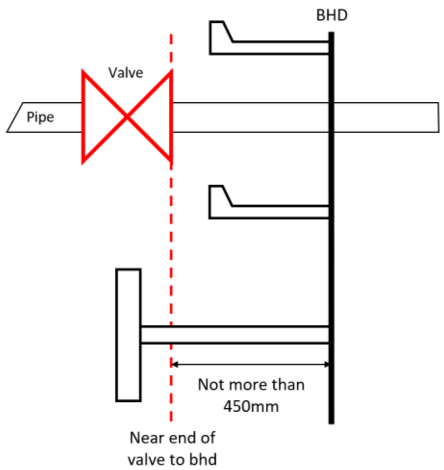
Regulation 7.6

Refer to the explanatory notes for regulation 7-2.2 for the treatment of free surfaces during all stages of flooding.

Regulation 7.7

1 *This explanatory note only applies to ships for which the building contract is placed on or after 1 January 2020 and which are constructed before 1 January 2024.* Pipes and valves directly adjacent or situated as close as practicable to a bulkhead or to a deck can be considered to be part of the bulkhead or deck, provided the separation distance on either side of the bulkhead or deck is of the same order as the bulkhead or deck stiffening structure. The same applies for small recesses, drain wells, etc.

2 *This explanatory note only applies to ships constructed on or after 1 January 2024.* Pipes and valves directly adjacent or situated as close as practicable to a bulkhead or to a deck can be considered to be part of the bulkhead or deck, provided the separation distance on either side of the bulkhead or deck is of the same order as the bulkhead or deck stiffening structure. The same applies for small recesses, drain wells, etc. In no case should the separation distance on either side of the bulkhead or deck be more than 450 mm measured from the valve's near end to the bulkhead or deck.



~~2~~3 For ships up to L = 150 m the provision for allowing "minor progressive flooding" should be limited to pipes penetrating a watertight subdivision with a total cross-sectional area of not more than 710 mm^2 between any two watertight compartments. For ships of L = 150 m and upwards the total cross-sectional area of pipes should not exceed the cross-sectional area of one pipe with a diameter of L/5000 m.

REGULATION 7-1 – CALCULATION OF THE FACTOR p_i

General

1 The definitions below are intended to be used for the application of part B-1 only.

2 In regulation 7-1, the words "compartment" and "group of compartments" should be understood to mean "zone" and "adjacent zones".

3 Zone – a longitudinal interval of the ship within the subdivision length.

4 Room – a part of the ship, limited by bulkheads and decks, having a specific permeability.

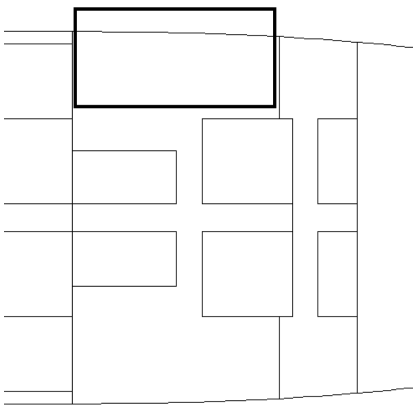
5 Space – a combination of rooms.

6 Compartment – a space within watertight boundaries.

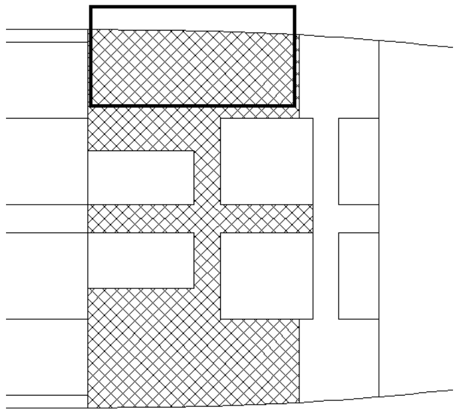
7 Damage – the three-dimensional extent of the breach in the ship.

8 For the calculation of *p*, *v*, *r* and *b* only the damage should be considered, for the calculation of the *s*-value the flooded space should be considered. The figures below illustrate the difference.

Damage shown as the bold square:



Flooded space shown below:



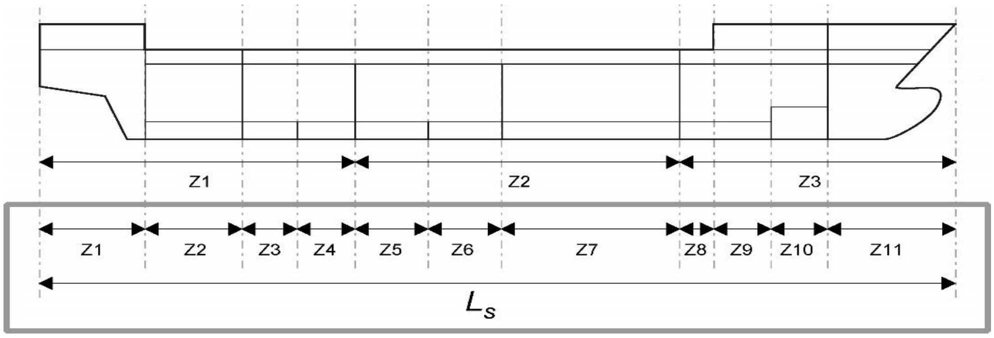
Regulation 7-1.1.1

1 The coefficients b_{11}, b_{12}, b_{21} and b_{22} are coefficients in the bi-linear probability density function on normalized damage length (J). The coefficient b_{12} is dependent on whether L_s is greater or less than L^* (i.e. 260 m); the other coefficients are valid irrespective of L_s.

Longitudinal subdivision

2 In order to prepare for the calculation of index A, the ship's subdivision length L_s is divided into a fixed discrete number of damage zones. These damage zones will determine the damage stability investigation in the way of specific damages to be calculated.

3 There are no specific rules for longitudinally subdividing the ship, except that the length L_s defines the extremities of the zones. Zone boundaries need not coincide with physical watertight boundaries. However, it is important to consider a strategy carefully to obtain a good result (that is a large attained index A). All zones and combination of adjacent zones may contribute to the index A. In general it is expected that the more zone boundaries the ship is divided into the higher will be the attained index, but this benefit should be balanced against extra computing time. The figure below shows different longitudinal zone divisions of the length L_s.



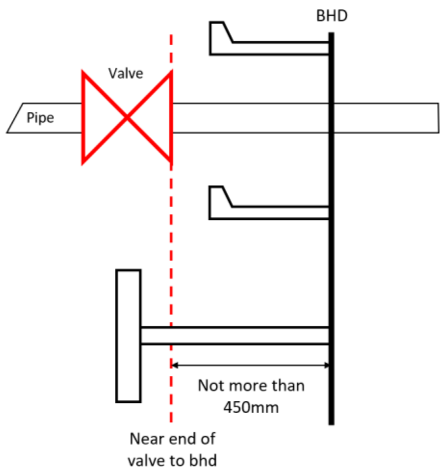
4 The first example is a very rough division into three zones of approximately the same size with limits where longitudinal subdivision is established. The probability that the ship will survive a damage in one of the three zones is expected to be low (i.e. the *s*-factor is low or zero) and, therefore, the total attained index *A* will be correspondingly low.

5 In the second example the zones have been placed in accordance with the watertight arrangement, including minor subdivision (as in double bottom, etc.). In this case there is a much better chance of obtaining higher *s*-factors.

6 Where transverse corrugated bulkheads are fitted, they may be treated as equivalent plane bulkheads, provided the corrugation depth is of the same order as the stiffening structure.

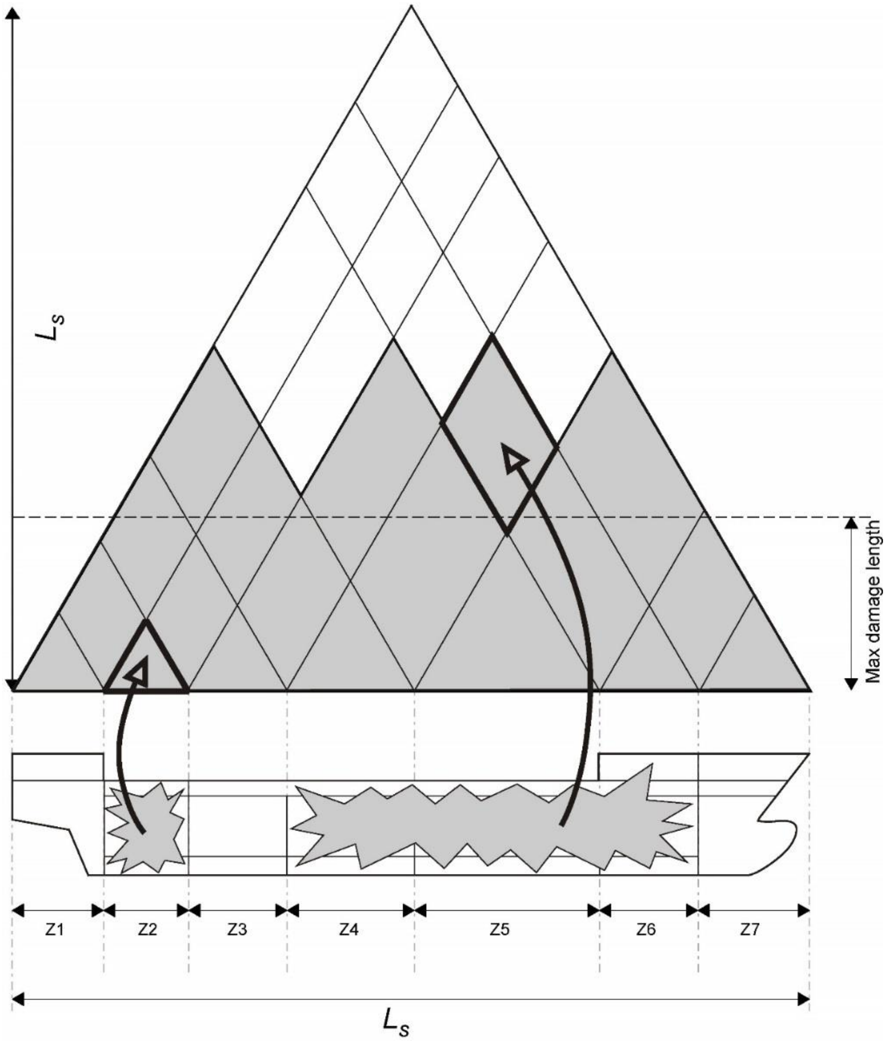
7 *This explanatory note only applies to ships for which the building contract is placed on or after 1 January 2020 and which are constructed before 1 January 2024.* Pipes and valves directly adjacent or situated as close as practicable to a transverse bulkhead can be considered to be part of the bulkhead, provided the separation distance on either side of the bulkhead is of the same order as the bulkhead stiffening structure. The same applies for small recesses, drain wells, etc.

8 *This explanatory note only applies to ships constructed on or after 1 January 2024.* Pipes and valves directly adjacent or situated as close as practicable to a transverse bulkhead can be considered to be part of the bulkhead, provided the separation distance on either side of the bulkhead is of the same order as the bulkhead stiffening structure. The same applies for small recesses, drain wells, etc. In no case should the separation distance on either side of the bulkhead or deck be more than 450 mm measured from the valve's near end to the bulkhead or deck.



~~8~~9 For cases where the pipes and valves cannot be considered as being part of the transverse bulkhead, when they present a risk of progressive flooding to other watertight compartments that will have influence on the overall attained index *A*, they should be handled either by introducing a new damage zone and accounting for the progressive flooding to associated compartments or by introducing a gap.

~~9~~10 The triangle in the figure below illustrates the possible single and multiple zone damages in a ship with a watertight arrangement suitable for a seven-zone division. The triangles at the bottom line indicate single zone damages and the parallelograms indicate adjacent zones damages.



~~10~~11 As an example, the triangle illustrates a damage opening the rooms in zone 2 to the sea and the parallelogram illustrates a damage where rooms in the zones 4, 5 and 6 are flooded simultaneously.

~~11~~12 The shaded area illustrates the effect of the maximum absolute damage length. The *p*-factor for a combination of three or more adjacent zones equals zero if the length of the combined adjacent damage zones minus the length of the foremost and the aft most damage zones in the combined damage zone is greater than the maximum damage length. Having this in mind when subdividing L_s could limit the number of zones defined to maximize the attained index *A*.

~~12~~13 As the *p*-factor is related to the watertight arrangement by the longitudinal limits of damage zones and the transverse distance from the ship side to any longitudinal barrier in the zone, the following indices are introduced:

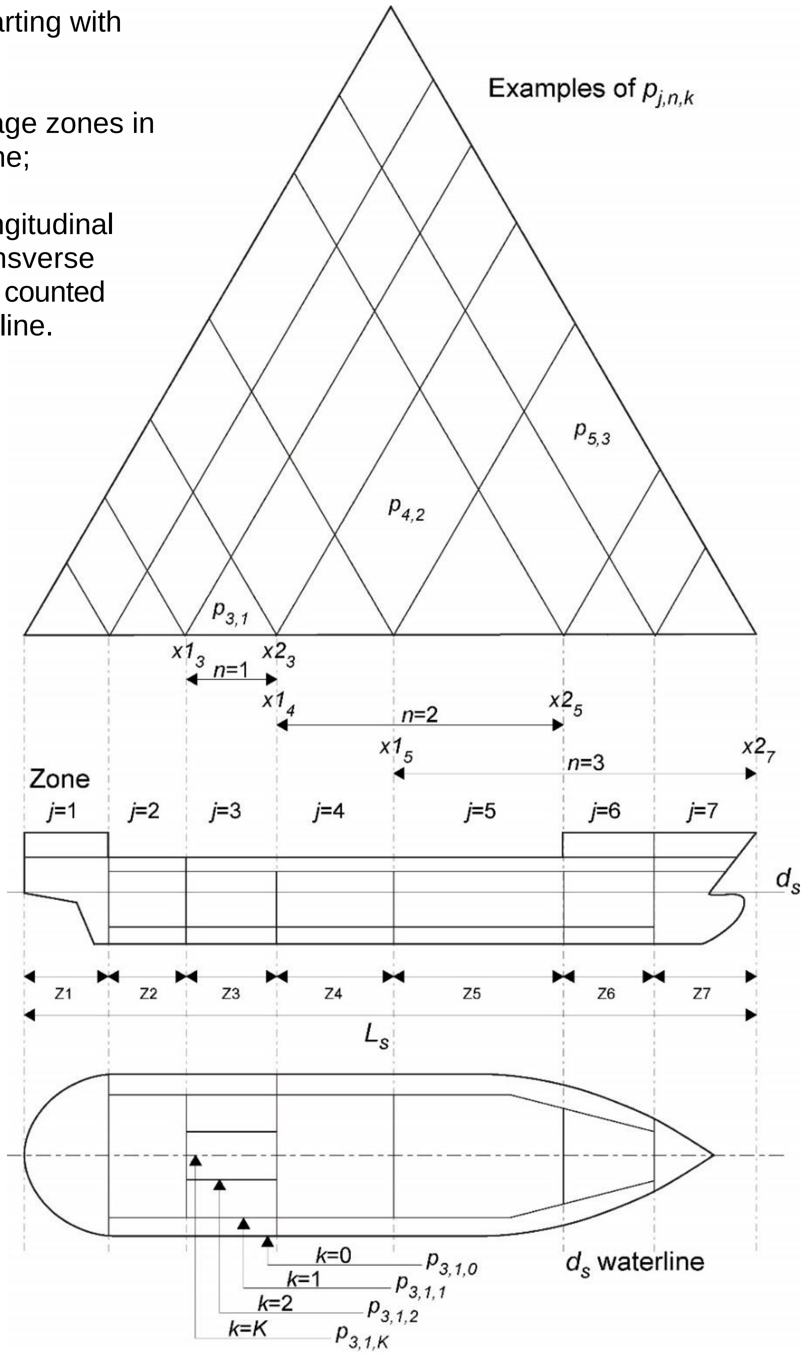
j: the damage zone number starting with No.1 at the stern;

n: the number of adjacent damage zones in question where j is the aft zone;

k: the number of a particular longitudinal bulkhead as a barrier for transverse penetration in a damage zone counted from shell towards the centreline. The shell has No.0;

K: total number of transverse penetration boundaries;

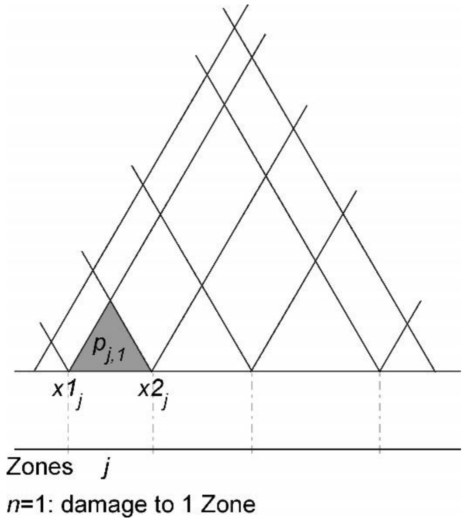
$p_{j,n,k}$: the p-factor for a damage in zone j and next (n-1) zones forward of j damaged to the longitudinal bulkhead k.



Pure longitudinal subdivision

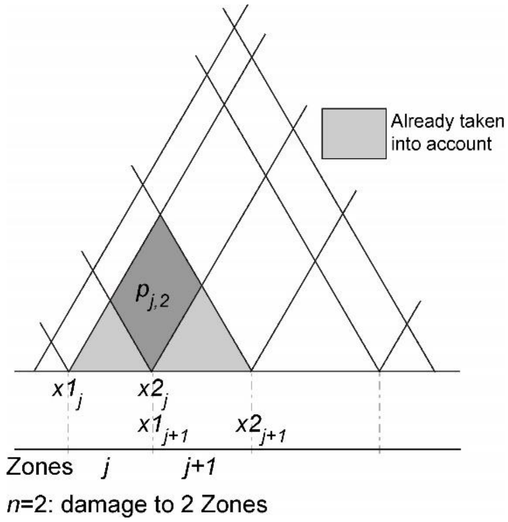
Single damage zone, pure longitudinal subdivision:

$p_{j,1} = p(x1_j,x2_j)$



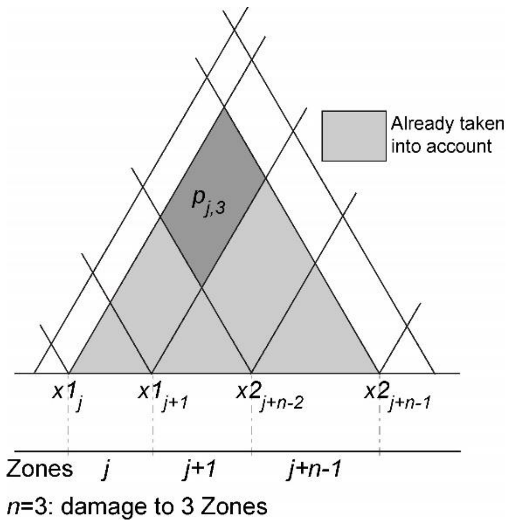
Two adjacent zones, pure longitudinal subdivision:

$p_{j,2} = p(x1_j,x2_{j+1}) - p(x1_j,x2_j) - p(x1_{j+1},x2_{j+1})$



Three or more adjacent zones, pure longitudinal subdivision:

$p_{j,n} = p(x1_j,x2_{j+n-1}) - p(x1_j,x2_{j+n-2}) - p(x1_{j+1},x2_{j+n-1}) + p(x1_{j+1},x2_{j+n-2})$



Regulation 7-1.1.2

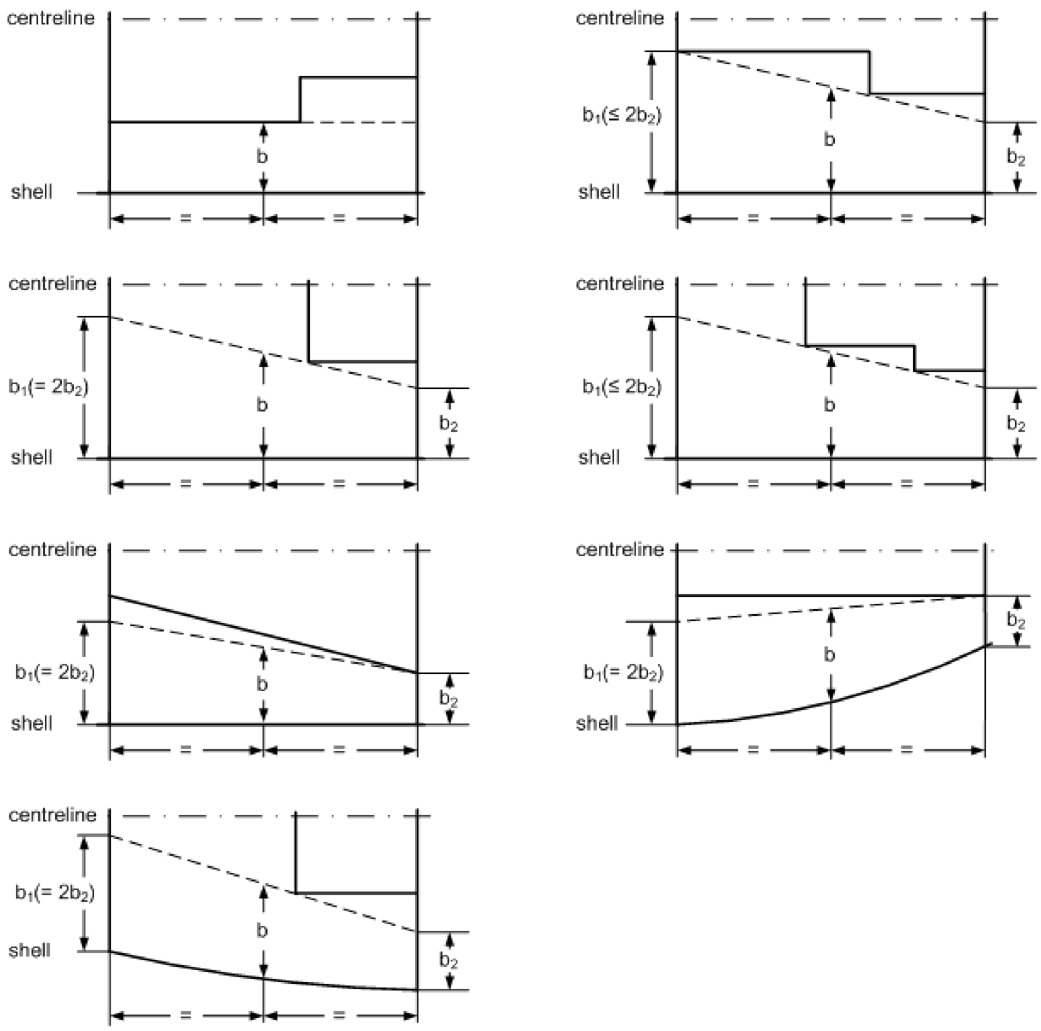
Transverse subdivision in a damage zone

1 Damage to the hull in a specific damage zone may just penetrate the ship's watertight hull or penetrate further towards the centreline. To describe the probability of penetrating only a wing compartment, a probability factor *r* is used, based mainly on the penetration depth *b*. The value of *r* is equal to 1, if the penetration depth is *B/2* where *B* is the maximum breadth of the ship at the deepest subdivision draught d_s, and *r* = 0 if *b* = 0.

2 The penetration depth *b* is measured at level deepest subdivision draught d_s as a transverse distance from the ship side right-angled to the centreline to a longitudinal barrier.

3 Where the actual watertight bulkhead is not a plane parallel to the shell, *b* should be determined by means of an assumed line, dividing the zone to the shell in a relationship b_1/b_2 with $1/2 \le b_1/b_2 \le 2$.

4 Examples of such assumed division lines are illustrated in the figure below. Each sketch represents a single damage zone at a water line plane level d_s and the longitudinal bulkhead represents the outermost bulkhead position below d_s + 12.5 m.



4.1 If a transverse subdivision intercepts the deepest subdivision draught waterline within the extent of the zone, *b* is equal to zero in that zone for that transverse subdivision, see figure 1. A non-zero *b* can be obtained by including an additional zone, see figure 2.

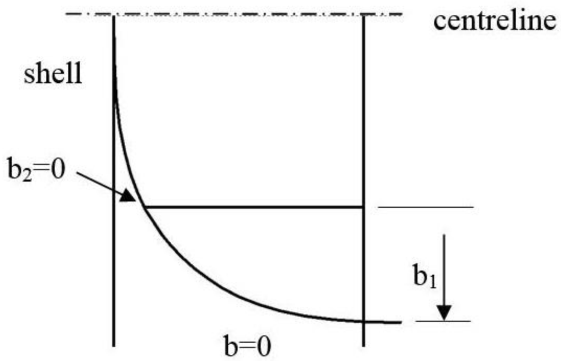


Figure 1

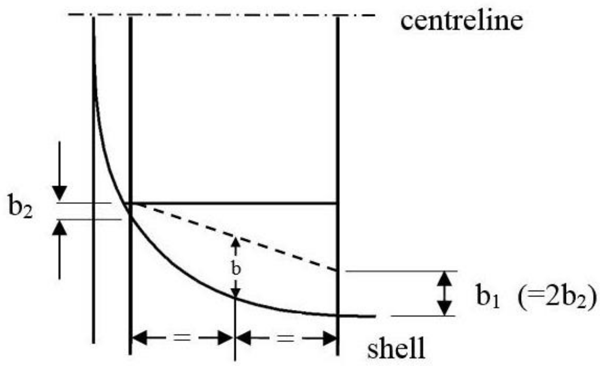


Figure 2

4.2 If the deepest subdivision draught waterline on the side of a single hull ship includes a part where multiple transverse (y) coordinates occur for a longitudinal (x) location, a straightened reference waterline can be used for the calculation of *b*. If this approach is chosen, the original waterline is replaced by an envelope curve including straight parts perpendicular to the centreline where multiple transverse coordinates occur, see figures 1 to 4. The maximum transverse damage extent *B/2* should then be calculated from waterline or the reference waterline, if applicable, at the deepest subdivision draught.

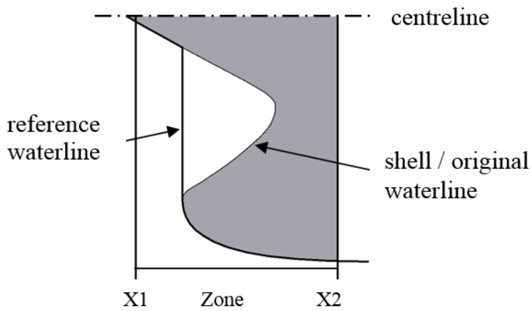


Figure 1

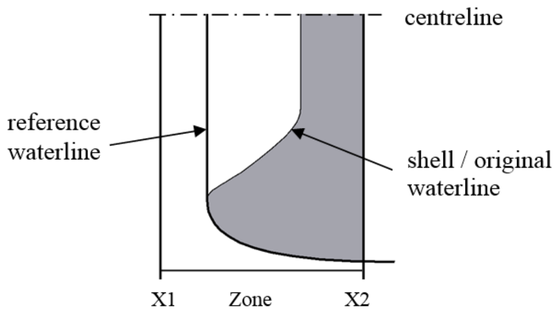


Figure 2

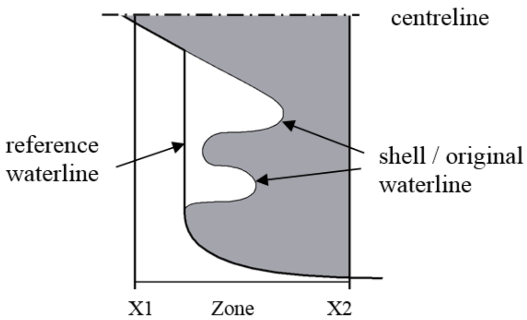


Figure 3

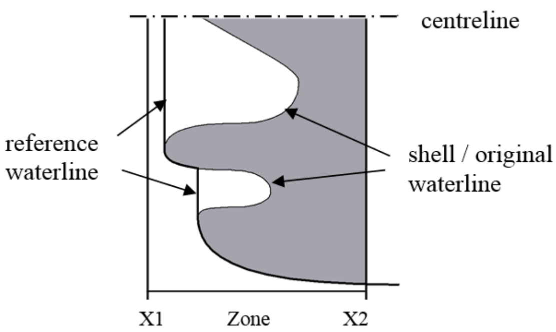


Figure 4

5 In calculating *r*-values for a group of two or more adjacent compartments, the *b*-value is common for all compartments in that group, and equal to the smallest *b*-value in that group:

$$b = \min\{b_1, b_2, \ldots, b_n\}$$

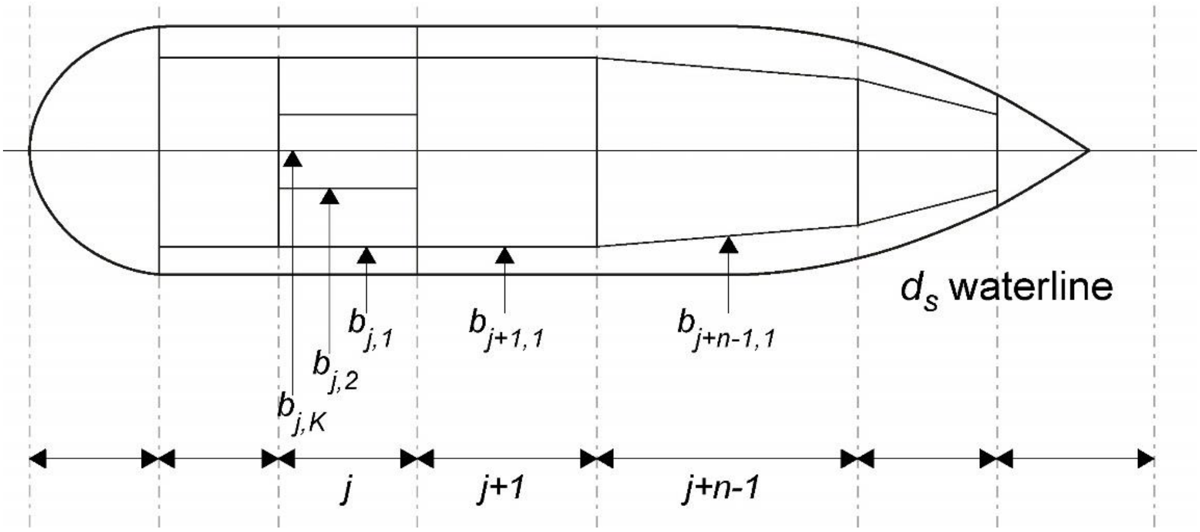
where: $n =$ number of wing compartments in that group;
$b_1, b_2, \ldots, b_n =$ mean values of *b* for individual wing compartments contained in the group.

Accumulating p

6 The accumulated value of *p* for one zone or a group of adjacent zones is determined by:

$$p_{j,n} = \sum_{k=1}^{k=K_{j,n}} p_{j,n,k}$$

where $K_{j,n} = \sum_{j}^{j+n-1} K_j$ the total number of b_k's for the adjacent zones in question.



7 The figure above illustrates *b*'s for adjacent zones. The zone *j* has two penetration limits and one to the centre, the zone *j+1* has one *b* and the zone *j+n-1* has one value for *b*. The multiple zones will have (2+1+1) four values of *b*, and sorted in increasing order they are:

$(b_{j,1} ; b_{j+1,1} ; b_{j+n-1,1} ; b_{j,2} ; b_K)$

8 Because of the expression for *r(x1, x2, b)* only one b_K should be considered. To minimize the number of calculations, *b*'s of the same value may be deleted.

As $b_{j,1} = b_{j+1,1}$ the final *b*'s will be $(b_{j,1} ; b_{j+n-1,1} ; b_{j,2} ; b_K)$

Examples of multiple zones having a different b

9 Examples of combined damage zones and damage definitions are given in the figures below. Compartments are identified by R10, R12, etc.

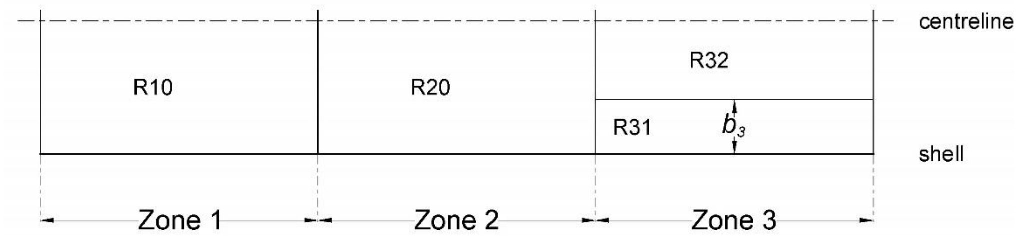


Figure: Combined damage of zones 1 + 2 + 3 includes a limited penetration to b_3, taken into account generating two damages:

1) to b_3 with R10, R20 and R31 damaged;
2) to *B/2* with R10, R20, R31 and R32 damaged.

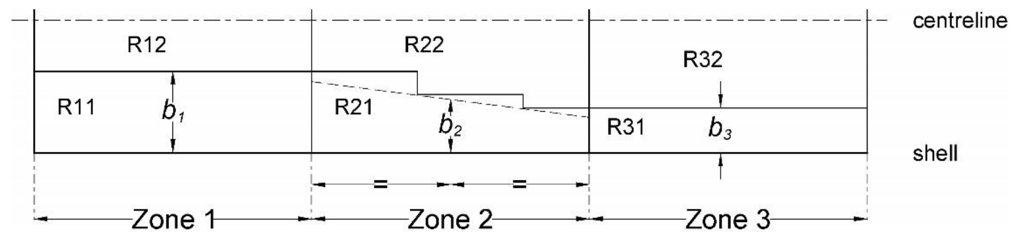


Figure: Combined damage of zones 1 + 2 + 3 includes 3 different limited damage penetrations generating four damages:

1) to b_3 with R11, R21 and R31 damaged;
2) to b_2 with R11, R21, R31 and R32 damaged;
3) to b_1 with R11, R21, R31, R32, and R22 damaged;
4) to *B/2* with R11, R21, R31, R32, R22 and R12 damaged.

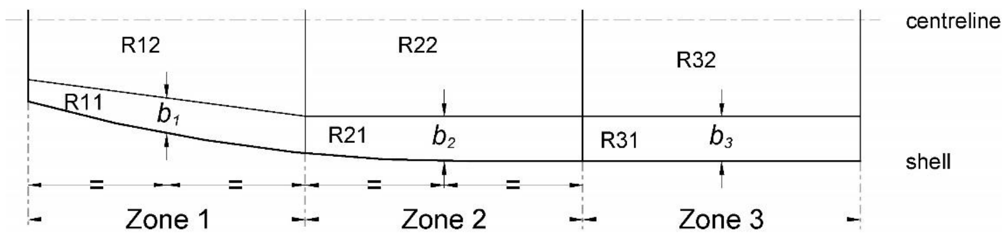
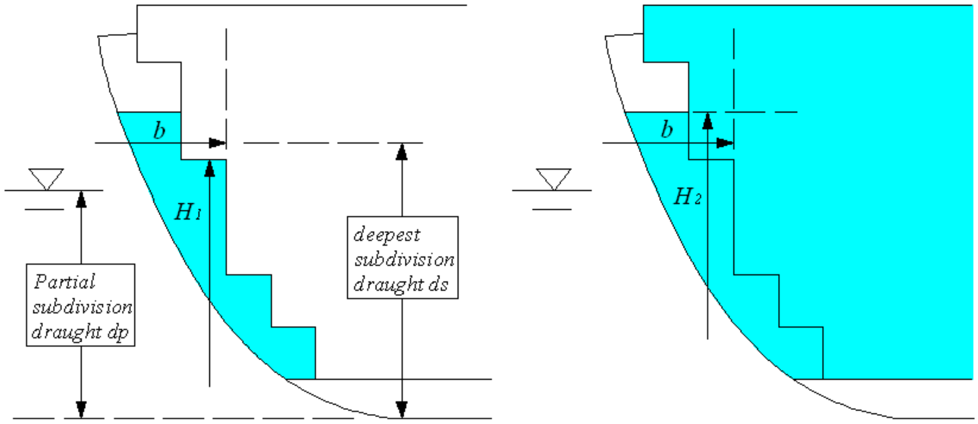


Figure: Combined damage of zone 1 + 2 + 3 including 2 different limited damage penetrations ($b_1 < b_2 = b_3$) generating three damages:

1) to b_1 with R11, R21 and R31 damaged;
2) to b_2 with R11, R21, R31 and R12 damaged;
3) to *B/2* with R11, R21, R31, R12, R22 and R32 damaged.

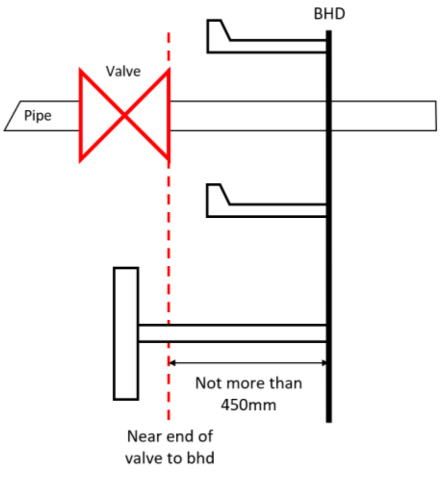
10 A damage having a transverse extent *b* and a vertical extent H_2 leads to the flooding of both wing compartment and hold; for *b* and H_1 only the wing compartment is flooded. The figure below illustrates a partial subdivision draught d_p damage.



11 The same is valid if *b*-values are calculated for arrangements with sloped walls.

12 *This explanatory note only applies to ships for which the building contract is placed on or after 1 January 2020 and which are constructed before 1 January 2024.* Pipes and valves directly adjacent or situated as close as practicable to a longitudinal bulkhead can be considered to be part of the bulkhead, provided the separation distance on either side of the bulkhead is of the same order as the bulkhead stiffening structure. The same applies for small recesses, drain wells, etc.

13 *This explanatory note only applies to ships constructed on or after 1 January 2024.* Pipes and valves directly adjacent or situated as close as practicable to a longitudinal bulkhead can be considered to be part of the bulkhead, provided the separation distance on either side of the bulkhead is of the same order as the bulkhead stiffening structure. The same applies for small recesses, drain wells, etc. In no case should the separation distance on either side of the bulkhead or deck be more than 450 mm measured from the valve's near end to the bulkhead or deck.



REGULATION 7-2 – CALCULATION OF THE FACTOR s_i

General

1 Initial condition – an intact loading condition to be considered in the damage analysis described by the mean draught, vertical centre of gravity and the trim; or alternative parameters from where the same may be determined (e.g. displacement, *GM* and trim). There are three initial conditions corresponding to the three draughts d_s, d_p and d_l.

2 Immersion limits – immersion limits are an array of points that are not to be immersed at various stages of flooding as indicated in regulations 7-2.5.2 and 7-2.5.3.

3 Openings – all openings need to be defined: both weathertight and unprotected. Openings are the most critical factor to preventing an inaccurate index *A*. If the final waterline immerses the lower edge of any opening through which progressive flooding takes place, the factor "*s*" may be recalculated taking such flooding into account. However, in this case the *s* value should also be calculated without taking into account progressive flooding and corresponding opening. The smallest *s* value should be retained for the contribution to the attained index.

Regulation 7-2.1

1 In cases where the *GZ* curve may include more than one "range" of positive righting levers for a specific stage of flooding, only one continuous positive "range" of the *GZ* curve may be used within the allowable range/heel limits for calculation purposes. Different stages of flooding may not be combined in a single *GZ* curve.

Figure 1

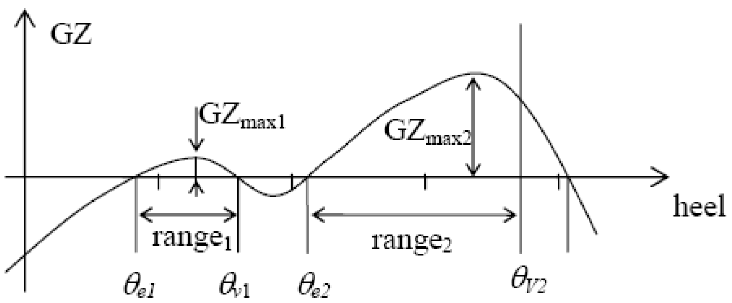
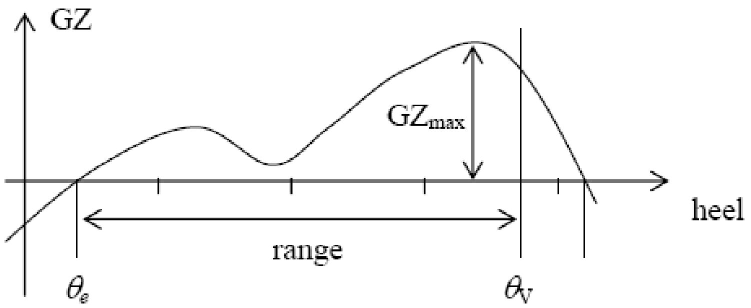


Figure 2



2 In figure 1, the *s*-factor may be calculated from the heel angle, range and corresponding GZ_{max} of the first or second "range" of positive righting levers. In figure 2, only one *s*-factor can be calculated.

Regulation 7-2.2

Intermediate stages of flooding

1 The case of instantaneous flooding in unrestricted spaces in way of the damage zone does not require intermediate stage flooding calculations. Where intermediate stages of flooding calculations are necessary in connection with progressive flooding, flooding through non-watertight boundaries or cross-flooding, they should reflect the sequence of filling as well as filling level phases. Calculations for intermediate stages of flooding should be performed whenever equalization is not instantaneous, i.e. equalization is of a duration greater than 60 s. Such calculations consider the progress through one or more floodable (non-watertight) spaces, or cross-flooded spaces. Bulkheads surrounding refrigerated spaces, incinerator rooms and longitudinal bulkheads fitted with non-watertight doors are typical examples of structures that may significantly slow down the equalization of main compartments.

Flooding boundaries

2 If a compartment contains decks, inner bulkheads, structural elements and doors of sufficient tightness and strength to seriously restrict the flow of water, for intermediate stage flooding calculation purposes it should be divided into corresponding non-watertight spaces. It is assumed that the non-watertight divisions considered in the calculations are limited to "A" class fire-rated bulkheads and decks, and do not apply to "B" class fire-rated bulkheads normally used in accommodation areas (e.g. cabins and corridors). This guidance also relates to regulation 4.5. For spaces in the double bottom, in general, only main longitudinal structures with a limited number of openings have to be considered as flooding boundaries.

Sequential flooding computation

3 For each damage scenario, the damage extent and location determine the initial stage of flooding. Calculations should be performed in stages, each stage comprising of at least two intermediate filling phases in addition to the full phase per flooded space. Unrestricted spaces in way of damage should be considered as flooded immediately. Every subsequent stage involves all connected spaces being flooded simultaneously until an impermeable boundary or final equilibrium is reached. Unless the flooding process is simulated using time-domain methods, when a flooding stage leads to both a self-acting cross-flooding device and a non-watertight boundary, the self-acting cross-flooding device is assumed to act immediately and occur before the non-watertight boundary is breached. If due to the configuration of the subdivision in the ship it is expected that other intermediate stages of flooding are more onerous, then those should be investigated.

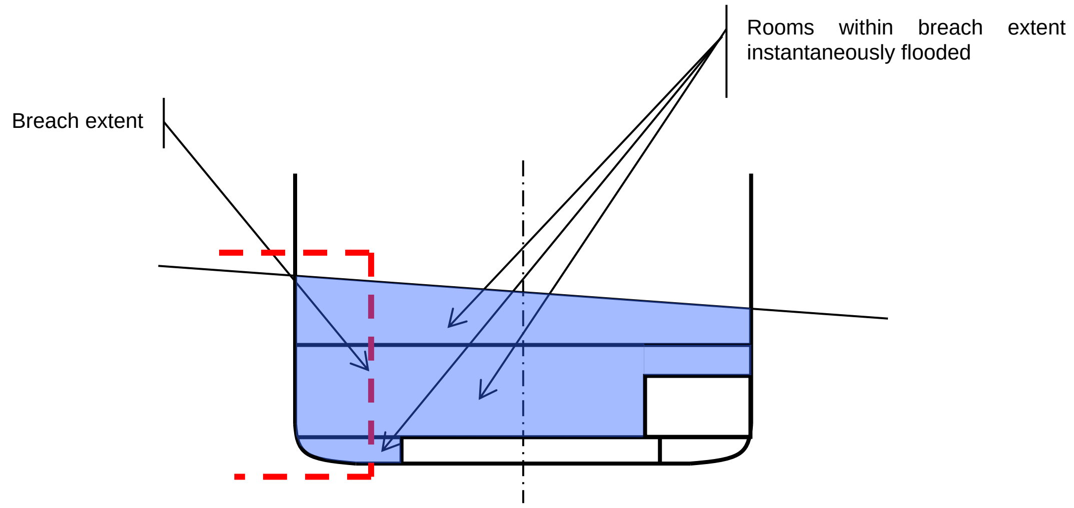
3.1 For each phase of a flooding stage (except the final full phase), the instantaneous transverse moment of this floodwater is calculated by assuming a constant volume of water at each heeling angle. The *GZ* curve is calculated with a constant intact displacement at all stages of flooding. Only one free surface needs to be assumed for water in spaces flooded during the current stage.

In the final full phase of each stage, the water level in rooms flooded during this stage reaches the outside sea level, so the lost buoyancy method can be used. The same method applies for every successive stage (added volume of water with a constant intact displacement for all phases before the final full phase of the stage in consideration), while each of the previous stages at the final full phase can be calculated with the lost buoyancy method.

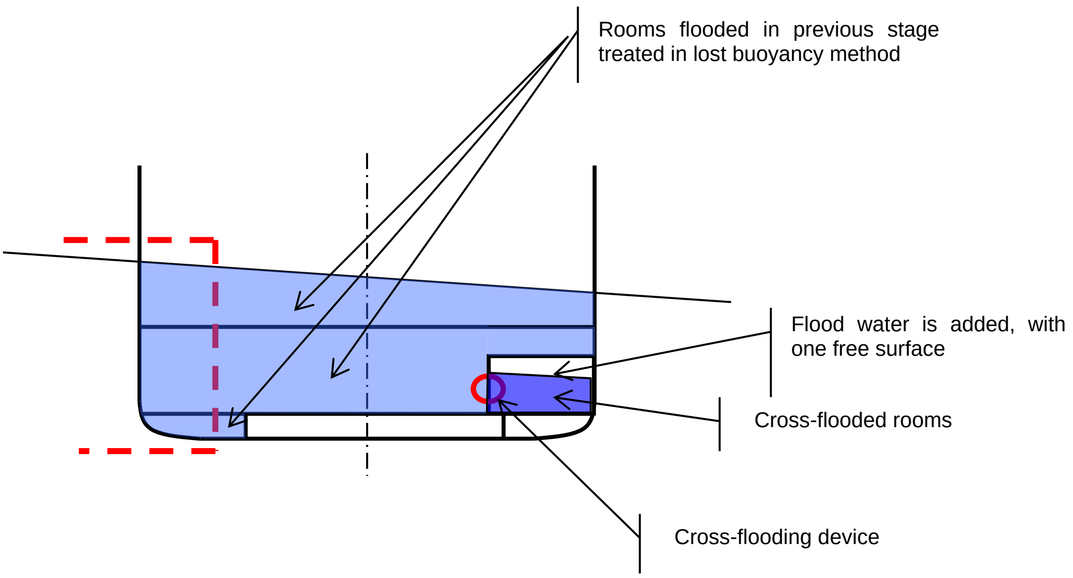
The examples below present a simplified, sequential approach to intermediate stage downflooding and cross-flooding. Because simultaneous downflooding and cross-flooding is not accounted for, any time-to-flood calculated with this sequential approach should be conservative. Alternative approaches, such as time-domain* flooding simulation, are also acceptable.

Example 1: Major damage with cross-flooding device

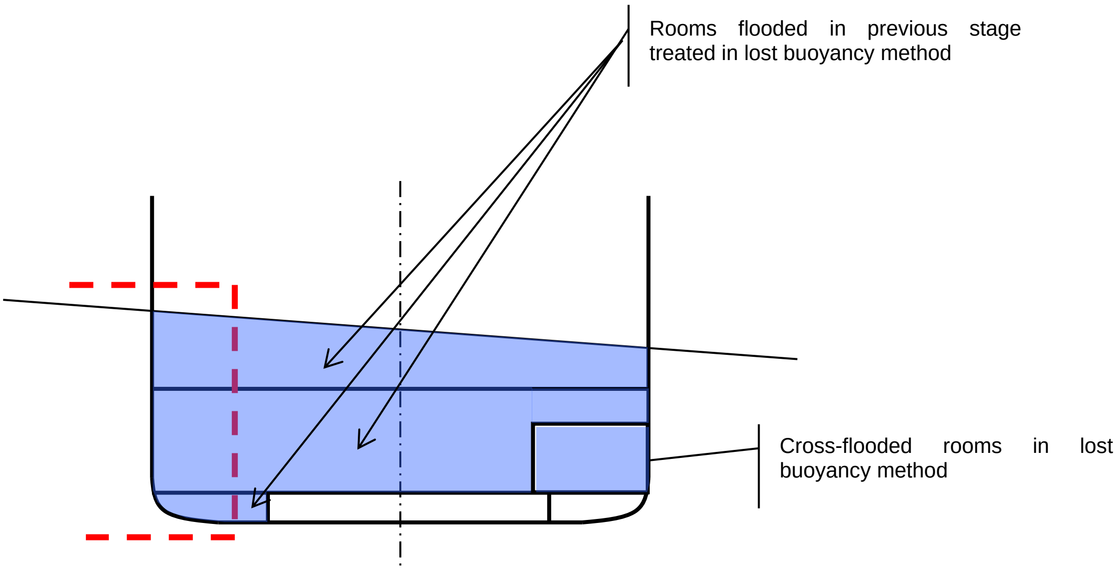
Stage 0: Unrestricted spaces in way of damage should be considered as flooded immediately (intermediate phases are not considered). The lost buoyancy method is applied as this is a full (final) phase. Provided the ship does not capsize and remains at a floating position from which cross-flooding can proceed, stage 0 need not be taken into account for the s_{factor} calculation as the first intermediate stage to be calculated is after 60 seconds. See cross-flooding/equalization explanatory note 5 below.



Stage 1: Cross-flooding of opposite room



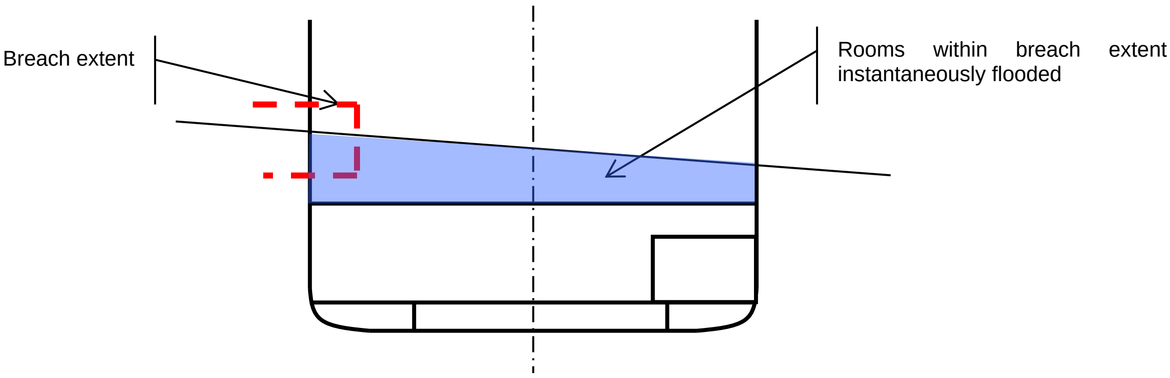
An intermediate phase



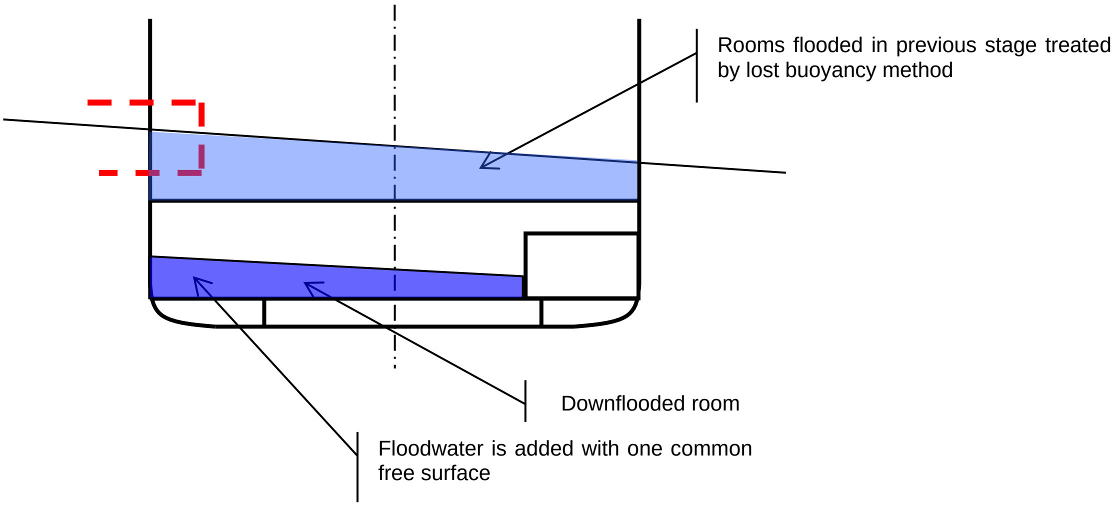
Full (final) phase of flooding stage 1

Example 2: Minor damage with downflooding and cross-flooding

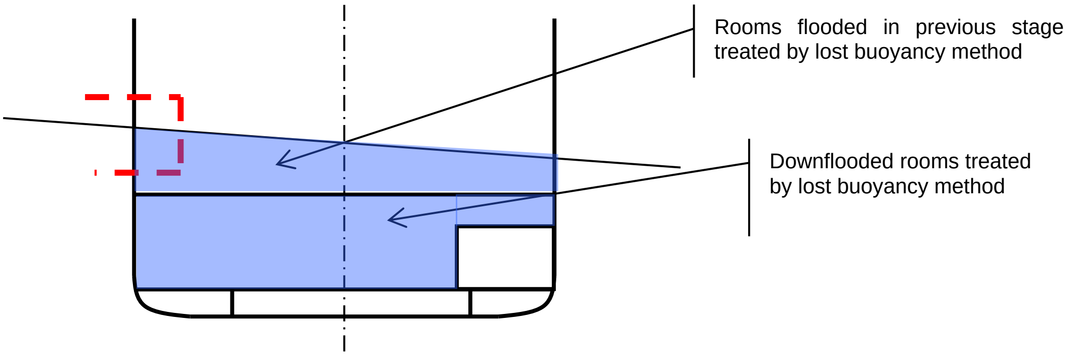
Stage 0: Unrestricted spaces in way of damage should be considered as flooded immediately (intermediate phases are not considered). The lost buoyancy method is applied as this is a full (final) phase. Provided the ship does not capsize and remains at a floating position from which cross-flooding can proceed, stage 0 need not be taken into account for the s_{factor} calculation as the first intermediate stage to be calculated is after 60 seconds. See cross-flooding/equalization explanatory note 5 below.



Stage 1: Downflooding through non-watertight deck

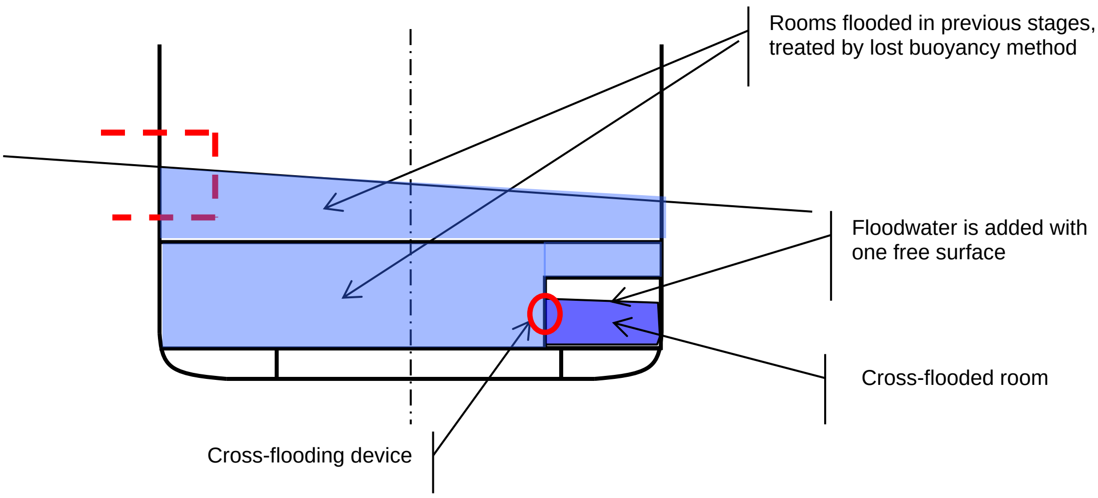


An intermediate phase

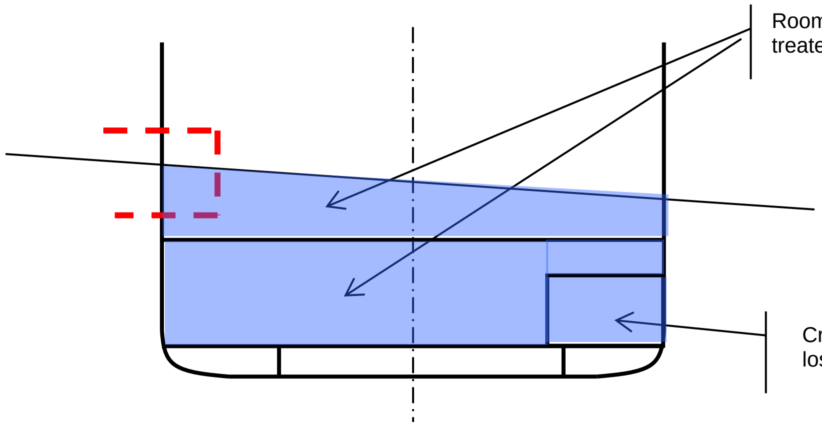


Final (full) phase of stage 1

Stage 2: Cross-flooding



An intermediate phase



Full (final) phase of stage 2

Cross-flooding/equalization

4 In general, cross-flooding is flooding of an undamaged space of the ship to reduce the heel in the final equilibrium condition.

5 The cross-flooding time should be calculated in accordance with the *Revised recommendation on a standard method for evaluating cross-flooding arrangements* (resolution MSC.362(92)). If complete fluid equalization occurs in 60 s or less, it should be treated as instantaneous and no further calculations need to be carried out. Additionally, in cases where $s_{\text{final}} = 1$ is achieved in 60 s or less, but equalization is not complete, instantaneous flooding may also be assumed if s_{final} will not become reduced. In any cases where complete fluid equalization exceeds 60 s, the value of $s_{\text{intermediate}}$ after 60 s is the first intermediate stage to be considered. Only self-acting open cross-flooding arrangements without valves should be considered effective for instantaneous flooding cases.

6 Provided that the ship has a *GZ* greater than 0 and remains in a position from which cross-flooding can proceed, stage 0 need not be taken into account for the s_{factor} calculation as the first intermediate stage to be calculated is after 60 seconds.

7 Only cross-flooding devices which are sufficiently submerged below the external waterline at stage 0 are to be used in the calculation for cross-flooding according to resolution MSC.362(92).

8 If complete fluid equalization can be finalized in 10 min or less, the assessment of survivability is carried out using the formula in regulation 7-2.1.1 (i.e. as the smallest value of $s_{\text{intermediate}}$ or $s_{\text{final}} \cdot s_{\text{mom}}$)

9 In case the equalization time is longer than 10 min, s_{final} is calculated for the floating position achieved after 10 min of equalization. This floating position is computed by calculating the amount of flood water according to resolution MSC.362(92) using interpolation, where the equalization time is set to 10 min, i.e. the interpolation of the flood water volume is made between the case before equalization (T=0) and the total calculated equalization time. For damage cases involving different cross-flooding devices serving different spaces, when the interpolation between the case before equalization ($T=0$) and the total calculated equalization time is needed for flood water volume calculation after 60 s or 10 min, the total equalization time is to be calculated separately for each cross-flooding device.

10 In any cases where complete fluid equalization exceeds 10 min, the value of s_{final} used in the formula in regulation 7-2.1.1 should be the minimum of s_{final} at 10 min or at final equalization.

11 The factor $s_{intermediate,i}$ may be used for cross-flooding stages if they are intermediate stages which are followed by other subsequent flooding stages (e.g. the flooding stages of non-watertight compartments).

Alternatives

12 As an alternative to the procedure described above in the explanatory notes for regulation 7-2.2, direct calculation using computational fluid dynamics (CFD), time-domain flooding simulations or model testing may be used to analyse intermediate stages of flooding and determine the time for equalization.

Regulation 7-2.3

1 The formulation of $s_{final,i}$ is based on target values for *GZ* and *Range* to achieve *s* = 1. These values are defined as TGZ_{max} and *TRange*.

2 If ro-ro spaces are damaged there might be the possibility of water accumulation on these deck spaces. To account for this, in any damage case where the ro-ro space is damaged the higher values for TGZ_{max} and *TRange* are to be applied for the calculation of s_i.

Regulation 7-2.4.1.2

The parameter *A* (projected lateral area) used in this paragraph does not refer to the attained subdivision index.

Regulation 7-2.5.2.1 and 7-2.5.2.3

Unprotected openings

1 The flooding angle will be limited by immersion of such an opening. It is not necessary to define a criterion for non-immersion of unprotected openings at equilibrium, because if it is immersed, the range of positive *GZ* limited to flooding angle will be zero so "*s*" will be equal to zero.

2 An unprotected opening connects two rooms or one room and the outside. An unprotected opening will not be taken into account if the two connected rooms are flooded or none of these rooms are flooded. If the opening is connected to the outside, it will not be taken into account if the connected compartment is flooded. An unprotected opening does not need to be taken into account if it connects a flooded room or the outside to an undamaged room, if this room will be considered as flooded in a subsequent stage.

Openings fitted with a weathertight mean of closing ("weathertight openings")
Applies to passenger ships for which the building contract is placed on or after 1 January 2020 and which are constructed before 1 January 2024, and to cargo ships.

3 The survival "*s*" factor will be "0" if any such point is submerged at a stage which is considered as "final". Such points may be submerged during a stage or phase which is considered as "intermediate", or within the range beyond equilibrium.

4 If an opening fitted with a weathertight means of closure is submerged at equilibrium during a stage considered as intermediate, it should be demonstrated that this weathertight means of closure can sustain the corresponding head of water and that the leakage rate is negligible.

5 These points are also defined as connecting two rooms or one room and the outside, and the same principle as for unprotected openings is applied to take them into account or not. If several stages have to be considered as "final", a "weathertight opening" does not need to be taken into account if it connects a flooded room or the outside to an undamaged room if this room will be considered as flooded in a successive "final" stage.

Regulation 7-2.5.2.2

1 Partial immersion of the bulkhead deck may be accepted at final equilibrium. This provision is intended to ensure that evacuation along the bulkhead deck to the vertical escapes will not be impeded by water on that deck. A "horizontal evacuation route" in the context of this regulation means a route on the bulkhead deck connecting spaces located on and under this deck with the vertical escapes from the bulkhead deck required for compliance with SOLAS chapter II-2.

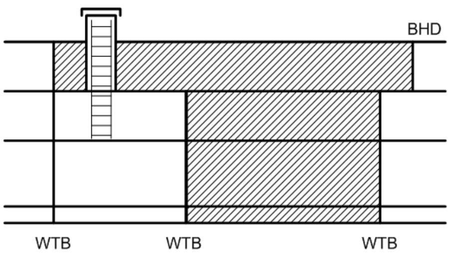
2 Horizontal evacuation routes on the bulkhead deck include only escape routes (designated as category 2 stairway spaces according to SOLAS regulation II-2/9.2.2.3 or as category 4 stairway spaces according to SOLAS regulation II-2/9.2.2.4 for passenger ships carrying not more than 36 passengers) used for the evacuation of undamaged spaces. Horizontal evacuation routes do not include corridors (designated as category 3 corridor spaces according to SOLAS regulation II-2/9.2.2.3 or as category 2 corridor spaces according to SOLAS regulation II-2/9.2.2.4 for passenger ships carrying not more than 36 passengers) or escape routes within a damaged zone. No part of a horizontal evacuation route serving undamaged spaces should be immersed.

3 s_i = 0 where it is not possible to access a stair leading up to the embarkation deck from an undamaged space as a result of flooding to the "stairway" or "horizontal stairway" on the bulkhead deck.

Regulation 7-2.5.3.1

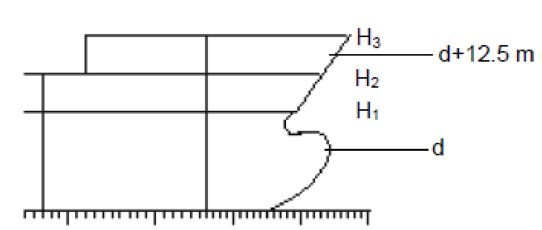
1 The purpose of this paragraph is to provide an incentive to ensure that evacuation through a vertical escape will not be obstructed by water from above. The paragraph is intended for smaller emergency escapes, typically hatches, where fitting of a watertight or weathertight means of closure would otherwise exclude them from being considered as flooding points.

2 Since the probabilistic regulations do not require that the watertight bulkheads be carried continuously up to the bulkhead deck, care should be taken to ensure that evacuation from intact spaces through flooded spaces below the bulkhead deck will remain possible, for instance by means of a watertight trunk.



Regulation 7-2.6

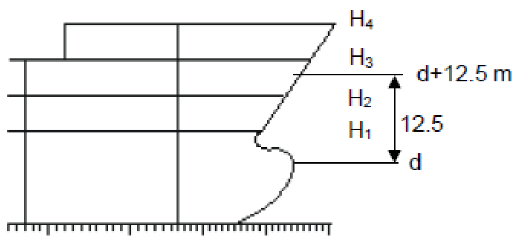
The sketches in the figure illustrate the connection between position of watertight decks in the reserve buoyancy area and the use of factor *v* for damages below these decks.



Example 1: vertical extent of damage above the waterline

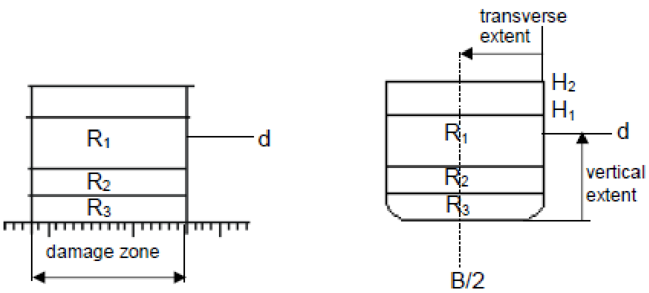
In example 1, there are 3 horizontal subdivisions (H_1, H_2 and H_3) to be taken into account as the vertical extent of damage.

The example shows the maximum possible vertical extent of damage *d* + 12.5 m is positioned between H_2 and H_3. H_1 with factor v_1, H_2 with factor $v_2 > v_1$ but $v_2 < 1$ and H_3 with factor $v_3 = 1$.



Example 2: vertical extent of damage above the waterline

In example 2, the factors v_1 and v_2 are the same as above. The reserve buoyancy above H_3 should be taken undamaged in all damage cases.



Example 3: vertical extent of damage below the waterline

In example 3, the combination of damages into the rooms R_1, R_2 and R_3 positioned below the initial water line should be chosen so that the damage with the lowest *s*-factor is taken into account. That often results in the definition of alternative damages to be calculated and compared within a damage zone taking into account the vertical and the transverse extent. If the deck taken as the lower limit of damage is not watertight, down flooding should be considered.

Regulation 7-2.6.1

The parameters x_1 and x_2 are the same as parameters *x1* and *x2* used in regulation 7-1.

REGULATION 7-3 – PERMEABILITY

Regulation 7-3.2

1 The following additional cargo permeabilities may be used:

Spaces	Permeability at draught d_s	Permeability at draught d_p	Permeability at draught d_l
Timber cargo in holds	0.35	0.7	0.95
Wood chip cargo	0.6	0.7	0.95

2 Reference is made to MSC/Circ.998 (IACS Unified Interpretation regarding timber deck cargo in the context of damage stability requirements) regarding timber deck cargo.

Regulation 7-3.3

1 Concerning the use of other figures for permeability "if substantiated by calculations", such permeabilities should reflect the general conditions of the ship throughout its service life rather than specific loading conditions.

2 This paragraph allows for the recalculation of permeabilities. This should only be considered in cases where it is evident that there is a major discrepancy between the values shown in the regulation and the real values. It is not designed for improving the attained value of a deficient ship of regular type by the modification of chosen spaces in the ship that are known to provide significantly onerous results. All proposals should be considered on a case-by-case basis by the Administration and should be justified with adequate calculations and arguments.

REGULATION 8 – SPECIAL REQUIREMENTS CONCERNING PASSENGER SHIP STABILITY

Regulation 8.1

This regulation is intended to ensure a sufficient safety level if a large compartment is located aft of the collision bulkhead.

REGULATION 8-1 – SYSTEM CAPABILITIES AND OPERATIONAL INFORMATION AFTER A FLOODING CASUALTY ON PASSENGER SHIPS

Regulation 8-1.2

1 In the context of this regulation, "compartment" has the same meaning as defined under regulation 7-1 of these explanatory notes (i.e. an on-board space within watertight boundaries).

2 The purpose of the paragraph is to prevent any flooding of limited extent from immobilizing the ship. This principle should be applied regardless of how the flooding might occur. Only flooding below the bulkhead deck need be considered.

REGULATION 9 – DOUBLE BOTTOMS IN PASSENGER SHIPS AND CARGO SHIPS OTHER THAN TANKERS

Regulation 9.1

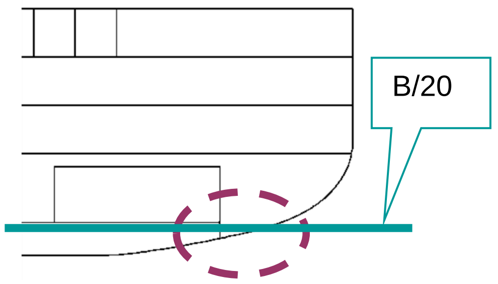
1 This regulation is intended to minimize the impact of flooding from a minor grounding. Special attention should be paid to the vulnerable area at the turn of the bilge. When justifying a deviation from fitting an inner bottom an assessment of the consequences of allowing a more extensive flooding than reflected in the regulation should be provided.

2 The determination regarding the requirement to fit a double bottom "as far as this is practicable and compatible with the design and proper working of the ship" is made, or should be accepted by, the Administration or a recognized organization acting on its behalf.

Compliance with the damage stability requirement in regulation 9.8 should not be considered as an equivalent optional requirement to the fitting of a dimensionally compliant double bottom. This is because a flooded watertight compartment, such as an engine-room, that complies with the damage stability requirement in regulation 9.8 is not equivalent to a flooded double bottom below that compartment. Compliance with the damage stability requirement in regulation 9.8 is intended to provide a minimum level of safety in cases when the fitting of a double bottom is not practicable or compatible with the design and proper working of the ship.

Regulation 9.2

1 Except as provided in regulations 9.3 and 9.4, parts of the double bottom not extended for the full width of the ship as required by regulation 9.2 should be considered an unusual arrangement for the purpose of this regulation and should be handled in accordance with regulation 9.7. An example is provided below.



2 If an inner bottom is located higher than the partial subdivision draught d_p, this should be considered an unusual arrangement and is to be handled in accordance with regulation 9.7.

Regulations 9.3.2.2, 9.6 and 9.7

For cargo ships of less than 80 m in length (*L*), the alternative arrangements to provide a level of safety satisfactory to the Administration should be limited to compartments not having a double bottom, having an unusual bottom arrangement, or having an "other well" extending below the required double bottom height that is greater than the *h*/2 or 500 mm limit indicated in regulation 9.3.2.1. In these cases compliance with the bottom damage standard in regulation 9.8 should be demonstrated assuming that the damage will only occur between the transverse watertight bulkheads in compartments not having a double bottom, having an unusual bottom arrangement, or having an "other well" extending below the required double bottom height that is greater than the *h*/2 or 500 mm limit indicated in regulation 9.3.2.1.

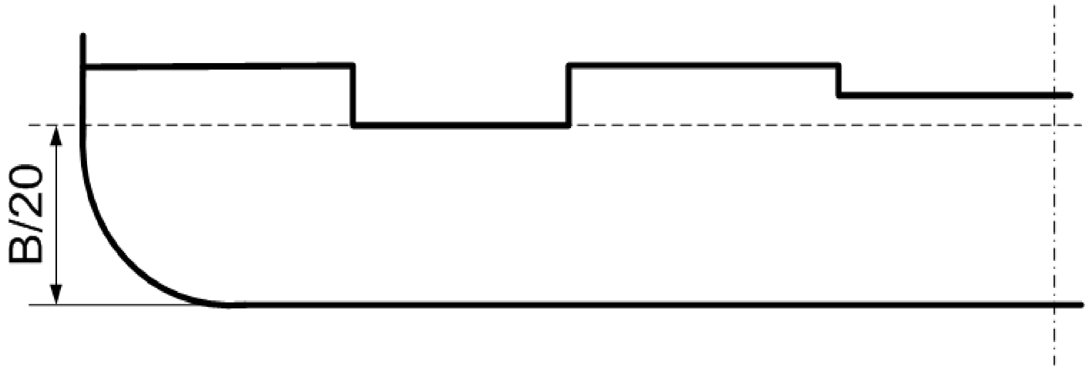
Regulation 9.6

1 Any part of a passenger ship or a cargo ship of 80 m in length (*L*) and upwards where a double bottom is omitted in accordance with regulation 9.1, 9.4 or 9.5 shall be capable of withstanding bottom damages, as specified in regulation 9.8. The intent of this provision is to specify the circumstances under which the Administration should require calculations, which damage extents to assume and what survival criteria to apply when double bottoms are not fitted.

2 The definition of "watertight" in regulation 2.17 implies that the strength of inner bottoms and other boundaries assumed to be watertight should be verified if they are to be considered effective in this context.

Regulation 9.7

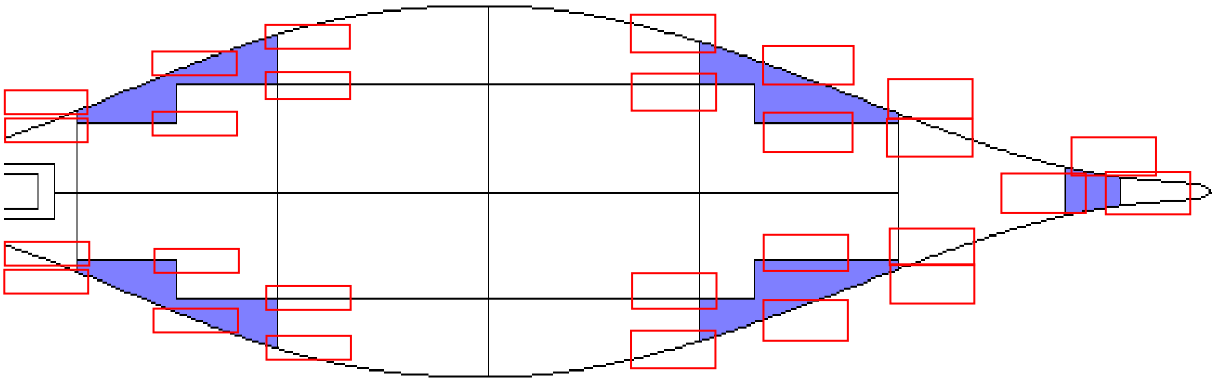
The reference to a "plane" in regulation 9.2 does not imply that the surface of the inner bottom may not be stepped in the vertical direction. Minor steps and recesses need not be considered unusual arrangements for the purpose of this paragraph as long as no part of the inner bottom is located below the reference plane. Discontinuities in way of wing tanks are covered by regulation 9.4.



Regulation 9.8

1 For ships to which the probabilistic damage stability requirements of part B-1 apply, the term "all service conditions" used in this paragraph means the three loading conditions with all trims used to calculate the attained subdivision index *A*. For ships not subject to the probabilistic damage stability requirements in part B-1, such as cargo ships that comply with the subdivision and damage stability requirements of other instruments as allowed by regulation II-1/4.2.1.2 and cargo ships of less than 80 m in length (*L*), "all service conditions" means that the limit curves or tables required by regulation 5-1.2.1 should include values calculated for the same draught and trim range(s) as for the other applicable stability requirements.

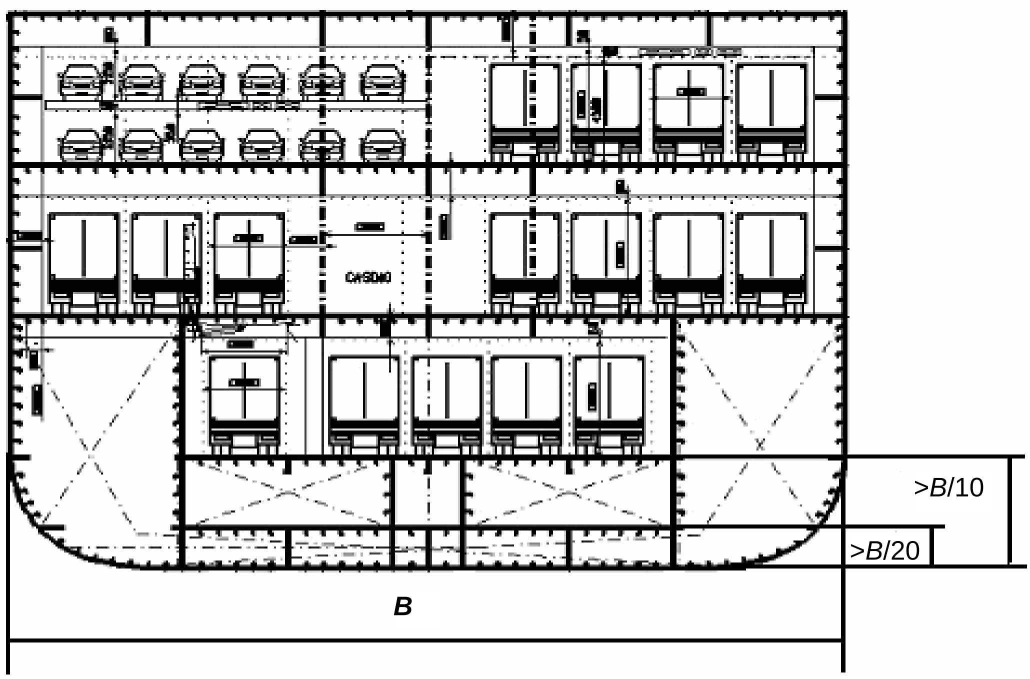
2 The damage extents specified in this paragraph should be applied to all parts of the ship where no double bottom is fitted, as permitted by regulations 9.1, 9.4 or 9.5, and include any adjacent spaces located within the extent of damage. Small wells in accordance with regulation 9.3.1 do not need to be considered damaged even if within the extent of the damage. Possible positions of the damages are shown in an example below (parts of the ship not fitted with a double bottom are shaded; the damages to be assumed are indicated by boxes).



Regulation 9.9

1 For the purpose of identifying "large lower holds", horizontal surfaces having a continuous deck area greater than approximately 30% in comparison with the waterplane area at subdivision draught should be taken to be located anywhere in the affected area of the ship. For the alternative bottom damage calculation, a vertical extent of *B*/10 or 3 m, whichever is less, should be assumed.

2 The increased minimum double bottom height of not more than *B*/10 or 3 m, whichever is less, for passenger ships with large lower holds, is applicable to holds in direct contact with the double bottom. Typical arrangements of ro-ro passenger ships may include a large lower hold with additional tanks between the double bottom and the lower hold, as shown in the figure below. In such cases, the vertical position of the double bottom required to be *B*/10 or 3 m, whichever is less, should be applied to the lower hold deck, maintaining the required double bottom height of *B*/20 or 2 m, whichever is less (but not less than 760 mm). The figure below shows a typical arrangement of a modern ro-ro passenger ferry.



REGULATION 10 – CONSTRUCTION OF WATERTIGHT BULKHEADS

Regulation 10.1

For the treatment of steps in the bulkhead deck of passenger ships see explanatory notes for regulation 13. For the treatment of steps in the freeboard deck of cargo ships see explanatory notes for regulation 13-1.

REGULATION 12 – PEAK AND MACHINERY SPACE BULKHEADS, SHAFT TUNNELS, ETC.

Regulation 12.6.1

For cargo ships, for which the building contract is placed on or after 1 January 2020 and which are constructed before 1 January 2024, the following figures show examples of suitable butterfly valve arrangements:

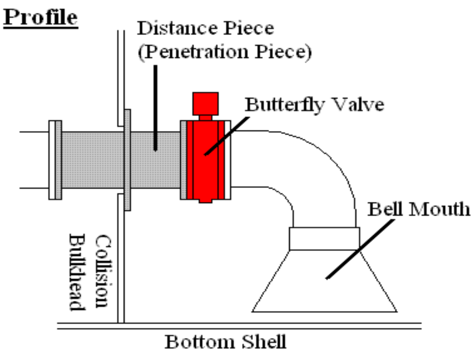


Figure 1

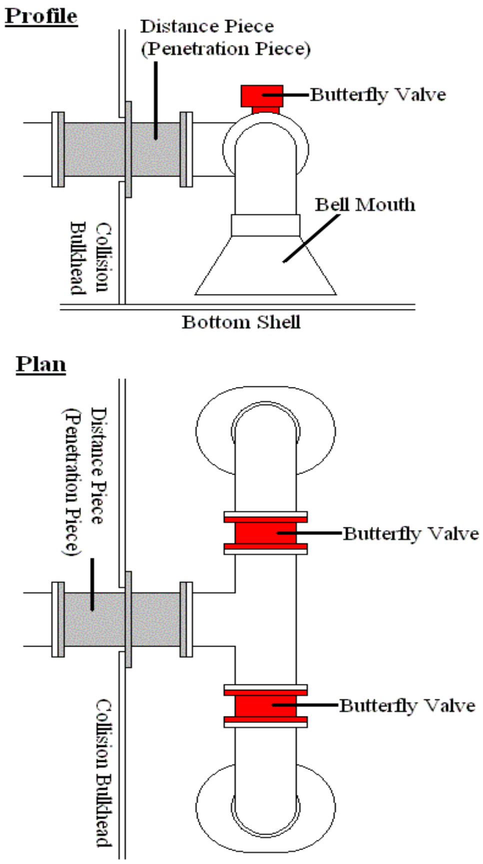


Figure 2

As butterfly valves must be capable of being remotely operated the following shall apply:

.1 the actuator shall be of a double acting type;

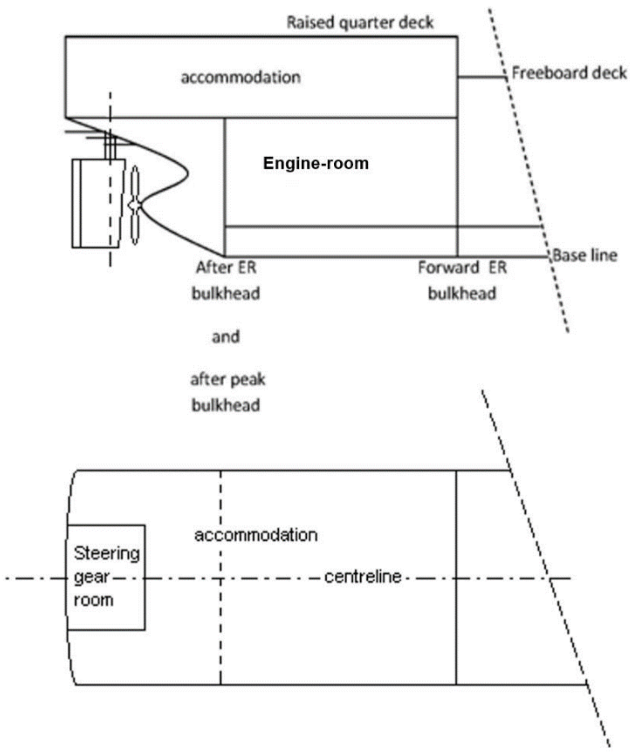
.2 when subject to loss of power, the actuator shall remain in its current position; and

.3 when subject to loss of power, the valve shall be able to be manually operated.

Regulation 12.10

1 In cargo ships the after engine-room bulkhead can be regarded as the afterpeak bulkhead provided that the after peak adjoins the engine-room.

2 In cargo ships with a raised quarter deck, it may be impracticable to extend the afterpeak bulkhead to the freeboard deck as the freeboard deck does not extend to the aft perpendicular. Provided that the afterpeak bulkhead extends above the deepest load line, and that all rudderstock bearings are housed in a watertight compartment without open connection to spaces located in front of the afterpeak bulkhead, termination of the afterpeak bulkhead on a watertight deck lower than the freeboard deck can be accepted by the Administration.



Regulation 12.11

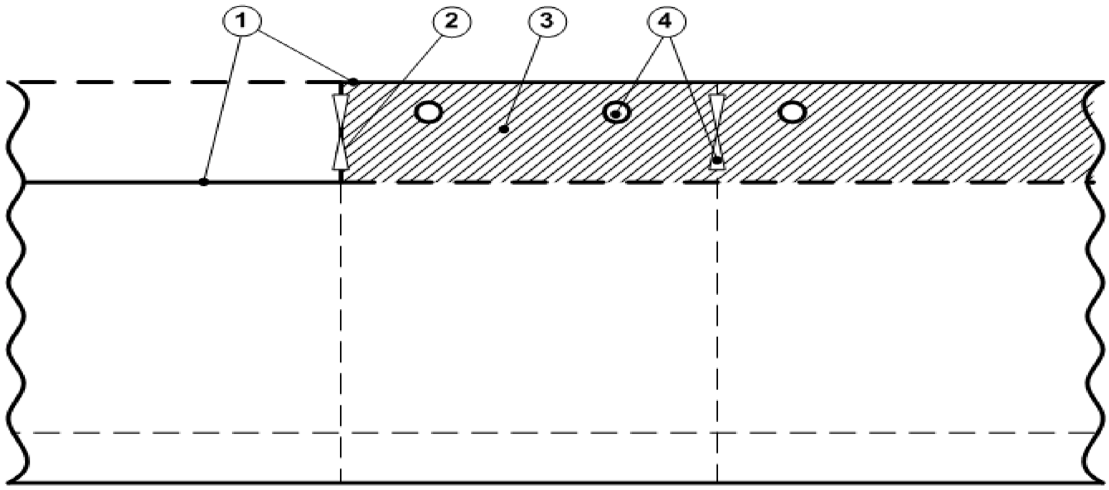
In cargo ships a stern tube enclosed in a watertight space of moderate volume, such as an afterpeak tank, where the inboard end of the stern tube extends through the afterpeak/engine-room watertight bulkhead into the engine-room is considered to be an acceptable solution satisfying the requirement of this regulation, provided the inboard end of the stern tube is effectively sealed at the afterpeak/engine-room bulkhead by means of an approved watertight/oiltight gland system.

REGULATION 13 – OPENINGS IN WATERTIGHT ~~BULKHEADS~~ BOUNDARIES BELOW THE BULKHEAD DECK IN PASSENGER SHIPS

General – Steps in the bulkhead deck

1 If the transverse watertight bulkheads in a region of the ship are carried to a higher deck which forms a vertical step in the bulkhead deck, openings located in the bulkhead at the step may be considered as being located above the bulkhead deck. Such openings should then comply with regulation 17 and should be taken into account when applying regulation 7-2.

2 All openings in the shell plating below the upper deck throughout that region of the ship should be treated as being below the bulkhead deck and the provisions of regulation 15 should be applied. See figure below.



1 Bulkhead deck 2 Considered as located above the bulkhead deck
3 Ship's side 4 Considered as located below the bulkhead deck

Regulation 13.2.3

1 For closed piping systems compliance with this regulation is achieved if approved pipe penetrations are fitted at the crossing of watertight ~~bulkheads~~ boundaries to ensure that heat-sensitive pipes outside the space affected by the fire remain intact, so that any flooding of the fire affected space does not cause progressive flooding through the piping or pipe penetration.

For open piping systems compliance with this regulation is achieved if approved pipe penetrations are fitted at the crossing of watertight ~~bulkheads~~ boundaries as are required for closed piping systems, and additionally each pipe connection to a watertight compartment is fitted with an isolation or non-return valve, as appropriate, to prevent progressive flooding through the piping system after a fire. As an alternative to fitting an isolation or non-return valve, pipes may be routed above the damaged waterline in such a way that progressive flooding is prevented, taking into account the dynamic movements of the ship in a damaged condition.

However, progressive flooding may be taken into account in accordance with regulation 7-2.5.4 instead.

2 For the purpose of this explanatory note the following definitions apply:

A *closed piping system* is a piping system without openings in multiple watertight compartments.

An *open piping system* is a piping system with openings in multiple watertight compartments.

3 Materials used in systems which penetrate watertight ~~bulkheads~~ boundaries should be of sufficient strength after exposure to heat or be considered as part of an open piping system.

Closing devices using intumescent material (swelling when exposed to heat) for open piping systems should not be considered equivalent to the fitting of a valve, since the fire might be located too far from the device to create a watertight seal.

4 Approval of pipe penetrations fitted to ensure the watertight integrity of a bulkhead or deck where heat-sensitive materials are used should include a prototype test of watertightness after having undergone the standard fire test appropriate for the location in which the penetrations are to be installed.[1]

The fire tested pipe penetration should then be tested to a test pressure of not less than 1.5 times the design pressure as defined in regulation 2.18. The pressure should be applied to the same side of the division as the fire test.

The fire tested pipe penetration should be tested for a period of at least 30 minutes under hydraulic pressure equal to the test pressure, but minimum 1.0 bar. There should be no leakage during this test.

The fire tested pipe penetration should continue to be tested for a further 30 minutes with the test pressure. The quantity of water leakage is not to exceed a total of 1 litre.

The prototype test should be considered valid only for the pipe typology (e.g. thermoplastic and multilayer), pressure classes, the maximum/minimum dimensions tested, and the type and fire rating of the division tested.

5 The pressure test need not be carried out on the hot penetration arrangement. Ample time may be given to prepare for the pressure test, i.e. dismantling the fire testing equipment and rigging the pressure test equipment.

The pressure test should be carried out with the pipe section used in the fire test still in place.

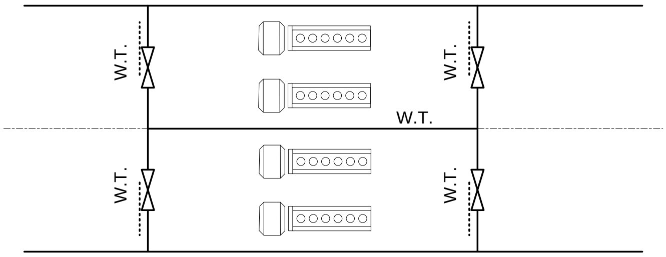
Any pipe insulation fitted for the purpose of the fire test may be removed before the pressure test.

Prototype testing need not be carried out if the pipe penetration is made of steel or equivalent material having a thickness of 3 mm or greater and a length of not less than 900 mm (preferably 450 mm on each side of the division), and there are no openings. Such penetrations shall be suitably insulated by extension of the insulation at the same level of the division. See also regulation II-2/9.3.1 with respect to piping. However, the penetration must still comply with the watertight integrity requirement in regulation 2.17.

Regulation 13.4

In cases where main and auxiliary propulsion machinery spaces, including boilers serving the needs for propulsion, are divided by watertight longitudinal bulkheads in order to comply with redundancy requirements (e.g. according to regulation 8-1.2), one watertight door in each watertight bulkhead may be permitted, as shown in the figure below.

1 Refer to the requirements for A-class division set out in part 3 of annex 1 to the 2010 FTP Code.



REGULATION 13-1 – OPENINGS IN WATERTIGHT BULKHEADS AND INTERNAL DECKS IN CARGO SHIPS

Regulation 13-1.1

1 If the transverse watertight bulkheads in a region of the ship are carried to a higher deck than in the remainder of the ship, openings located in the bulkhead at the step may be considered as being located above the freeboard deck.

2 All openings in the shell plating below the upper deck throughout that region of the ship should be treated as being below the freeboard deck, similar to the bulkhead deck for passenger ships (see relevant figure under regulation 13 above), and the provisions of regulation 15 should be applied.

REGULATION 15 – OPENINGS IN THE SHELL PLATING BELOW THE BULKHEAD DECK OF PASSENGER SHIPS AND THE FREEBOARD DECK OF CARGO SHIPS

General – Steps in the bulkhead deck and freeboard deck

For the treatment of steps in the bulkhead deck of passenger ships see explanatory notes for regulation 13. For the treatment of steps in the freeboard deck of cargo ships see explanatory notes for regulation 13-1.

REGULATION 15-1 – EXTERNAL OPENINGS IN CARGO SHIPS

Regulations 15-1.1 to 15-1.3 apply to cargo ships which are subject to the damage stability analysis required in part B-1 or other IMO instruments.

Regulation 15-1.1

With regard to air-pipe closing devices, they should be considered weathertight closing devices (not watertight). This is consistent with their treatment in regulation 7-2.5.2.1. However, in the context of regulation 15-1, "external openings" are not intended to include air-pipe openings.

REGULATION 16 – CONSTRUCTION AND INITIAL TESTS OF WATERTIGHT CLOSURES

General

These requirements are only to establish a general design standard for watertight closures. They are not intended to require any non-watertight hatches to be watertight, nor do they override the requirements of the International Convention on Load Lines.

Regulation 16.2

Large doors, hatches or ramps on passenger and cargo ships, of a design and size that would make pressure testing impracticable, may be exempted from regulation 16.2, provided it is demonstrated by calculations that the doors, hatches or ramps maintain watertightness at design pressure with a proper margin of resistance. Where such doors utilize gasket seals, a prototype pressure test to confirm that the compression of the gasket material is capable of accommodating any deflection, revealed by the structural analysis, should be carried out. After installation every such door, hatch or ramp should be tested by means of a hose test or equivalent.

Note: See explanatory notes for regulation 13 for additional information regarding the treatment of steps in the bulkhead deck of passenger ships. See explanatory notes for regulation 13-1 for additional information regarding the treatment of steps in the freeboard deck of cargo ships.

REGULATION 17 – INTERNAL WATERTIGHT INTEGRITY OF PASSENGER SHIPS ABOVE THE BULKHEAD DECK

General – Steps in the bulkhead deck

For the treatment of steps in the bulkhead deck of passenger ships see explanatory notes for regulation 13.

Regulation 17.1

This explanatory note only applies to passenger ships for which the building contract is placed on or after 1 January 2020 and which are constructed before 1 January 2024.

1 Sliding watertight doors with a reduced pressure head that are located above the bulkhead deck and which are immersed in the final or during any intermediate stage of flooding should comply fully with the requirements of regulation 13. These types of sliding watertight doors tested with reduced pressure head must not be immersed at any stage of flooding by a head of water higher than the tested pressure head. See figure 1 below. These sliding watertight doors shall be kept closed during navigation in compliance with the requirements of regulation 22 and this should be clearly indicated in the damage control information required by regulation 19.

2 If watertight doors are located above the worst final and above the worst intermediate waterline in damage cases contributing to the attained subdivision index *A*, but within the area where the door becomes intermittently immersed (fully or partly) at angles of heel in the required range of positive stability beyond the equilibrium position, such doors are to be power operated and remotely controlled sliding semi-watertight doors complying with the requirements of regulation 13, except that the scantlings and sealing requirements could be reduced to the maximum head of water caused by the waterline being intermittently immersed (see figure 1 below). These doors should be closed in case of damage and this should be clearly indicated in the damage control information required by regulation 19.

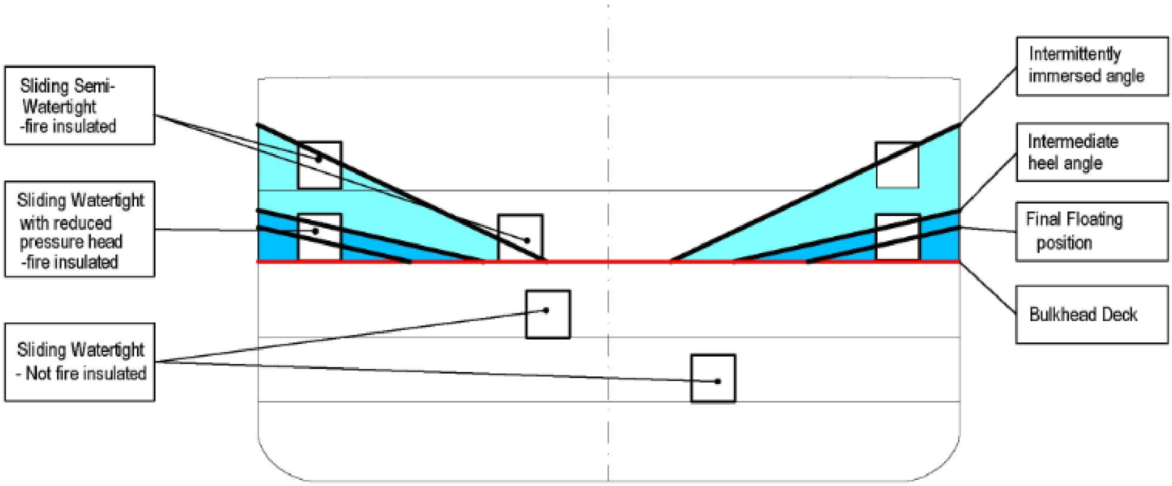


Figure 1

3 The use of sliding watertight ~~sliding~~ doors above the bulkhead deck affects the escape provisions of regulation II-2/13. When such doors are used above the bulkhead deck, there should be at least two means of escape from each main vertical zone or similarly restricted space or group of spaces, at least one of which should be independent of watertight doors and at least one of which should give access to a stairway forming a vertical escape. Sliding watertight doors that will be used frequently by passengers must not create a tripping hazard.

4 Doors fitted above the bulkhead deck, which are required to meet both fire protection and watertight requirements should comply with the fire requirements in regulation II-2/9.4.1.1 and the watertight requirements in paragraphs 1 and 2 above. Notwithstanding ~~the ultimate sentence of~~ regulation II-2/9.4.1.1.~~2~~3, watertight doors fitted above the bulkhead deck should be insulated to the standard required by table 9.1 and regulation II-2/9.2.2.1.1.1. The door must be capable of operation using both the remote fire door control circuit and the remote watertight door control circuit. If two doors are fitted, they must be capable of independent operation. The operation of either door separately must not preclude closing of the other door. Both doors must be capable of being operated from either side of the bulkhead.

Regulation 17.2

This explanatory note only applies to passenger ships constructed on or after 1 January 2024.

1 Doors fitted in internal watertight subdivision boundaries located above the bulkhead deck that are immersed at either the final equilibrium or worst intermediate stage of flooding waterlines should be sliding watertight doors that comply fully with the requirements of regulation 13. They should not be immersed at any stage of flooding by a head of water higher than their design scantlings or their tested pressure head. These sliding watertight doors should be kept closed during navigation in accordance with the requirements of regulation 22 and this should be clearly indicated in the damage control information required by regulation 19.

2 The use of sliding watertight doors above the bulkhead deck affects the escape provisions of regulation II-2/13. When such doors are used above the bulkhead deck, there should be at least two means of escape from each main vertical zone or similarly restricted space or group of spaces, at least one of which should be independent of watertight doors and at least one of which should give access to a stairway forming a vertical escape. Sliding watertight doors that will be used frequently by passengers must not create a tripping hazard.

3 Doors fitted above the bulkhead deck, which are required to meet both fire protection and watertight requirements should comply with the fire requirements in regulation II-2/9.4.1.1 and the watertight requirements in paragraph 1 above. Notwithstanding regulation II-2/9.4.1.1.3, watertight doors fitted above the bulkhead deck should be insulated to the standard required by table 9.1 and regulation II-2/9.2.2.1.1.1. The door must be capable of operation using both the remote fire door control circuit and the remote watertight door control circuit. If two doors are fitted, they must be capable of independent operation. The operation of either door separately must not preclude closing of the other door. Both doors must be capable of being operated from either side of the bulkhead.

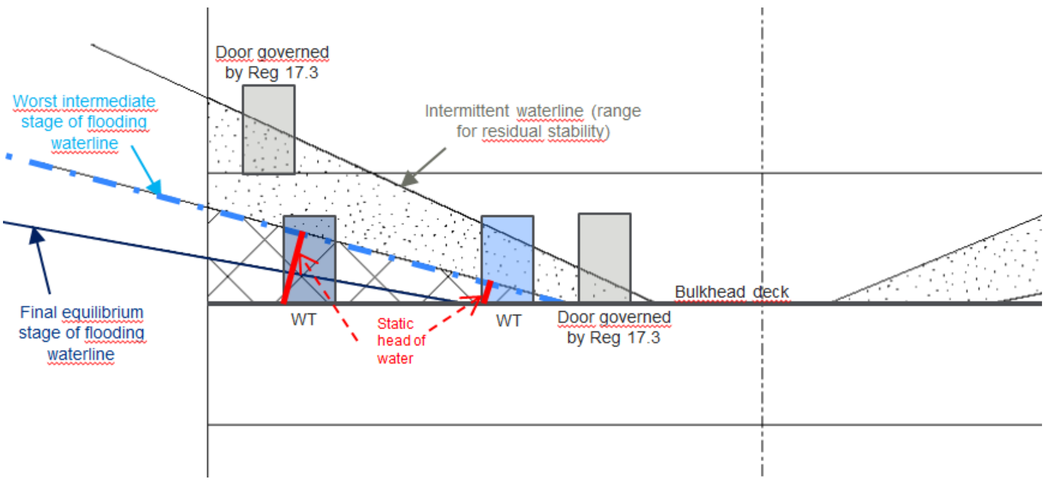
Regulation 17.3

This explanatory note only applies to passenger ships constructed on or after 1 January 2024.

1 To be considered capable of preventing the passage of water when intermittently immersed in the required range of positive stability, these doors should meet a watertight standard for a minimum 1 m head of water. These doors may be hinged or sliding, provided they comply with the design requirements applied from both sides of the door. Consideration should be given to the opening direction for hinged doors, so that they do not open against the intended direction of escape. These doors should be closed in case of damage and this should be clearly indicated in the damage control information required by regulation 19.

2 These doors are required to meet the fire protection requirements in chapter II-2. Because these doors are not watertight doors that comply with the requirements in regulation 13, the exclusions for watertight doors in chapter II-2 do not apply. In addition to operation using the fire door control circuit, these doors should be provided with a separate remote closure control circuit located on the navigation bridge with the central operating console for the power-operated sliding watertight doors that is required by regulation 13.7.1. A diagram showing the location of each door, with visual indicators to show whether each door is open or closed, should also be at the central operating console. A red light should indicate a door is fully open and a green light should indicate a door is fully closed. When the door is closed remotely, the red light should indicate the intermediate position by flashing. The indicating circuit should be independent of the control circuit for each door. Indication should also be provided to the onboard stability computer, if installed in accordance with regulation 8-1.3.1.

3 These doors should also be capable of being remotely closed with the ship listed 15 degrees either way.



	Situation/waterlines	Type	Structural and functional scantling	Use at sea
Watertight door according to regulations 17.2 and 13	Immersed at the final equilibrium stage of flooding waterline or the worst intermediate stage of flooding waterline	Sliding	According to Revised MSC.1/Circ.1572	Closed during navigation
Door according to regulation 17.3	Above the worst intermediate and final equilibrium waterlines but within the area where the door becomes intermittently immersed (fully or partially) at angles of heel in the required range of positive stability beyond the equilibrium position	Hinged or Sliding		Doors that are remotely operated should be closed in case of damage

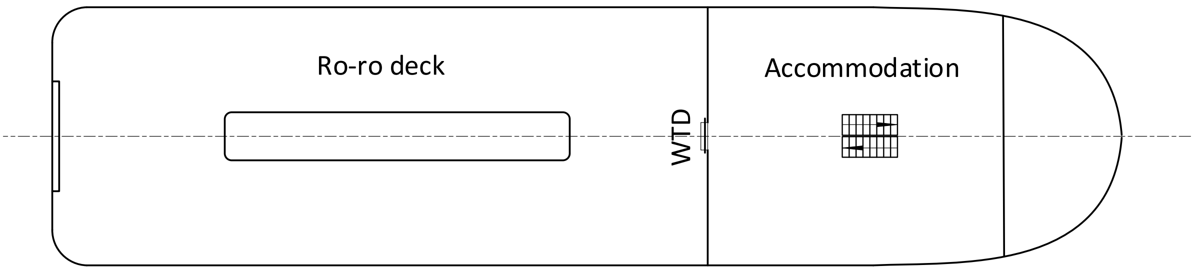
Regulation 17.~~3~~5

For passenger ships for which the building contract is placed on or after 1 January 2020 and which are constructed before 1 January 2024, this is regulation 17.3.

This paragraph is intended to ensure that progressive flooding through air pipes of volumes located above a horizontal division in the superstructure, which is considered as a watertight boundary when applying regulation 7-2.6.1.1, will be taken into consideration if a side or bottom damage would cause flooding via tanks or spaces located below the waterline.

REGULATION 17-1 – INTEGRITY OF THE HULL AND SUPERSTRUCTURE, DAMAGE PREVENTION AND CONTROL ON RO-RO PASSENGER SHIPS

Regulations 17-1.1.1 and 17-1.1.3 apply only to direct accesses from a ro-ro space to spaces located below the bulkhead deck. The operation of watertight doors in bulkheads separating a ro-ro space and other spaces as per regulation 13.8.1 should be limited to compliance with regulation 23.3.



Regulation 17-1.1.2

If a non-watertight vehicle ramp closure is assumed to restrict the flow of water during the calculation of the attained subdivision index *A*, the vehicle ramp opening should comply with regulation 7-2.5.3.4.

REGULATION 22 – PREVENTION AND CONTROL OF WATER INGRESS, ETC.

The word "port" used in this regulation includes all berths and sheltered locations where loading and/or discharging may take place.

Regulation 22.3

Regarding the requirement that Administrations authorize watertight doors that may be opened during navigation only after careful consideration of the impact on ship operations and survivability taking into account guidance issued by the Organization, no prescribed guidance with respect to stability survivability is considered necessary for cargo ships. For cargo ships, these authorizations are left to the discretion of the Administration.

Regulation 22.7

This provision applies to any hatches that are considered watertight in the damage stability calculations, whether fitted above or below the bulkhead deck of passenger ships or the freeboard deck of cargo ships.

REGULATION 23 – SPECIAL REQUIREMENTS FOR RO-RO PASSENGER SHIPS

Regulation 23.6

In the context of this paragraph, the movement of cargo during navigation should not be considered "the essential working of the ship".

APPENDIX

GUIDELINES FOR THE PREPARATION OF SUBDIVISION AND DAMAGE STABILITY CALCULATIONS

1 GENERAL

1.1 Purpose of the Guidelines

1.1.1 These Guidelines serve the purpose of simplifying the process of the damage stability analysis, as experience has shown that a systematic and complete presentation of the particulars results in considerable saving of time during the approval process.

1.1.2 A damage stability analysis serves the purpose to provide proof of the damage stability standard required for the respective ship type. At present, two different calculation methods, the deterministic concept and the probabilistic concept are applied.

1.2 Scope of analysis and documentation on board

1.2.1 The scope of subdivision and damage stability analysis is determined by the required damage stability standard and aims at providing the ship's master with clear intact stability requirements. In general, this is achieved by determining *KG*-respective *GM*-limit curves, containing the admissible stability values for the draught range to be covered.

1.2.2 Within the scope of the analysis thus defined, all potential or necessary damage conditions will be determined, taking into account the damage stability criteria, in order to obtain the required damage stability standard. Depending on the type and size of ship, this may involve a considerable amount of analyses.

1.2.3 Referring to SOLAS chapter II-1, regulation 19, the necessity to provide the crew with the relevant information regarding the subdivision of the ship is expressed, therefore plans should be provided and permanently exhibited for the guidance of the officer in charge. These plans should clearly show for each deck and hold the boundaries of the watertight compartments, the openings therein with means of closure and position of any controls thereof, and the arrangements for the correction of any list due to flooding. In addition, Damage Control Booklets containing the aforementioned information should be available.

2 DOCUMENTS FOR SUBMISSION

2.1 Presentation of documents

The documentation should begin with the following details: principal dimensions, ship type, designation of intact conditions, designation of damage conditions and pertinent damaged compartments, *KG*-respective *GM*-limit curve.

2.2 General documents

For the checking of the input data, the following should be submitted:

.1 main dimensions;

.2 lines plan, plotted or numerically;

.3 hydrostatic data and cross curves of stability (including drawing of the buoyant hull);

.4 definition of sub-compartments with moulded volumes, centres of gravity and permeability;

.5 layout plan (watertight integrity plan) for the sub-compartments with all internal and external opening points including their connected sub-compartments, and particulars used in measuring the spaces, such as general arrangement plan and tank plan. The subdivision limits, longitudinal, transverse and vertical, should be included;

.6 light service condition;

.7 load line draught;

.8 coordinates of opening points with their level of tightness (e.g. weathertight, unprotected);

.9 watertight door location with pressure calculation;

.10 side contour and wind profile;

.11 cross and downflooding devices and the calculations thereof according to resolution MSC.362(92) with information about diameter, valves, pipe lengths and coordinates of inlet/outlet;

.12 pipes in damaged area when the destruction of these pipes results in progressive flooding; and

.13 damage extensions and definition of damage cases.

2.3 Special documents

The following documentation of results should be submitted.

2.3.1 Documentation

2.3.1.1 Initial data:

.1 subdivision length L_s;

.2 initial draughts and the corresponding *GM*-values;

.3 required subdivision index *R*; and

.4 attained subdivision index *A* with a summary table for all contributions for all damaged zones.

2.3.1.2 Results for each damage case which contributes to the index *A*:

.1 draught, trim, heel, *GM* in damaged condition;

.2 dimension of the damage with probabilistic values *p*, *v* and *r*;

.3 righting lever curve (including GZ_{max} and range) with factor of survivability s;

.4 critical weathertight and unprotected openings with their angle of immersion; and

.5 details of sub-compartments with amount of in-flooded water/lost buoyancy with their centres of gravity.

2.3.1.3 In addition to the requirements in paragraph 2.3.1.2, particulars of non-contributing damages (s_i = 0 and p_i > 0.00) should also be submitted for passenger ships and ro-ro ships fitted with long lower holds including full details of the calculated factors.

2.3.2 Special consideration

For intermediate conditions, as stages before cross-flooding or before progressive flooding, an appropriate scope of the documentation covering the aforementioned items is needed in addition.

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ANNEX 2

DRAFT MSC CIRCULAR

AMENDMENTS TO SECTION 3 OF MSC.1/CIRC.1572

1 The Maritime Safety Committee, at its [102nd session (13 to 22 May 2020)], approved amendments to section 3 of the *Unified interpretations of SOLAS chapters II-1 and XII, of the Technical provisions for means of access for inspections (resolution MSC.158(78)) and of the Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers (resolution MSC.188(79))* (MSC.1/Circ.1572), as set out in the annex, prepared by the Sub-Committee on Ship Design and Construction, at its seventh session (3 to 7 February 2020).

2 Member States are invited to use the new section 3 set out in the annex and to bring it to the attention of all parties concerned.

ANNEX[*]

AMENDMENTS TO SECTION 3 OF THE ANNEX TO MSC.1/CIRC.1572

Section 3 of the annex to MSC.1/Circ.1572 is replaced by the following new text:

"3 SOLAS chapter II-1, parts B-2 – subdivision, watertight and weathertight integrity and B-4 – stability management

DOORS IN WATERTIGHT BULKHEADS OF PASSENGER SHIPS AND CARGO SHIPS

Interpretation

This interpretation pertains to doors[1] located in way of the internal watertight subdivision boundaries and the external watertight boundaries necessary to ensure compliance with the relevant subdivision and damage stability regulations.

[1] Doors in watertight bulkheads of small cargo ships, not subject to any statutory subdivision and damage stability requirements, may be hinged quick-acting doors arranged to open out of the major space protected. They should be constructed in accordance with the requirements of the Administration and have notices affixed to each side stating: "To be kept closed at sea".

This interpretation does not apply to doors located in external boundaries above equilibrium or intermediate waterplanes.

~~The design and testing requirements for watertight doors vary according to their location relative to the equilibrium waterplane or intermediate waterplane at any stage of assumed flooding.~~
The design and testing requirements for watertight doors vary according to their location relative to the 1) equilibrium waterplane or intermediate waterplane at any stage of assumed flooding, and/or 2) bulkhead deck or freeboard deck.

1 DEFINITIONS

For the purpose of this interpretation the following definitions apply:

1.1 Watertight: Capable of preventing the passage of water in any direction under a design head. The design head for any part of a structure should be determined by reference to its location relative to the bulkhead deck or freeboard deck, as applicable, or to the most unfavourable equilibrium/intermediate waterplane, in accordance with the applicable subdivision and damage stability regulations, whichever is the greater. A watertight door is thus one that will maintain the watertight integrity of the subdivision bulkhead in which it is located.

1.2 Equilibrium waterplane: The waterplane in still water when, taking account of flooding due to an assumed damage, the weight and buoyancy forces acting on a ship are in balance. This relates to the final condition when no further flooding takes place or after cross flooding is completed.

1.3 Intermediate waterplane: The waterplane in still water, which represents the instantaneous floating position of a ship at some intermediate stage between commencement and completion of flooding when, taking account of the assumed

[*] Tracked changes are indicated using "strikeout" for deleted text and "grey shading" to highlight all modifications and new insertions, including deleted text.

instantaneous state of flooding, the weight and buoyancy forces acting on a ship are in balance.

1.4 Sliding door or rolling door: A door having a horizontal or vertical motion generally parallel to the plane of the door.

1.5 Hinged door: A door having a pivoting motion about one vertical or horizontal edge.

2 STRUCTURAL DESIGN

Doors and their frames should be of approved design and substantial construction in accordance with the requirements of the Administration and should preserve the strength of the subdivision bulkheads in which they are fitted.

3 OPERATION MODE, LOCATION AND OUTFITTING

Doors should be fitted in accordance with all requirements regarding their operation mode, location and outfitting, i.e. provision of controls, means of indication, etc., as shown in table 1 below. This table should be read in conjunction with paragraphs 3.1 to 5.4 below.

3.1 Frequency of use while at sea

3.1.1 Normally closed: Kept closed at sea but may be used if authorized. To be closed again after use.

3.1.2 Permanently closed: The time of opening such doors in port and of closing them before the ship leaves port should be entered in the logbook. Should such doors be accessible during the voyage, they should be fitted with a device to prevent unauthorized opening.

~~3.1.3 Normally open: May be left open provided it is always ready to be immediately closed.~~

3.1.~~4~~3 Used: ~~In regular use, may be left open provided it is ready to be immediately closed.~~ Kept closed, but may be opened during navigation when authorized by the Administration to permit the passage of passengers or crew, or when work in the immediate vicinity of the door necessitates it being opened. The door should be immediately closed after use.

3.2 Type

Power operated, sliding or rolling[2]	POS
Power operated, hinged	POH
Sliding or rolling	S
Hinged	H

[2] Rolling doors are technically identical to sliding doors.

3.3 Control

3.3.1 Local

3.3.1.1 ~~All doors, except those which should be permanently closed at sea, should be capable of being opened and closed by hand locally,[3] from both sides of the doors, with the ship listed to either side.~~

~~[3] Arrangements for passenger ships should be in accordance with regulation II-1/13.7.1.4.~~

All doors, except those which should be permanently closed at sea, should be capable of being opened and closed by hand (and by power, where applicable) locally[3] from both sides of the doors, with the ship listed to either side.

[3] Arrangements should be in accordance with regulations II-I/13.7.1.4 and II-1/13.7.1.5 for passenger ships and regulation II-I/13-1.2 for cargo ships.

3.3.1.2 For passenger ships, the angle of list at which operation by hand should be possible is 15 degrees ~~or 20º if the ship is allowed to heel up to 20º during intermediate stages of flooding~~.

3.3.1.3 For cargo ships, the angle of list at which operation by hand should be possible is 30 degrees.

3.3.2 Remote

Where indicated in table 1, doors should be capable of being remotely closed by power from the bridge[4] for all ships, and also by hand from a position above the bulkhead deck for passenger ships as required by regulation II-1/13.7.1.4. Where it is necessary to start the power unit for operation of the watertight door, means to start the power unit ~~is also to~~ should also be provided at remote control stations. The operation of such remote control should be in accordance with regulations II-1/13.8.1 to II-1/13.8.3. For tankers, where there is a permanent access from a pipe tunnel to the main pump-room, in accordance with regulation II-2/4.5.2.4 the watertight door should be capable of being manually closed from outside the main pump-room entrance in addition to the requirements above.

[4] Arrangements ~~for passenger ships~~ should be in accordance with regulation II-1/13.7.1.5 for passenger ships and II-1/13-1.2 for cargo ships.

3.4 Indication[5]

3.4.1 Where shown in table 1, position indicators should be provided at all remote operating positions~~[5]~~ ~~as well as locally, on both sides of the doors,~~~~[6]~~ for all ships and provided locally on both sides of the internal doors for cargo ships, to show whether the doors are open or closed and, if applicable, with all dogs/cleats fully and properly engaged.

[5] ~~Indication at all remote control positions (regulation II-1/13.6).~~ Refer to regulations II-I/13, 13-1, 15-1 and 17-1, IEC 60092-504, and the Code on Alerts and Indicators, 2009 (resolution A.1021(26)).

~~[6] Refer to regulation II-1/13-1.3.~~

3.4.2 The door position indicating system should be of self-monitoring type and the means for testing of the indicating system should be provided at the position where the indicators are fitted.

3.4.3 ~~An indication (i.e. red light) should be placed locally showing that the door is in remote control mode ("doors closed mode"). Refer also to regulation II-1/13.8.1. Special care should be taken in order to avoid potential danger when passing through the door. Signboard/instructions should be placed in way of the door advising how to act when the door is in "doors closed" mode.~~ A diagram showing the location of the door and an indication to show its position should be provided at the central operating console located at the navigation bridge. A red light should indicate the door is in the open position and a green light should indicate the door is in the closed position. When the door is closed from this remote position, the red light should flash when the door is in an intermediate position. This applies to passenger ships and cargo ships.

3.4.4 Special care should be taken in order to avoid potential danger when passing through the door. Signboard/instructions should be placed in way of the door advising how to act when the door is in "doors closed" mode.

3.5 Alarms[6]

[6] Refer to regulations II-I/13, 13-1, 15-1 and 17-1, IEC 60092-504, and the Code on Alerts and Indicators, 2009 (resolution A.1021(26)).

3.5.1 For passenger ships, failure of the normal power supply of the required alarms should be indicated by an audible and visual alarm at the central operating console at the navigation bridge. For cargo ships, failure of the normal power supply of the required alarms should be indicated by an audible and visual alarm at the navigation bridge.

3.5.~~1~~2 All door types, including power-operated sliding watertight ~~D~~doors, which ~~should be~~ are capable of being remotely closed should be provided with an audible alarm, distinct from any other alarm in the area, which will sound whenever such a door is remotely closed. For passenger ships the alarm should sound for at least 5 seconds but not more than 10 seconds before the door begins to move and should continue sounding until the door is completely closed. In the case of remote closure by hand operation, an alarm ~~is required to~~ should sound only while the door is actually moving.

3.5.~~2~~3 In passenger areas and areas of high ambient noise, the audible alarms should be supplemented by visual signals at both sides of the doors.

3.5.4 All watertight doors, including sliding doors, operated by hydraulic door actuators, either a central hydraulic unit or independent for each door should be provided with a low fluid level alarm or low gas pressure alarm, as applicable, or some other means of monitoring loss of stored energy in the hydraulic accumulators. For passenger ships, this alarm should be both audible and visible and should be located at the central operating console at the navigation bridge. For cargo ships, this alarm should be both audible and visible and should be located at the navigation bridge.

3.6 Notices

As shown in table 1, doors which are normally closed at sea, but are not provided with means of remote closure, should have notices fixed to both sides of the doors stating: "To be kept closed at sea". Doors which should be permanently closed at sea should have notices fixed to both sides stating: "Not to be opened at sea".

3.7 Location

For passenger ships the watertight doors and their controls should be located in compliance with regulations II-1/13.5.3 and II-1/13.7.1.2.2.

4 FIRE DOORS

4.1 Watertight doors may also serve as fire doors but need not be fire-tested ~~when intended for use below the bulkhead deck. Where such doors are used at locations above the bulkhead deck they should, in addition to complying with the provisions applicable to fire doors at the same locations,~~ if fitted on cargo ships or if fitted below the bulkhead deck on passenger ships. However, such doors fitted above the bulkhead deck on passenger ships should be tested to the Fire Test Procedures (FTP) Code in accordance with the fire rating of the division they are fitted in. These doors should also comply with the means of escape provisions of regulation II-2/13. If it is not practicable to ensure self-closing, means of indication on the bridge showing whether these doors are open or closed and a notice stating "To be kept closed at sea" can be an alternative to self-closing.

4.2 Where a watertight door is located adjacent to a fire door, both doors should be capable of independent operation, remotely if required by regulations II-1/13.8.1 to II-1/13.8.3 and from both sides of each door.

5 TESTING

5.1 Doors which become immersed by an equilibrium or intermediate waterplane or are below the freeboard or bulkhead deck should be subjected to a hydrostatic pressure test.

5.2 For large doors intended for use in the watertight subdivision boundaries of cargo spaces, structural analysis may be accepted in lieu of pressure testing. Where such doors utilize gasket seals, a prototype pressure test to confirm that the compression of the gasket material is capable of accommodating any deflection, revealed by the structural analysis, should be carried out.

5.3 Doors above freeboard or bulkhead deck, which are not immersed by an equilibrium or intermediate waterplane but become intermittently immersed at angles of heel in the required range of positive stability beyond the equilibrium position, should be hose tested.

5.4 Pressure testing

5.4.1 The head of water used for the pressure test should correspond at least to the head measured from the lower edge of the door opening, at the location in which the door should be fitted in the ship, to the bulkhead deck or freeboard deck, as applicable, or to the most unfavourable damage waterplane, if that be greater. Testing may be carried out at the factory or other shore-based testing facility prior to installation in the ship.

5.4.2 Leakage criteria

5.4.2.1 The following acceptable leakage criteria should apply:

Doors with gaskets	No leakage
Doors with metallic sealing	Maximum leakage 1 litre/min

5.4.2.2 Limited leakage may be accepted for pressure tests on large doors located in cargo spaces employing gasket seals or guillotine doors located in conveyor tunnels, in accordance with the following:[7]

$$\text{Leakage rate (litre/min)} = \frac{(P+4.572)\,h^3}{6568}$$

where P = perimeter of door opening (metres)
h = test head of water (metres)

[7] Published in the ASTM F 1196, Standard Specification for Sliding Watertight Door Assemblies and referenced in the Title 46 US Code of Federal Regulations 170.270 Door design, operation installation and testing.

5.4.2.3 However, in the case of doors where the water head taken for the determination of the scantling does not exceed 6.1 m, the leakage rate may be taken equal to 0.375 *litre*/min if this value is greater than that calculated by the above-mentioned formula.

5.4.3 For doors of passenger ships which are ~~normally open and~~ used at sea and which become submerged by the equilibrium or intermediate waterplane, a prototype test should be conducted, on each side of the door, to check the satisfactory closing of the door against a force equivalent to a water height of at least 1 m above the sill on the centre line of the door.[8]

[8] Arrangements for passenger ships should be in accordance with regulation II-1/13.5.2.

5.5 Hose testing after installation

All watertight doors should be subject to a hose test[9] after installation in a ship. Hose testing should be carried out from each side of a door unless, for a specific application, exposure to floodwater is anticipated only from one side. Where a hose test is not practicable because of possible damage to machinery, electrical equipment insulation, or outfitting items, it may be replaced by means such as an ultrasonic leak test or an equivalent test.

[9] Refer to IACS URS 14.2.3 IACS Reg. 1996/Rev.2, 2001.

~~Table 1 – Internal doors in watertight bulkheads in cargo ships and passenger ships~~

~~Position relative to equilibrium or intermediate waterplane~~	**~~1 Frequency of use whilst at sea~~**	**~~2 Type~~**	**~~3 Remote control~~**[6]	**~~4 Indication locally and on bridge~~**[6]	**~~5 Audible alarm~~**[6]	**~~6 Notice~~**	**~~7 Comments~~**	**~~8 Regulation~~**
~~I. Passenger ships~~								
~~A.~~ ~~At or below~~	~~Normally closed~~	~~POS~~	~~Yes~~	~~Yes~~	~~Yes~~	~~No~~	~~Certain doors may be left open, see regulation II-1/22.4~~	~~II-1/22.1 to II-1/22.4~~
	~~Permanently closed~~	~~S, H~~	~~No~~	~~No~~	~~No~~	~~Yes~~	~~See Notes 1 + 4~~	~~II-1/13.9.1 and II-1/13.9.2~~
~~B.~~ ~~Above~~	~~Normally open~~	~~POS, POH~~	~~Yes~~	~~Yes~~	~~Yes~~	~~No~~		~~II-1/22.4 II-1/17.1 MSC/Circ.541~~
	~~Normally closed~~	~~S, H~~	~~No~~	~~Yes~~	~~No~~	~~Yes~~	~~See Note 2~~	
		~~S, H~~	~~No~~	~~Yes~~	~~No~~	~~Yes~~	~~Doors giving access to ro-ro deck~~	~~II-1/17-1~~
~~II. Cargo ships~~								
~~A.~~ ~~At or below~~	~~Used~~	~~POS~~	~~Yes~~	~~Yes~~	~~Yes~~	~~No~~		~~II-1/13-1.2~~
	~~Normally closed~~	~~S, H~~	~~No~~	~~Yes~~	~~No~~	~~Yes~~	~~see Notes 2 + 3 + 5~~	~~II-1/13-1.3~~
	~~Permanently closed~~	~~S, H~~	~~No~~	~~No~~	~~No~~	~~Yes~~	~~see Notes 1 + 4~~	~~II-1/13-1.4 II-1/15-1~~
~~B.~~ ~~Above~~	~~Used~~	~~POS~~	~~Yes~~	~~Yes~~	~~Yes~~	~~No~~		~~II-1/13-1.2~~
	~~Normally closed~~	~~S, H~~	~~No~~	~~Yes~~	~~No~~	~~Yes~~	~~See Notes 2 + 5~~	~~II-1/13-1.3 II-1/15-1~~

~~Notes:~~

~~1 Doors in watertight bulkheads subdividing cargo spaces.~~

~~2 If hinged, this door should be of quick-acting or single-action type.~~

~~3 SOLAS requires remotely operated watertight doors to be sliding doors.~~

~~4 The time of opening such doors in port and closing them before the ship leaves port should be entered in the logbook.~~

~~5 The use of such doors should be authorized by the officer of the watch.~~

~~6 Cables for control and power systems to power-operated watertight doors and their status indication should comply with the requirements of IACS UR E15.~~

Table 1 – Doors in internal watertight bulkheads and external watertight boundaries in passenger ships and cargo ships

A. Doors in internal watertight bulkheads

Position relative to bulkhead or freeboard deck	1 SOLAS Regulation	2 Frequency of use while at sea	3 Type	4 Remote closure	5 Remote indication	6 Audible or visual alarm	7 Notice	8 Comments
I. Passenger ships								
A. Below	II-1/10, 13.4, 13.5.1, 13.5.2, 13.6, 13.7.1, 13.8.1, 13.8.2, 16.2, 22.1, 22.3 and 22.4	Used	POS	Yes	Yes	Yes (local)	No	For doors that are used, see II-1/22.3 and MSC.1/Circ.1564
	II-1/10, 13.9.1, 13.9.2, 14.2, 16.2, 22.2 and 22.5	Permanently Closed	S, H	No	No	No	Yes	See Notes 2 + 3 + 4
B. At or above	II-1/10, 16.2, 17.1 and 22.3	Used	POS, POH	Yes	Yes	Yes (local)	No	See Note 5
			S, H	No	Yes	No	Yes	See Note 1
	II-1/17-1.1.1, 17-1.1.2, 17-1.1.3, 23.6 and 23.8		S, H	No	Yes	Yes (remote)	Yes	Doors giving access to below the ro-ro deck
	II-1/17-1.1.1, 17-1.1.2, 17-1.1.3, 22.7 and 23.3 to 23.5	Permanently Closed	S, H	No	Yes	Yes (remote)	Yes	See Notes 1 + 2 + 3
II. Cargo ships								
A. Below	II-1/10, 13-1.2, 16.2 and 22.3	Used	POS	Yes	Yes	Yes (local)	No	
	II-1/10, 13-1.3, 16.2, 22.3 and 24.4	Normally closed	S, H	No	Yes	No	Yes	See Note 1
	II-1/10, 13-1.4, 16.2, 24.3, and 24.4	Permanently closed	S, H	No	No	No	Yes	See Notes 2 + 3
	II-1/10, 13-1.4, 13-1.5, 16.2, 22.2, 24.3 and 24.4							
B. At or above	II-1/10, 13-1.2, 16.2 and 22.3	Used	POS	Yes	Yes	Yes (local)	No	
	II-1/10, 13-1.3, 16.2, 22.3 and 24.4	Normally closed	S, H	No	Yes	No	Yes	See Note 1
	II-1/10, 13-1.4, 13-1.5, 16.2, 24.3 and 24.4	Permanently closed	S, H	No	No	No	Yes	See Notes 2 + 3

Notes:

1 If hinged, this door should be of quick acting or single action type.

2 The time of opening such doors in port and closing them before a voyage commences should be entered in the logbook, in case of doors in watertight bulkheads subdividing cargo spaces.

3 Doors should be fitted with a device which prevents unauthorized opening.

4 Passenger ships which have to comply with regulation II-1/14.2 require an indicator on the navigation bridge to show automatically when each door is closed and all door fastenings are secured.

5 Refer to the explanatory note to regulation II-1/17.1 regarding sliding watertight doors with a reduced pressure head and sliding semi-watertight doors.

B. Doors in external watertight boundaries below equilibrium or intermediate waterplane

Position relative to bulkhead or freeboard deck	1 SOLAS Regulation	2 Frequency of use while at sea	3 Type	4 Remote closure	5 Remote indication	6 Audible or visual alarm	7 Notice	8 Comments
I. Passenger ships								
A. Below	II-1/15.9, 22.6 and 22.12	Permanently closed	S, H	No	No	No	Yes	See Notes 2 + 3
B. At or above	II-1/17.1 and 22.3 MSC.Circ.541	Normally closed	S, H	No	Yes	No	Yes	See Note 1
	II-1/17-1.1.1, 17-1.1.2, 17-1.3, 23.6 and 23.8		S, H	No	Yes	Yes (Remote)	Yes	Doors giving access to below ro-ro deck
	II-1/17-1.1.1, 17-1.2, 17-1.3, 23.3 and 23.5	Permanently closed	S, H	No	Yes	Yes (Remote)	Yes	See Notes 2 + 3
II. Cargo ships								
A. Below	II-1/15.9, 15-1.2, 15-1.3, 15-1.4, 22.6, 22.12 and 24.1	Permanently closed	S, H	No	Yes	No	Yes	See Notes 2 + 3
B. At or above	II-1/15-1.2	Normally closed	S, H	No	Yes	No	Yes	See Note 1
	II-1/15-1.2 and 15-1.4	Permanently closed	S, H	No	Yes	No	Yes	See Notes 2 + 3

Notes:

1 If hinged, this door should be of quick acting or single action type.

2 The time of opening such doors in port and closing them before a voyage commences should be entered in the logbook.

3 Doors should be fitted with a device which prevents unauthorized opening."

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ANNEX 3

DRAFT MSC CIRCULAR

GUIDELINES FOR SAFETY MEASURES FOR FISHING VESSELS OF 24 M IN LENGTH AND OVER OPERATING IN POLAR WATERS

1 The Maritime Safety Committee, at its [102nd session (13 to 22 May 2020)], approved the *Guidelines for safety measures for fishing vessels of 24 m in length and over operating in polar waters*, as set out in the annex, prepared by the Sub-Committee on Ship Design and Construction, at its seventh session (3 to 7 February 2020).

2 Member States are invited to use the annexed Guidelines and to bring them to the attention of all parties concerned.

ANNEX

GUIDELINES FOR SAFETY MEASURES FOR FISHING VESSELS OF 24 M IN LENGTH AND OVER OPERATING IN POLAR WATERS

PREAMBLE

These Guidelines for fishing vessels of 24 m in length and over have been developed to supplement existing IMO instruments in order to increase the safety of fishing vessels operating in polar waters and persons on board, and to mitigate the impact on the people and environment in the remote, vulnerable and potentially harsh polar waters.

These Guidelines are designed to align with the Cape Town Agreement of 2012, the entry into force of which is pending. The International Code for Ships Operating in Polar Waters (Polar Code) also provides useful context to the current Guidelines.

These Guidelines are recommendatory and their wording is designed to provide guidance rather than mandatory direction. They are not intended to infringe on national systems of shipping control.

INTRODUCTION

1 Purpose

These Guidelines provide for the enhanced safety of fishing vessels of 24 m in length and over and persons on board by addressing risks specific to their operation in polar waters.

2 Background

These Guidelines were developed in acknowledgement that operating in polar waters imposes additional demands on vessel systems, including navigation, communications, life-saving, main and auxiliary machinery, environmental protection and damage control, beyond those normally encountered.

These Guidelines also recognize that safe operation in such conditions requires special attention to human factors, including crewing arrangements, training in emergency and operational procedures, to ensure safety in a polar environment.

These Guidelines focus on the need to ensure that fishing vessel systems are capable of functioning effectively under anticipated operating conditions and to provide adequate levels of safety in accident and emergency situations.

In June 2018, the Maritime Safety Committee reviewed safety measures for non-SOLAS ships operating in polar waters. The Committee noted the lack of a legal framework to allow for the mandatory application of the Polar Code to non-SOLAS ships, together with evidence regarding the number of accidents involving non-SOLAS ships operating in polar waters, particularly in the Antarctic area. Concluding that these facts revealed a significant risk to the safety of lives at sea and a continuing threat to the marine environment, the Committee determined that urgent action needed to be taken. These Guidelines are the result of the Committee’s decision to develop recommendatory safety measures for fishing vessels of 24 m in length and over, operating in polar waters.

3 Source of hazards

These Guidelines consider hazards which may expose fishing vessels to elevated levels of risk, some of which are unique to polar conditions. These include:

.1 ice, as it may affect hull structure, stability characteristics, machinery systems, navigation, the outdoor working environment, maintenance and emergency preparedness tasks and malfunction of safety equipment and systems;

.2 experiencing topside icing, with potential reduction of stability and equipment functionality;

.3 low temperature, as it affects the working environment and human performance, maintenance and emergency preparedness tasks, material properties and equipment efficiency, survival time and performance of safety equipment and systems;

.4 extended periods of darkness or daylight as it may affect navigation and human performance;

.5 high latitude, as it affects navigation systems, communication systems and the quality of ice imagery information;

.6 remoteness and possible lack of accurate and complete hydrographic data and information, reduced availability of navigational aids and seamarks with increased potential for groundings compounded by remoteness, limited readily deployable search and rescue (SAR) facilities, delays in emergency response and limited communications capability, with the potential to affect incident response;

.7 potential lack of experience in polar operations, with potential for human error;

.8 potential lack of suitable emergency response equipment, with the potential for limiting the effectiveness of mitigation measures; and

.9 rapidly changing and severe weather conditions, with the potential for escalation of incidents.

The risk level within polar waters may differ depending on the geographical location and time of the year with respect to daylight, ice-coverage, etc. Therefore, mitigating measures suitable to address the above specific hazards may vary within polar waters and may be different in Arctic waters and the Antarctic area.

These Guidelines also recognize that, while Arctic waters and the Antarctic area have a number of similarities, there are also significant differences, and that the specific features of the legal and political regimes applicable to their respective vulnerable marine environments should be taken into account.

CHAPTER 1
GENERAL

Purpose

This chapter provides guidance on general operating and safety arrangements.

1.1 Application

These Guidelines provide guidance for fishing vessels of 24 m in length and over operating in polar waters.

1.2 Definitions

The following definitions are applicable to these Guidelines.

1.2.1 *Antarctic area* means those waters which are south of 60° S (see figure 1).

1.2.2 *Arctic waters* means those waters which are located north of a line extending from latitude 58°00'.0 N, longitude 042°00'.0 W to latitude 64°37'.0 N, longitude 035°27'.0 W and thence by a rhumb line to latitude 67°03'.9 N, longitude 026°33'.4 W and thence by a rhumb line to Sørkapp, Jan Mayen and by the southern shore of Jan Mayen to the Island of Bjørnøya and thence by a great circle line from the Island of Bjørnøya to Cap Kanin Nos and thence by the northern shore of the Asian continent eastward to the Bering Strait and thence from the Bering Strait westward to latitude 60° N as far as Il'pyrskiy and following the 60th North parallel eastward as far as and including Etolin Strait and thence by the northern shore of the North American continent as far south as latitude 60° N and thence eastward along parallel of latitude 60° N, to longitude 56°37'.1 W and thence to the latitude 58°00'.0 N, longitude 042°00'.0 W (see figure 2).

1.2.3 *Directional control system* means any device or devices intended either as a primary or auxiliary means of steering the ship. The directional control system includes all associated power sources, linkages, controls and actuating systems.

1.2.4 *Escort* means any ship with superior ice capability in transit with another ship.

1.2.5 *Hull penetrations* means areas where water can get into the hull, including seawater inlets, rudder pintles and propeller shaft seals.

1.2.6 *Ice-covered waters* means polar waters where local ice conditions present a structural risk to a ship.

1.2.7 *Icebreaker* means any ship whose operational profile may include escort or ice management functions, whose powering and dimensions allow it to undertake aggressive operations in ice-covered waters.

1.2.8 *Ice of land origin* means ice formed on land or in an ice shelf, found floating in water.

1.2.9 *Maximum expected rescue time* means the time adopted for the design of equipment and systems that provide survival support. It should typically be not less than five days.

1.2.10 *Mean Daily Low Temperature (MDLT)* means the mean value of the daily low temperature for each day of the year over a minimum 10-year period. A data set acceptable to the Administration may be used if 10 years of data is not available.

1.2.11 *Open water* means a large area of freely navigable water in which sea ice is present in concentrations less than 1/10. No ice of land origin is present.

1.2.12 *Polar service temperature* (PST) means a temperature specified for a ship which is intended to operate in low air temperature, which should be set at least 10° C below the lowest MDLT for the intended area and season of operation in polar waters.

1.2.13 *Polar waters* includes both Arctic waters and the Antarctic area.

1.2.14 *Sea ice* means any form of ice found at sea which has originated from the freezing of sea water.

1.2.15 *Ship intended to operate in low air temperature* means a ship which is intended to undertake voyages to or through areas where the lowest MDLT is below -10° C.

1.2.16 *Sufficient positive stability* means that the ship is in a state of equilibrium with a positive metacentric height of at least 150 mm, and a line 150 mm below the edge of the freeboard deck, is not submerged.

Figure 1 – Maximum extent of Antarctic area application

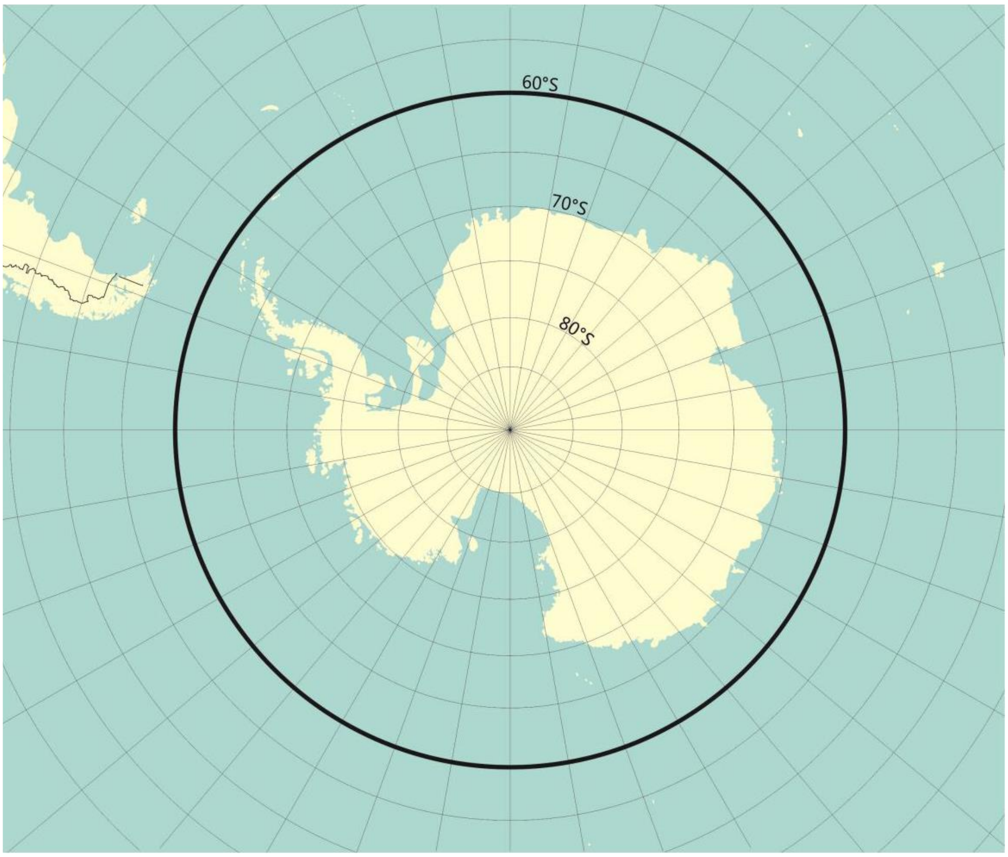

Figure 2 – Maximum extent of Arctic waters application

1.3 Performance standards

1.3.1 Unless provided otherwise, fishing vessel systems and equipment addressed in these Guidelines should satisfy at least the same performance standards referred to in the 2005 Code of Safety for Fishermen and Fishing Vessels, the *Voluntary guidelines for the design, construction, and equipment of small fishing vessels 2005*, an applicable national standard, or the appropriate requirements of a recognized organization.

1.3.2 Fishing vessels and their equipment should be designed, constructed and maintained in compliance with applicable national standards of the Administration or the appropriate requirements of a recognized organization or competent body which provide an equivalent level of safety for its intended service.

1.3.3 The structures, equipment and arrangements essential for the safety and operation of the fishing vessel should take account of the anticipated temperatures.

1.3.4 Special attention should be given to essential operating and safety equipment and associated systems. For example, the potential for ice building up inside ballast tanks, sea chests and in other potential areas that can be penetrated through the hull affecting the ballast and piping system respectively should be considered. The fire-extinguishing and life-saving equipment specified in chapters 1 and 7 of these Guidelines, when stored or located in an exposed position, should be of a type that is rated to perform its design functions at the mean daily low temperature. In particular, attention is drawn to the inflation of life-saving equipment and the starting of engines in lifeboats and rescue boats.

1.3.5 For fishing vessels operating in low air temperature, a PST should be specified which should be at least 10°C below the lowest MDLT for the intended area and season of operation in polar waters. Systems and equipment recommended by these Guidelines should be fully functional at PST.

1.3.6 For fishing vessels operating in low air temperature, survival systems and equipment should be fully operational at PST during the maximum expected rescue time.

1.4 Operational arrangements

1.4.1 Fishing vessels not required to have a safety management system (International Safety Management (ISM) Code or similar) should carry on board a supplementary operating manual containing information directly relevant to operations in polar waters. Information that might be included in such a manual is suggested in paragraph 1.5.2.

1.4.2 The vessel should not be operated outside the worst intended conditions and design limitations, the details of which should be set out in the supplementary operating manual described in paragraph 1.4.1, if one is carried.

1.4.3 Fishing vessels should take account of the distance from search and rescue facilities.

1.4.4 In order to establish procedures or operational limitations, an assessment should be made of fishing vessels intending to operate in polar waters, and their equipment. This assessment could be undertaken by the operator or shipowner to ensure that such fishing vessels are fit for the intended purpose. The assessment might consider the following:

.1 the anticipated range of operating and environmental conditions, such as:

.1 operation in low air temperature;

.2 operation in ice;

.3 operation in areas, and during periods, where ice accretion is likely to occur;

.4 operation in high latitude; and

.5 potential for abandonment onto ice or land; and

.2 hazards which may potentially occur in polar waters, as listed in section 3 of the introduction to these Guidelines.

1.5 Documentation

1.5.1 It is recommended that a supplementary operating manual containing information directly relevant to operations in polar waters is carried on board. The supplementary manual is intended to provide persons on board with sufficient information regarding the vessel's operational capabilities and limitations in order to support their decision-making process. The supplementary manual might include the type of information and procedures suggested below. Not every issue on the list will be applicable to every fishing vessel. Vessels that undertake occasional or limited polar voyages would not need to have procedures in place for situations of very low probability of occurrence.

1.5.2 Information in such a supplementary manual for operations in polar waters might include:

.1 details of the vessel's specific capabilities and operating limitations relevant to normal operations and to anticipated ice conditions and temperatures, including:

.1 systems susceptible to damage or loss of functionality by exposure to low temperatures, and measures to avoid malfunction;

.2 information on limitations on vessel endurance such as fuel tankage, freshwater capacity, provisions stores, etc.; and

.3 information on the icing allowance included in the stability calculations;

.2 operating procedures to be followed in normal conditions and in order to avoid encountering ice conditions that exceed the vessel's capabilities;

.3 procedures to be followed in the event of incidents in polar waters, including evacuation procedures and damage control;

.4 procedures for checking the integrity of hull structure in polar conditions;

.5 special measures to maintain equipment and system (especially communications and navigational) functionality under low temperatures, topside icing and the presence of sea ice, as applicable;

.6 description and operation of fire detection and fire-extinguishing equipment in a polar environment;

.7 guidance on how to prevent or mitigate icing by operational means, how to monitor and assess ice accretion, how to conduct de-icing using available equipment, and how to maintain safety of the vessel and persons on board during all of these aspects of the operation;

.8 guidance on how to monitor, prevent, or mitigate ice ingestion by seawater systems when operating in ice or in low water temperatures;

.9 procedures for voyage planning to avoid ice and/or temperatures that exceed the vessel's design capabilities or limitations;

.10 procedures to mitigate risk in adverse ice conditions, including:

.1 guidance on the use of low speeds in the presence of hazardous ice;

.2 procedures for enhanced watchkeeping and lookout crewing in situations with high risks from ice, e.g. in proximity to icebergs, operation at night and other situations of low visibility; and

.3 where possibilities for contact with hazardous ice exist, procedures should address regular monitoring, e.g. soundings or inspections of compartments and tanks below the waterline;

.11 procedures to establish requirements for supplies and appropriate safety levels for safety margins, taking into account various scenarios, e.g. slower than expected steaming, course alterations, adverse ice conditions, places of refuge and access to provisions. Sources for, and availability of, fuel types should be established, taking into account long lead times required for deliveries;

.12 guidance for human resources management, taking into account anticipated ice conditions and requirements for ice navigation, increased levels of watch keeping, hours of rest, fatigue and a process that ensures that these procedures are met;

.13 arrangements for receiving forecasts of the environmental conditions, including appropriate ice and weather information;

.14 arrangements for addressing any limitations of the hydrographic, meteorological and navigational information available;

.15 procedures to increase the effectiveness of emergency response measures where hazards specific to the polar environment are likely to be encountered;

.16 details for contacting emergency response providers for salvage, search and rescue (SAR), spill response, etc.; and

.17 procedures for maintaining life support and vessel integrity in the event of prolonged entrapment by ice.

CHAPTER 2
CONSTRUCTION AND WATERTIGHT INTEGRITY

Purpose

This chapter sets out standards sufficient to maintain structural construction and watertight integrity for fishing vessels operating in polar conditions.

2.1 General

2.1.1 The structure should be designed to resist both global and local loads anticipated under expected ice conditions.

2.1.2 Structural arrangements should aim to limit damage resulting from accidental overloads to local areas.

2.2 Materials

2.2.1 For fishing vessels intended to operate in low air temperature, materials used should be suitable for operation at the vessel's PST.

2.2.2 Abrasion and corrosion-resistant coatings and claddings used in ice-strengthened areas should be matched to the anticipated loads and structural response.

2.3 Weathertight integrity

2.3.1 All closing appliances and doors relevant to watertight and weathertight integrity should be operable in polar conditions.

2.3.2 When operating in areas and during periods where ice accretion is likely to occur, means should be provided to remove or prevent ice and snow accretion around hatches and doors.

2.3.3 If the hatches or doors are hydraulically operated, means should be provided to prevent freezing or excessive viscosity of liquids.

2.3.4 Watertight and weathertight doors, hatches and closing devices which are not within a habitable environment and require access while at sea, should be capable of being operated by persons wearing heavy winter clothing including thick mittens.

2.4 Subdivision

Where double bottoms are fitted over the breadth and the length between forepeak and afterpeak bulkheads, the height of the double bottom height should be in accordance with the rules of a recognized organization or competent body.

CHAPTER 3
STABILITY

Purpose

This chapter sets out standards for adequate stability of fishing vessels in both intact and damaged conditions.

3.1 General

Account should be taken of the effect of icing in the stability calculations in accordance with the International Code on Intact Stability, 2008 (2008 IS Code).

3.2 Stability in intact conditions

3.2.1 The supplementary manual, if carried (see 1.5.1), should include information on the icing allowance included in the stability calculations.

3.2.2 Ice accretion should be monitored and appropriate measures taken to ensure that the ice accretion does not exceed the values given in the supplementary manual, if carried.

3.2.3 For each standard loading condition, vessels should be shown by design calculations to meet the intact stability criteria of Part B/2.1 of the 2008 IS Code.

3.3 Stability in damaged conditions

Consideration should be given to vessel stability in damaged conditions, taking into account the type of vessel, the intended service and area of operation.

CHAPTER 4
MACHINERY AND ELECTRICAL INSTALLATIONS

Purpose

This chapter sets out the required functionality for machinery and electrical installations necessary for the fishing vessel's safe operation.

4.1 General

4.1.1 The design, rating, installation, operation and maintainability of all onboard machinery and equipment should be suitable for operation and navigation in polar waters and the harsh weather conditions that often occur. Factors to be taken into account include:

.1 ice accretion and/or snow accumulation;
.2 ice ingestion from seawater;
.3 freezing and increased viscosity of liquids;
.4 seawater intake temperature; and
.5 snow ingestion.

4.1.2 In addition, for fishing vessels intended to operate in low air temperatures, factors to be taken into account include:

.1 cold and dense inlet air; and
.2 loss of performance of battery or other stored energy device.

4.1.3 Materials used for machinery and electrical installations should be suitable for operation at the vessel's PST. In particular, machinery and electrical installations which are essential for the safe operation when:

.1 located outside and above the waterline in any operating condition; or
.2 in unheated locations inside,

should not be susceptible to brittle fracture within the range of operating conditions.

4.1.4 For vessels intended to operate in ice-covered waters, machinery and electrical installations should provide functionality under the anticipated environmental conditions, taking into account loads imposed directly by ice interaction.

4.1.5 The layout and construction of machinery essential for the safe operation of the fishing vessel should be such that repairs which can be affected using the resources on board may be completed safely and effectively.

4.1.6 Ventilation systems should provide sufficient air at an appropriate temperature for the operation of machinery.

4.2 Main propulsion systems

4.2.1 The main propulsion machinery should be designed and protected against the effects of the anticipated environmental and operational conditions. The reliability and availability of the equipment and systems, including spare parts for components which can be readily repaired, should be considered.

4.2.2 Main propulsion machinery and all auxiliary machinery essential to the propulsion system should be:

.1 designed for loads and vibrations resulting from propeller/hull/rudder-ice interactions;

.2 located to provide protection from freezing spray, ice and snow;

.3 designed to operate when the vessel is inclined at any combined angle of heel or trim that may be expected during operations in ice; and

.4 designed to be protected from a direct hit by ice.

4.2.3 The installed propulsive power should be sufficient to ensure that the vessel can navigate safely, without risk of structural damage under the design ice, weather and anticipated operational conditions.

4.2.4 Piping and intake systems associated with the main propulsion plant and auxiliary machinery essential to the propulsion system should be designed to withstand frost so as not to be affected by the impact of the polar environment.

4.3 Auxiliary machinery systems

4.3.1 Equipment and systems should be designed so that exposure of persons on board to cold temperatures and other environmental hazards during normal operations including routine maintenance is minimized.

4.3.2 Essential equipment or systems required for safe operation, located within spaces which, upon failure of the primary heating system, could be subject to outside ambient air temperatures should be:

.1 provided with an independent source of heat; and

.2 fabricated from materials that are not susceptible to brittle fracture under the anticipated loads and temperatures.

4.4 Directional control systems

4.4.1 Directional control systems, if fitted, should be of adequate strength and suitable design to enable efficient operation in polar waters.

4.4.2 Where interaction between the vessel's directional control systems and propulsion systems occurs or where dual purpose components are fitted, the provisions of this chapter relating to propulsion systems should also be followed.

4.5 Electrical installations

4.5.1 Electrical installations should be designed for operation in polar waters and for the provision of emergency heat and power.

4.5.2 For vessels intended to operate in ice-covered waters, precautions should be taken to minimise risk of supplies to essential and emergency services being interrupted by the inadvertent or accidental opening of switches or circuit breakers due to vibrations or accelerations during icebreaking operations.

4.5.3 Emergency power batteries including the reserve source of energy for the radio installation, including those stored in deck boxes, should be secured in a position where excessive movement is prevented during ice-transiting operations and explosive gas ventilation is not restricted by the accumulation of ice or snow.

4.5.4 Control systems based on computers and other electronic hardware installations necessary for the proper functioning of essential equipment should be designed for redundancy and resistance to vibration, dampness and low humidity.

CHAPTER 5
FIRE PROTECTION, FIRE DETECTION, FIRE EXTINCTION AND FIRE FIGHTING

Purpose

This chapter sets out standards for fire safety systems and appliances on fishing vessels to ensure they are effective and operable in polar conditions, and that means of escape remain available so persons on board can safely and swiftly escape under the expected environmental conditions.

5.1 General

5.1.1 Components of fire safety systems and appliances should be designed to ensure availability and effectiveness under PST.

5.1.2 Components of the fire-fighting system and appliances which may be exposed to icing and snow accumulation that could interfere with the proper functioning of that component should be adequately protected.

5.1.3 Local equipment and machinery controls should be arranged so as to avoid freezing, snow accumulation and ice accretion and their location to remain accessible at all times.

5.1.4 Fire safety systems and appliances should be capable of being operated normally by persons wearing bulky and cumbersome polar clothing.

5.1.5 Means should be provided to remove or prevent ice and snow accretion from accesses.

5.1.6 Extinguishing media should be suitable for the intended operation.

5.2 Ventilation

Closing apparatus for ventilation inlets and outlets should be designed and located to protect them from ice or snow accumulation that could interfere with the effective closure of such systems.

5.3 Fire detection and fire-extinguishing systems

5.3.1 Fire-extinguishing systems should be designed or located so that they are not made inaccessible or inoperable by ice or snow accumulation or low temperature such that:

.1 equipment, appliances, systems and extinguishing agents should be protected from freezing for the intended voyage;

.2 precautions should be taken to prevent nozzles, piping and valves of any fire-extinguishing system from becoming clogged by impurities, corrosion or ice build-up; and

.3 exhaust gas outlets and pressure vacuum arrangements should be protected from ice build-up that could interfere with effective operation.

5.3.2 Water or foam extinguishers should not be located in any position that is exposed to freezing temperatures. These locations should be provided with extinguishers capable of operation under such conditions.

5.4 Fire pumps and associated equipment

5.4.1 Where a fixed water-based fire-extinguishing system or an alternative fire-extinguishing system situated in a space separate from the compartment containing the main fire pumps utilizes its own independent sea suction, this sea suction should be capable of being cleared of ice accumulation.

5.4.2 Fire pumps, including emergency fire pumps, water mist and water spray pumps should, wherever reasonable and practicable, be installed in heated compartment(s) and in any event should be adequately protected from freezing.

5.4.3 Isolating valves should be located so that they are accessible. Any isolating valves located in exposed positions should not be subject to icing from freezing spray. The fire main should be arranged so that exposed sections can be isolated and means of draining exposed sections should be provided.

5.4.4 Hydrants should be positioned or designed to remain operable under all anticipated temperatures. Ice accumulation and freezing should be taken into account.

5.4.5 All hydrants should be equipped with an efficient two-handed valve handle.

5.4.6 In addition, for fishing vessels intended to operate in low air temperature portable and semi-portable extinguishers should be located in positions protected from freezing temperatures, as far as practical. Locations subject to freezing should be provided with extinguishers capable of operation under PST.

5.5 Firefighters' outfits

Sufficient firefighters' outfits, including one spare, should be readily available to the accommodation area and elsewhere as appropriate. Such firefighters' outfits should be stored in warm positions as widely separated as practical.

CHAPTER 6
PROTECTION OF PERSONS ON BOARD

Purpose

This chapter sets out standards for the protection of persons on board when the vessel is operating in polar water conditions.

6.1 General

6.1.1 Particular care should be taken to ensure that decks are designed or treated so as to minimize the possibility of slipping in icy deck conditions.

6.1.2 Fishing vessels should have sufficiently available and reliable facilities to maintain a life sustaining environment in the event of an emergency and/or of extended ice entrapment.

6.2 Bulwarks, rails and guards

Particular care should be taken to ensure that the bulwarks or guard rails that are to be fitted on all exposed parts of the working deck and on superstructure decks if they are working platforms should be designed so as to provide adequate protection of persons on board in the harsher weather conditions that can occur in polar regions.

6.3 Stairways and ladders

All stairways and ladders should be dimensioned so as not to hinder passage for persons wearing suitable polar clothing.

6.4 Other safety measures

Accommodation should be designed and arranged to protect the occupants from unfavourable environmental conditions and minimize risk of injury during normal (including ice transiting or icebreaking) operations and emergency conditions.

6.5 Means of escape

6.5.1 Means of escape from accommodation or interior working spaces should not be rendered inoperable by ice accretion or by malfunction due to low external ambient air temperatures.

6.5.2 Escape routes should remain accessible and safe, taking into consideration the potential icing of structures and snow accumulation. They should be of a dimension so as not to hinder passage for persons wearing suitable polar clothing.

6.5.3 All means of escape from accommodation or interior working spaces in the case of fire should be in accordance with the relevant provisions relating to fire safety in chapter V of these Guidelines.

CHAPTER 7
LIFE-SAVING APPLIANCES AND ARRANGEMENTS

Purpose

This chapter sets out standards for the safe escape, evacuation and survival of persons on board.

7.1 General

7.1.1 Fishing vessels should carry life-saving appliances and survival equipment suited to the polar environment.

7.1.2 All survival craft, rescue boats, appliances and associated equipment, and survival equipment should be designed so as to remain functional under the possible adverse environmental conditions during the maximum expected time of rescue.

7.1.3 All survival craft and rescue boats should be designed so as to provide effective protection against possible adverse environmental conditions including direct wind chill, for all on board.

7.1.4 All survival craft, rescue boats, life-saving appliances and associated equipment, and survival equipment should take account of the potential of operation in long periods of darkness, taking into consideration the intended voyage.

7.1.5 Adequate supplies of protective clothing and thermal insulating materials should be provided, taking into account the intended voyage, anticipated weather conditions and the potential for immersion in polar water.

7.1.6 Survival craft should have sufficient space to accommodate persons equipped with polar clothing suitable for the environment.

7.1.7 Survival craft should carry equipment, appropriate for use in polar conditions, to communicate with rescue assets.

7.1.8 Survival craft should carry adequate emergency rations for the maximum expected time of rescue, taking account of high rates of energy expenditure under polar conditions.

7.1.9 Insulated immersion suits should be carried.

7.1.10 Training in the use of emergency equipment, as appropriate, and training on action to take in an emergency, should be included as an element of the operating procedures and drills described in chapter 8.

7.2 Embarkation into survival craft

7.2.1 Embarkation arrangements should be such as to not hinder passage by persons wearing suitable polar clothing.

7.2.2 Embarkation arrangements should be adequate to ensure the safety of persons on board taking into consideration the possible adverse environmental conditions during an emergency.

7.2.3 Embarkation arrangements should provide for the safe deployment of survival craft and associated equipment and be functional under the possible adverse environmental conditions during the maximum expected time of rescue. Where survival equipment requires a source of power, this should be able to operate independently of the vessel's main source of power.

7.3 Lifeboats

7.3.1 All lifeboats should be either of the partially or totally enclosed type to provide adequate shelter from the anticipated operating environment.

7.3.2 The capacity of lifeboats should be evaluated with regard to operability, accessibility, seating capacity and overall space, considering the needs of personnel wearing suitable polar clothing.

7.3.3 Any ice accretion should be regularly removed from the lifeboats, launch area and launching equipment to ensure readiness for launching when required. An icing removal mallet should be available in the vicinity of the lifeboats.

7.3.4 All lifeboat engines should be equipped with a means to ensure they start readily when required at the MDLT.

7.3.5 The lifeboat engine fuel oil should be suitable for operation in the minimum anticipated operating temperature.

7.3.6 For vessels intended to operate in extended periods of darkness, searchlights suitable for continuous use to facilitate identification of ice should be provided for each lifeboat.

7.3.7 Lifeboats and containers for group survival equipment in their stowed position should have means to mitigate the freezing of drinking water supplies.

7.4 Liferafts

7.4.1 Any ice accretion should be regularly removed from the liferafts, cradles, launch area and launching equipment to ensure readiness for launching and inflation when required. An icing removal mallet should be available in the vicinity of the liferafts.

7.4.2 Fishing vessels should carry in a warm space in the vicinity of the liferafts manual inflation pumps that are proven to be effective in PST.

7.4.3 Air or other proven cold temperature gas should be used for the inflation of life-saving equipment according to their environmental conditions of operation.

7.5 Additional survival kits for polar conditions

7.5.1 Sufficient personal and group survival kits should be carried to cover at least 110% of the persons on board the vessel.

7.5.2 Personal survival kits (PSK) should be carried whenever a voyage is anticipated to encounter mean daily temperatures below 0°C.

7.5.3 PSKs should be stored so that they may be easily retrieved in an emergency situation. Arrangements such as storage in dedicated lockers near the assembly stations may be considered.

7.5.4 Persons on board should be advised as appropriate that their PSK is for emergency survival use only and items should not be removed from the carrying bag.

7.5.5 Suggested contents of a PSK are listed in the table below.

Table 7.1: Sample of items for inclusion in a personal survival kit

Suggested equipment
Protective clothing (hat, gloves, socks, face and neck protection, thermal underwear, etc.)
Skin protection cream
Insulated immersion suit
Handwarmers
Sunglasses or goggles
Whistle
Signal mirror
Personal Locator Beacon
Drinking mug
Emergency food
Penknife
Handbook (Polar Survival)
Carrying bag

7.5.6 Group survival kits (GSK) should be carried whenever a voyage is anticipated to encounter ice conditions which may prevent the lowering and operation of survival craft, potentially involving abandonment onto ice or land.

7.5.7 GSKs should be stored so that they may be easily retrieved and deployed in an emergency situation. Any containers should be located adjacent to the survival craft and liferafts. Containers should be designed so that they may be easily moved over the ice and be floatable.

7.5.8 Suggested contents of a GSK are listed in the table below.

Table 7.2: Sample of items for inclusion in a group survival kit

Suggested equipment
Shelter – tents or storm shelters or equivalent – sufficient for maximum number of persons
Foam sleeping mats or similar – sufficient for at least one between two persons
Sleeping bags – sufficient for at least one between two persons
Shovels – at least 2

Sanitation (e.g. toilet paper)
Stove and fuel – sufficient for maximum number of persons ashore and maximum anticipated time of rescue
Emergency food – sufficient for maximum number of persons ashore and maximum anticipated time of rescue
One first aid kit in a waterproof case
Flashlights – one per shelter
Waterproof and windproof matches – two boxes per shelter
Whistle
Signal mirror
Emergency Position Indicating Radio Beacon
Appropriate communications equipment, separate from that carried on the
Water containers & water purification tablets
Spare set of personal survival equipment
Snow saw and snow knife
Tarpaulin
Group survival equipment container (waterproof and floatable)

7.5.9 PSK and GSK inspections should be carried out no less frequently than on an annual basis.

7.5.10 Where PSK and/or GSK are fitted, consideration should be given to providing additional kits for training and demonstration purposes.

CHAPTER 8
EMERGENCY PROCEDURES, MUSTERS AND DRILLS

Purpose

This chapter sets out standards to ensure that persons on board fishing vessels are adequately trained and familiar with emergency procedures, their duties, musters and drills specific to an emergency in polar waters.

8.1 General

Emergency drills should be carried out on a regular basis.

8.2 Onboard instruction for emergency operations

8.2.1 Instructions for drills and emergency instructions as detailed in this section should be incorporated as annexes to the training manual referred to in paragraph 11.5.6 of these Guidelines.

8.2.2 Onboard instruction and operation of life-saving, fire and damage control appliances and systems should include appropriate cross training of crew members with appropriate emphasis to changes to standard procedure made necessary by operations in polar waters.

8.2.3 All personnel should be given instructions which might include:

.1 awareness of problems of cold shock, snow blindness, sun burn, hypothermia, first-aid treatment of hypothermia and other appropriate first-aid procedures; and

.2 special instructions necessary for use of life-saving appliances in severe weather, and severe sea conditions on the ice or in a combination of water and ice cover.

8.3 Abandon ship drills

8.3.1 Abandon ship drills should be varied so that different emergency conditions are simulated, including abandonment into the water, onto the ice, or a combination of the two.

8.3.2 The abandon ship drills could include:

.1 checking that all personnel are suitably dressed;

.2 donning of immersion suits and thermal protective clothing;

.3 testing of emergency lighting for assembling and abandonment; and

.4 giving instructions in the use of life-saving appliances, and in survival at sea, on the ice, or a combination of both, as appropriate.

8.4 Rescue boat drills

Rescue boat drills should be conducted as far as is reasonable and practicable with due consideration of the dangers of launching into polar ice-covered waters.

8.5 Fire drills

8.5.1 Fire drills should be varied so that emergency conditions are simulated for different compartments of the vessel, with appropriate emphasis on those changes to standard procedures made necessary by operations in polar waters and low temperatures.

8.5.2 Fire drills should include elements made necessary by operation in a polar environment.

8.6 Damage control drills

Damage control drill scenarios should be varied so that emergency conditions are simulated for different damage conditions with appropriate emphasis to those conditions resultant from operations in polar waters.

CHAPTER 9
RADIOCOMMUNICATIONS

Purpose

This chapter provides standards for effective communication for fishing vessels and survival craft in polar waters during normal operation and in emergency situations.

9.1 General

9.1.1 Communications equipment should be suitable to provide adequate ship-to-ship and ship-to-shore communication at all points along the intended operating routes, taking into account the limitations of communications systems in high latitudes and the anticipated low temperature.

9.1.2 All two-way portable radio communication equipment should be operable at the polar service temperature.

9.1.3 Means for two-way on-scene and SAR coordination communications for search and rescue purposes including aeronautical frequencies should be provided.

9.1.4 Appropriate communication equipment to enable telemedical assistance in polar areas should be provided.

9.1.5 Emergency power for communications equipment provided by battery should be provided with a means whereby the batteries are protected from extreme low temperatures.

9.2 Survival craft and rescue boat communications capabilities

9.2.1 For fishing vessels intended to operate in low air temperature, all rescue boats and lifeboats, whenever released for evacuation, should maintain capability for distress alerting, locating and on-scene communications.

9.2.2 For fishing vessels intended to operate in low air temperature, all other survival craft, whenever released, should maintain capability for transmitting signals for location and on-scene communications.

9.2.3 Communication equipment intended for use in survival craft, including liferafts, and rescue boats should be capable of operation during the maximum expected time of rescue.

CHAPTER 10
SHIPBORNE NAVIGATIONAL EQUIPMENT AND ARRANGEMENTS

Purpose

This chapter provides for safe navigation in polar waters.

10.1 General

10.1.1 Taking account of the fact that use in high latitudes may affect their performance, navigational equipment and systems for providing reference headings and position fixing should be designed, constructed, and installed to retain their functionality under the expected environmental conditions in the intended area of operation.

10.1.2 Fishing vessels should have means of receiving and displaying current and forecasted information on ice conditions in the intended area of operation.

10.1.3 Sensors, antennas and other navigational equipment should be protected from ice accretion.

10.2 Additional navigational equipment for operations in polar waters

10.2.1 Fishing vessels should be fitted with two non-magnetic means to determine and display their heading.

10.2.2 Fishing vessels should be fitted with at least one appropriate speed and distance measuring system.

10.2.3 Fishing vessels should be fitted with at least two independent echo-sounding devices which provide an indication of the depth of water under the keel. Due account should be taken of the potential for ice interference or damage to any device designed to operate below the waterline.

10.2.4 Fishing vessels should be fitted with a total of at least two functionally independent radar systems. One of these should operate in the 3 GHz (10 cm, S-band) frequency range.

10.2.5 The use of radars equipped with enhanced ice detection capability should be encouraged.

10.2.6 Radar plotting systems that may be installed should have the capability of operating in both the sea and the ground stabilized mode.

10.2.7 A satellite system (GPS or GLONASS or equivalent) should be fitted on any vessel intending to navigate in areas outside of reliable coverage by a terrestrial hyperbolic system.

10.2.8 Fishing vessels should be provided with automatic identification system (AIS).

10.2.9 Separate rudder angle indicators should be provided for each rudder on fishing vessels with more than one independently operable rudder.

10.2.10 Fishing vessels should be equipped with suitable searchlights.

10.2.11 The searchlights described in paragraph 10.2.10 should be installed to provide, as far as is practicable, all-round illumination suitable for berthing, astern manoeuvres or emergency towing; and should be fitted with an adequate means of de-icing to ensure proper directional movement.

10.2.12 Fishing vessels should be fitted with a suitable means to de-ice sufficient helm position windows to provide sufficient watchkeeping capability.

10.2.13 All indicators providing information to the helm positions should be fitted with means of illumination control to ensure readability under all operating conditions.

10.3 Vision enhancement equipment

10.3.1 The windows described in paragraph 10.2.12 should be fitted with an efficient means of clearing melted ice, freezing rain, snow, mist and spray from outside and accumulated condensation from inside. A mechanical means to clear moisture from the outside face of a window should have operating mechanisms protected from freezing or the accumulation of ice that would impair effective operation.

10.3.2 All persons engaged in navigating the vessel should be provided with adequate protection from direct and reflected glare from the sun.

10.4 Navigating from chart information in polar waters

10.4.1 As the chart coverage of polar waters in many areas may not currently be adequate for coastal navigation, navigational officers should:

.1 exercise care to plan and monitor their voyage accordingly, taking due account of the information and guidance in the appropriate nautical publications;

.2 be familiar with the status of hydrographic surveys and the availability and quality of chart information for the areas in which they intend to operate;

.3 be aware of potential chart datum discrepancies with GNSS positioning; and

.4 aim to plan their route through charted areas and well clear of known shoal depths, following established routes whenever possible.

10.4.2 Any deviations from the planned route should be undertaken with particular caution. For example, and when operating on the continental shelf:

.1 the echo-sounder should be monitored to detect any sign of unexpected depth variation, especially when the chart is not based on a full search of the sea floor; and

.2 independent cross-checking of positioning information (e.g. visual and radar fixing and GNSS) should be undertaken at every opportunity. Mariners should ensure to report to the relevant charting authority (Hydrographic Office) any information that might contribute to improving the nautical charts and publications.

CHAPTER 11
OTHER SAFETY MEASURES

Purpose

This chapter sets out additional measures to improve the safety of fishing vessels, and their personnel.

11.1 Anchoring and towing arrangements

11.1.1 Fishing vessels should, as far as is practicable, be designed so the anchor is protected from being dislodged from its stowed position and from jamming or damaging the hull by direct impact with ice.

11.1.2 Anchoring systems should be provided with an independent means of securing the anchor so that the anchor cable can be disconnected for use as an emergency towing bridle.

11.1.3 As far as is practical, fishing vessels should be capable of anchoring and providing limited assistance in the case of debilitating damage or breakdown, towards the prevention of a catastrophic loss or incident. The capability of vessels to provide assistance should be considered, having due regard to the lack of repair facilities, the limited number of dedicated towing vessels available and the response time that may be required by a dedicated towing vessel to be able to provide effective assistance in polar ice-covered waters.

11.1.4 Fishing vessels designed to perform dedicated towing operations should be equipped with line throwing apparatus in addition to that required for life-saving. This apparatus should be capable of delivering messenger lines for the transfer of towing equipment. Such line throwing apparatus should not be of the powder or rocket type, in order that it may be safely used to make a transfer to a tanker.

11.1.5 Fishing vessels designed to perform dedicated towing operations should be provided with a quick release system, operable from the conning position.

11.1.6 Where fitted, close-coupled bow to stern towing arrangements should comprise strengthened bow plating on the towed vessel, appropriate towing slings, non-interfering positioning of bower anchors and disallowance of bulbous bows. In this case, arrangements should be provided for securing the anchor in the stowed position.

11.1.7 Fishing vessels should be capable of receiving emergency towing assistance.

11.1.8 Where appropriate, towing arrangements should facilitate connection and release of a towline and provide bollards, fairleads, and other components suitable for the size of vessel on which they are fitted.

11.2 Fuel and other flammable fluid tanks and systems

Refuelling of fishing vessels should be carried out while taking into account the special conditions imposed by low temperatures and ice conditions, where applicable.

11.3 Emergency equipment

11.3.1 Fishing vessels should be provided with an adequate number of first aid kits and equipment with contents suitable to the onboard location and the recognized provisions for personnel safety hazards of such locations.

11.3.2 Medical equipment, medicines and facilities should be considered with a view to the nature of the voyage, vessel operations and the ability to communicate and obtain timely medical aid, medical evacuation, or other medical assistance.

11.3.3 Crews should be provided with appropriate equipment and training to safely evacuate an individual in a medical emergency from the vessel.

11.3.4 Special consideration should be given to the reserve supply of fuel and lubricants taking into account the effect of heavy ice on fuel consumption.

11.3.5 Vessels operating in remote areas should give special consideration to carrying spare parts and equipment.

11.3.6 Fishing vessels should consider carrying the following emergency equipment:

.1 portable gas welding and cutting equipment with a reserve of consumables; and

.2 portable electro-submersible pump of 100 tonnes/h capacity, with a set of hoses.

11.4 Crewing

11.4.1 Arrangements for crewing should take account of the relative lack of shore and support infrastructure which may be available to assist in any operations.

11.4.2 Arrangements for crewing should take account of anticipated ice conditions and requirements for ice navigation, increased levels of watch keeping, hours of rest, and fatigue.

[11.5 Training*

11.5.1 In addition to the training requirements specified in the International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel, 1995 (STCW-F Convention), consideration should be given to additional training that may be required to equip persons on board appropriately to operate safely in conditions specific to polar waters.

11.5.2 As a minimum, all persons on board should be made familiar with cold weather survival by training or self-study of course material or publications, addressing in particular, the measures described in section 8.3.

11.5.3 The vessel's deck and engine officers should have appropriate training and experience in operations in ice-covered waters.

11.5.4 Officers in charge of navigation should have appropriate training and experience in recognizing navigational dangers specific to polar ice-covered waters.

11.5.5 All persons on board should be made familiar with the relevant procedures and equipment in the supplementary manual for operations in polar waters referred to in section 1.5, should one be carried.

11.5.6 In addition to the supplementary manual for operations in polar waters referred to in paragraph 1.4.1 and section 1.5, fishing vessels should consider carrying a training manual covering relevant aspects of operations in polar waters. Information contained in the manual might include:

.1 these Guidelines;
.2 ice recognition;
.3 navigation in ice; and
.4 escorted operation.]

* To be considered by HTW 7 (see paragraph 4.15).

11.6 Voyage planning

When planning a route through polar waters, in order to avoid potential hazards, the master of the fishing vessel should be taking into account the following factors:

.1 the procedures described in the supplementary manual for operations in polar waters referred to in section 1.5, should one be carried;

.2 any limitations of the hydrographic information and aids to navigation available;

.3 current information on the extent and type of ice and icebergs in the vicinity of the intended route;

.4 statistical information on ice and temperatures from former years;

.5 places of refuge;

.6 current information and measures to be taken when marine mammals are encountered relating to known areas with densities of marine mammals, including seasonal migration areas;

.7 current information on relevant routing systems, speed recommendations and vessel traffic services relating to known areas with densities of marine mammals, including seasonal migration areas;

.8 national and international designated protected areas along the route; and

.9 operation in areas remote from SAR capabilities.

***

ANNEX 4

DRAFT MSC CIRCULAR

GUIDELINES FOR SAFETY MEASURES FOR PLEASURE YACHTS OF 300 GROSS TONNAGE AND ABOVE NOT ENGAGED IN TRADE OPERATING IN POLAR WATERS

1 The Maritime Safety Committee, at its [102nd session (13 to 22 May 2020)], approved the *Guidelines for pleasure yachts of 300 gross tonnage and above not engaged in trade operating in polar waters*, as set out in the annex, prepared by the Sub-Committee on Ship Design and Construction, at its seventh session (3 to 7 February 2020).

2 Member States are invited to use the annexed Guidelines and to bring them to the attention of all parties concerned.

ANNEX

GUIDELINES FOR SAFETY MEASURES FOR PLEASURE YACHTS OF 300 GROSS TONNAGE AND ABOVE NOT ENGAGED IN TRADE OPERATING IN POLAR WATERS

PREAMBLE

These Guidelines for pleasure yachts of 300 gross tonnage and above have been developed to supplement existing industry and/or national standards by providing additional guidance aimed at increasing the safety of yachts and persons on board, to mitigate the additional risk arising from the climatic conditions and other hazards when operating in polar waters.

These Guidelines are recommendatory, and their wording is designed to provide guidance rather than mandatory direction. These Guidelines are not intended to infringe on national systems of shipping control.

INTRODUCTION

1 Purpose

These Guidelines provide for the enhanced safety of pleasure yachts of 300 gross tonnage and above not engaged in trade, and persons on board, specific to their operation in polar waters.

2 Background

These Guidelines were developed in acknowledgement that operating in polar waters imposes additional demands on yacht systems, including navigation, communications, life-saving, main and auxiliary machinery, environmental protection and damage control, beyond those normally encountered.

These Guidelines also recognize that safe operation in such conditions requires special attention to human factors including crewing arrangements and training in emergency and operational procedures to ensure their safety in a polar environment.

These Guidelines focus on the need to ensure that yacht systems are capable of functioning effectively under anticipated operating conditions and to provide adequate levels of safety in accident and emergency situations.

In June 2018, the Maritime Safety Committee reviewed the safety measures for non-SOLAS ships operating in polar waters. The Committee noted the lack of a legal framework to allow for the mandatory application of the Polar Code to non-SOLAS ships, together with evidence regarding the number of accidents involving non-SOLAS ships operating in polar waters, particularly in the Antarctic area. Concluding that these facts revealed a significant risk to the safety of lives at sea, and a continuing threat to the marine environment, the Committee determined that urgent action needed to be taken. These Guidelines are the result of the Committee’s decision to develop recommendatory safety measures for pleasure yachts of 300 gross tonnage and above not engaged in trade, operating in polar waters.

3 Source of hazards

These Guidelines consider hazards which may expose pleasure yachts to elevated levels of risk, some of which are unique to polar conditions. These include:

.1 ice, as it may affect hull structure, stability characteristics, machinery systems, navigation, the outdoor working environment, maintenance and emergency preparedness tasks and malfunction of safety equipment and systems;

.2 experiencing topside icing, with potential reduction of stability and equipment functionality;

.3 low temperature, as it affects the working environment and human performance, maintenance and emergency preparedness tasks, material properties and equipment efficiency, survival time and performance of safety equipment and systems;

.4 extended periods of darkness or daylight as it may affect navigation and human performance;

.5 high latitude, as it affects navigation systems, communication systems and the quality of ice imagery information;

.6 remoteness and possible lack of accurate and complete hydrographic data and information, reduced availability of navigational aids and seamarks with increased potential for groundings compounded by remoteness, limited readily deployable search and rescue (SAR) facilities, delays in emergency response and limited communications capability, with the potential to affect incident response;

.7 potential lack of experience in polar operations, with potential for human error;

.8 potential lack of suitable emergency response equipment, with the potential for limiting the effectiveness of mitigation measures; and

.9 rapidly changing and severe weather conditions, with the potential for escalation of incidents.

The risk level within polar waters may differ depending on the geographical location, time of the year with respect to daylight, ice-coverage, etc. Therefore, mitigating measures suitable to address the above specific hazards may vary within polar waters and may be different in Arctic waters and the Antarctic area.

These Guidelines also recognize that while Arctic waters and the Antarctic area have a number of similarities, there are also significant differences, and that the specific features of the legal and political regimes applicable to their respective vulnerable marine environments should be taken into account.

CHAPTER 1
GENERAL

1.1 Purpose

This chapter provides guidance on general operating and safety arrangements.

1.2 Application

These Guidelines provide guidance for pleasure yachts of 300 GT and over not engaged in trade operating in polar waters. However, Administrations are encouraged to apply them, as appropriate, to all yachts seeking to operate in polar waters.

1.3 Definitions

The following definitions are applicable to these Guidelines.

1.3.1 *Antarctic area* means those waters which are south of 60° S (see figure 1).

1.3.2 *Arctic waters* means those waters which are located north of a line extending from latitude 58°00'.0 N, longitude 042°00'.0 W to latitude 64°37'.0 N, longitude 035°27'.0 W and thence by a rhumb line to latitude 67°03'.9 N, longitude 026°33'.4 W and thence by a rhumb line to Sørkapp, Jan Mayen and by the southern shore of Jan Mayen to the Island of Bjørnøya and thence by a great circle line from the Island of Bjørnøya to Cap Kanin Nos and thence by the northern shore of the Asian continent eastward to the Bering Strait and thence from the Bering Strait westward to latitude 60° N as far as Il'pyrskiy and following the sixtieth North parallel eastward as far as and including Etolin Strait and thence by the northern shore of the North American continent as far south as latitude 60° N and thence eastward along parallel of latitude 60°N, to longitude 56°37'.1 W and thence to the latitude 58°00'.0 N, longitude 042°00'.0 W (see figure 2).

1.3.3 *Directional control system* means any device or devices intended either as a primary or auxiliary means of steering the ship. The directional control system includes all associated power sources, linkages, controls and actuating systems.

1.3.4 *Escort* means any ship with superior ice capability in transit with another ship.

1.3.5 *Hull penetrations* means areas where water can get into the hull, including seawater inlets, rudder pintles and propeller shaft seals.

1.3.6 *Ice-covered waters* means polar waters where local ice conditions present a structural risk to a ship.

1.3.7 *Icebreaker* means any ship whose operational profile may include escort or ice management functions, whose powering and dimensions allow it to undertake aggressive operations in ice-covered waters.

1.3.8 *Ice of land origin* means ice formed on land or in an ice shelf, found floating in water.

1.3.9 *Maximum expected rescue time* means the time adopted for the design of equipment and systems that provide survival support. It should typically be not less than five days.

1.3.10 *Mean Daily Low Temperature (MDLT)* means the mean value of the daily low temperature for each day of the year over a minimum 10-year period. A data set acceptable to the Administration may be used if 10 years of data is not available.

1.3.11 *Open water* means a large area of freely navigable water in which sea ice is present in concentrations less than 1/10. No ice of land origin is present.

1.3.12 *Polar service temperature* (PST) means a temperature specified for a ship which is intended to operate in low air temperature, which should be set at least 10° C below the lowest MDLT for the intended area and season of operation in polar waters.

1.3.13 *Polar waters* includes both Arctic waters and the Antarctic area.

1.3.14 *Sea ice* means any form of ice found at sea which has originated from the freezing of sea water.

1.3.15 *Ship intended to operate in low air temperature* means a ship which is intended to undertake voyages to or through areas where the lowest MDLT is below -10° C.

Figure 1 – Maximum extent of Antarctic area application

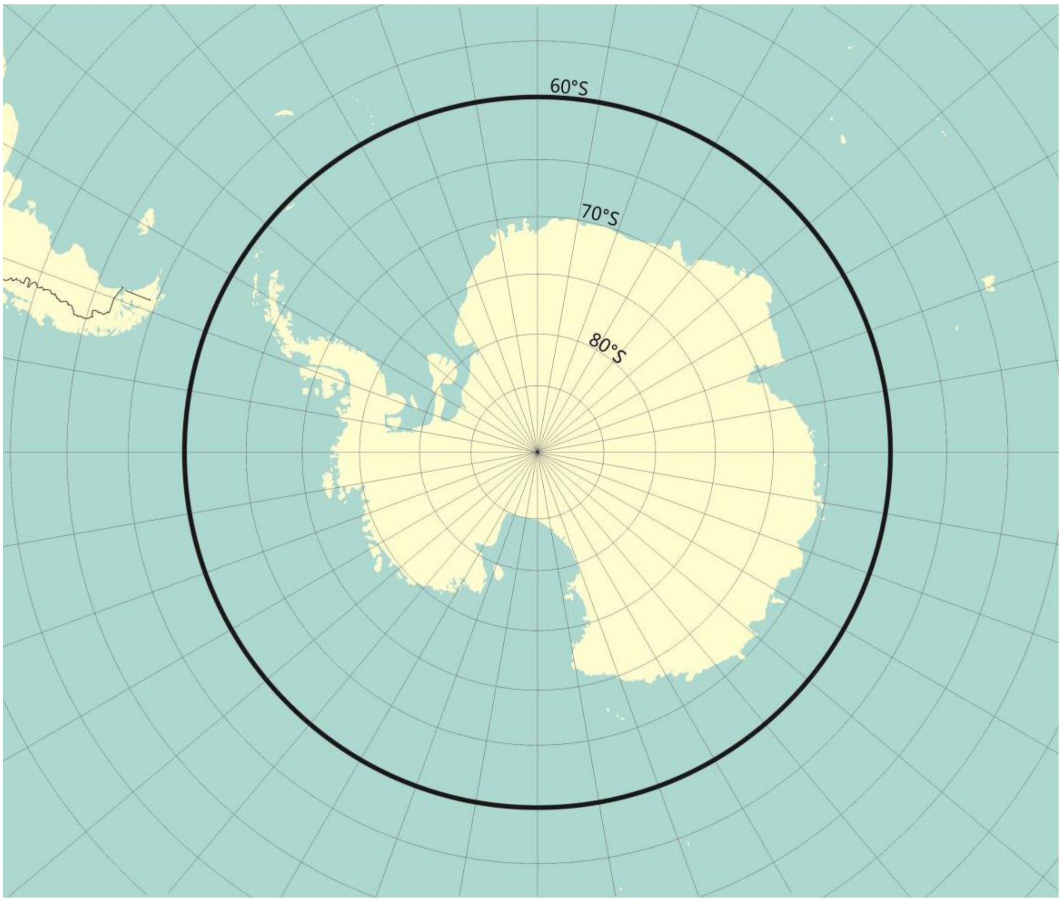

Figure 2 – Maximum extent of Arctic waters application

1.4 Performance standards

1.4.1 Yachts and their equipment should be designed, constructed and maintained in compliance with the applicable national standards of the Administration or the appropriate requirements of a recognized organization or competent body which provide an equivalent level of safety for its intended service.

1.4.2 The structures, equipment and arrangements essential for the safety and operation of the yacht should take account of the anticipated temperatures.

1.4.3 Special attention should be given to essential operating and safety equipment and associated systems. For example, the potential for ice building up inside the ballast tanks and sea chests and in other potential areas that can be penetrated through the hull affecting the ballast and piping system respectively should be considered. The fire-extinguishing and life-saving equipment specified in chapters 4 and 5 of these Guidelines, when stored or located in an exposed position, should be of a type that is rated to perform its design functions at the MDLT. In particular, attention should be given to the inflation of life-saving equipment and the starting of engines in lifeboats and rescue boats.

1.4.4 Operations in polar waters should take account of factors such as: yacht class, environmental conditions, icebreaker escort, prepared tracks, routeing, crew experience, support technology and services such as ice-mapping, availability of hydrographic information, communications, safe ports, repair facilities, and maximum expected rescue time.

1.5 Operational arrangement

1.5.1 The yacht should not be operated outside the worst intended conditions and design limitations which should be included in the operational guidelines.

1.5.2 Yachts operating in polar waters should take account of the distance from search and rescue facilities.

CHAPTER 2
CONSTRUCTION AND WATERTIGHT INTEGRITY

2.1 Purpose

This chapter sets out standards sufficient to maintain the structural construction and watertight integrity of yachts and their equipment operating in polar conditions.

2.2 General

2.2.1 Yachts should be strong and stable. Yachts undertaking regular expeditions in polar waters should be made of alloy or steel construction.

2.2.2 The structure should be designed to resist both global and local loads anticipated under the expected ice conditions.

2.2.3 For sailing yachts intended to operate in low air temperature, materials used should be suitable for operation at the yacht's PST.

2.2.4 The structure should be designed so as to maintain weather and watertight integrity in the anticipated sea and ice conditions.

2.2.5 Deck areas should be fitted with safety harness, jackstays and attachment points.

2.2.6 Yachts should be fitted with a sturdy boarding ladder or platform suitable for operations in the anticipated environmental conditions.

CHAPTER 3
MACHINERY AND ELECTRICAL INSTALLATIONS

3.1 Purpose

This chapter sets out the required functionality for machinery and electrical installations necessary for the yacht's safe operation.

3.2 General

3.2.1 The design, rating, installation, operation and maintainability of all onboard machinery and equipment should be suitable for operation and navigation in polar waters and the harsh weather conditions that often occur. Factors to be taken into account include:

- .1 ice accretion and/or snow accumulation;
- .2 ice ingestion from seawater;
- .3 freezing and increased viscosity of liquids;
- .4 seawater intake temperature; and
- .5 snow ingestion.

3.2.2 In addition, for yachts intended to operate in low air temperatures, factors to be taken into account include:

.1 cold and dense inlet air; and
.2 loss of performance of battery or other stored energy device.

3.2.3 Materials used for machinery and electrical installations should be suitable for operation at the yacht's PST. In particular, machinery and electrical installations which are essential for safe operation when:

.1 located outside and above the waterline in any operating condition; or
.2 in unheated locations inside,

should not be susceptible to brittle fracture within the range of operating conditions.

3.2.4 For yachts intended to operate in ice-covered waters, machinery and electrical installations should provide functionality under the anticipated environmental conditions, taking into account loads imposed directly by ice interaction.

3.2.5 The layout and construction of machinery essential for the safe operation of the yacht should be such that repairs which can be affected using the resources on board may be completed safely and effectively. Ventilation systems should provide sufficient air at an appropriate temperature for the operation of machinery.

3.3 Main propulsion systems

3.3.1 The main propulsion machinery should be designed and protected against the effects of the anticipated environmental and operational conditions. The reliability and availability of the equipment and systems, including spare parts for components which can be readily repaired, should be considered.

3.3.2 Main propulsion machinery and all auxiliary machinery essential to the propulsion system should be:

.1 designed for loads and vibrations appropriate to the anticipated environmental and operational conditions;

.2 located to provide protection from freezing spray, ice and snow; and

.3 designed to operate when the yacht is inclined at any combined angle of heel or trim that may be expected during operations in ice.

3.3.3 The installed propulsive power should be sufficient to ensure that the yacht can navigate safely, without risk of structural damage under the design ice, weather and anticipated operational conditions.

3.3.4 Piping and intake systems associated with the main propulsion plant and auxiliary machinery essential to the propulsion system should be designed so as not to be affected by the impact of the polar environment.

3.4 Auxiliary machinery systems

3.4.1 Equipment and systems should be designed so that the exposure of persons on board to cold temperatures and other environmental hazards during normal operations including routine maintenance is minimized.

3.4.2 Ventilation systems should provide sufficient air for the operation of auxiliary machinery, air conditioning and heating purposes.

3.4.3 Essential equipment or systems located within spaces subject to outside ambient air temperatures upon failure of the primary heating system should be:

.1 provided with an independent source of heat; and

.2 fabricated from materials that are not susceptible to brittle fracture under the anticipated loads and temperatures.

3.5 Directional control systems

3.5.1 Directional control systems, if fitted, should be of adequate strength and suitable design to enable efficient operation in ice-covered waters.

3.5.2 Where interaction between the yacht's directional control systems and propulsion systems occurs or where dual purpose components are fitted, the provisions of this chapter, relating to propulsion systems should also be followed.

3.6 Electrical installations

3.6.1 Electrical installations should be designed for operation in polar waters and for the provision of emergency heat and power.

3.6.2 Precautions should be taken to minimize the risk of supplies to essential and emergency services being interrupted by the inadvertent or accidental opening of switches or circuit breakers due to vibrations or accelerations during any icebreaking operations.

3.6.3 Emergency power batteries, including the reserve source of energy for the radio installation, including those stored in deck boxes, should be secured in a position where excessive movement is prevented during ice-transiting operations and explosive gas ventilation is not restricted by the accumulation of ice or snow.

3.6.4 Control systems based on computers and other electronic hardware installations necessary for the proper functioning of essential equipment should be designed for redundancy and resistance to vibration, dampness and low humidity.

CHAPTER 4
LIFE-SAVING APPLIANCES AND ARRANGEMENTS

4.1 Purpose

This chapter sets out standards for the safe escape, evacuation and survival of persons on board.

4.2 General life-saving appliances and survival arrangements

4.2.1 Yachts should carry life-saving appliances and survival equipment suited to the polar environment. Components of life-saving appliances should be designed to ensure availability and effectiveness under polar conditions.

4.2.2 Adequate supplies of protective clothing and thermal insulating materials should be provided, taking into account the intended voyage.

4.2.3 Training in the use of all emergency equipment, as appropriate, should be included as an element of the operating procedures and drills. Where appropriate, dedicated training equipment, including additional personal and group survival kits, should be carried to avoid compromising the performance of the emergency equipment itself.

4.2.4 Insulated immersion suits should be carried.

4.3 Categories of life-saving equipment

4.3.1 Yachts should carry life-saving appliances and survival equipment according to their environmental conditions of operation.

4.3.2 Personal survival kits (PSKs) should be carried whenever a voyage is anticipated to encounter mean daily temperatures below 0°C.

4.3.3 Group survival kits (GSKs) should be carried whenever a voyage is anticipated to encounter ice conditions which may prevent the lowering and operation of survival craft.

4.3.4 Sufficient PSKs and GSKs (as applicable) should be carried to cover at least 110% of the persons on board.

4.3.5 Personal survival kits should be stored so that they may be easily retrieved in an emergency situation. Arrangements such as storage in dedicated lockers near the assembly stations might be considered.

4.3.6 Group survival kits should be stored so that they may be easily retrieved and deployed in an emergency situation. Any containers should be located adjacent to the survival craft and liferafts. Containers should be designed so that they may be easily moved over the ice and be floatable.

4.4 Personal survival kit (PSK)

4.4.1 A sample of the contents of a personal survival kit is listed in the table below.

Table 4.1: Sample of items for inclusion in a personal survival kit

Suggested equipment
Protective clothing (hat, gloves, socks, face and neck protection, thermal underwear, etc.)
Skin protection cream
Insulated immersion suit
Handwarmers
Sunglasses

Survival candle
Signal mirror
Personal Locator Beacon
Drinking mug
Emergency food
Penknife
Handbook (Polar Survival)
Carrying bag

4.4.2 Personal survival kits should not be opened for training purposes.

4.4.3 The contents of personal survival kits should be reviewed no less frequently than annually.

4.5 Group survival kit (GSK)

4.5.1 A sample of the contents of the group survival kit is listed in the table below.

Table 4.2: Sample of items for inclusion in a group survival kit

Suggested equipment
Shelter – tents or storm shelters or equivalent – sufficient for maximum number of persons
Foam sleeping mats or similar – sufficient for at least one between two persons
Sleeping bags - sufficient for at least one between two persons
Shovels – at least 2
Sanitation (e.g. toilet paper)
Stove and fuel – sufficient for maximum number of persons ashore and maximum anticipated time of rescue
Emergency food – sufficient for maximum number of persons ashore and maximum anticipated time of rescue
One first aid kit in a waterproof case
Flashlights – one per shelter
Waterproof and windproof matches – two boxes per shelter
Whistle
Signal mirror
Emergency Position Indicating Radio Beacon
Appropriate communications equipment, separate from that carried on the vessel or survival craft
Water containers & water purification tablets

Spare set of personal survival equipment
Snow saw and snow knife
Tarpaulin
Group survival equipment container (waterproof and floatable)

4.5.2 Group survival kits should not be opened for training purposes.

4.5.3 The contents of group survival kits should be reviewed no less frequently than annually.

4.6 Lifeboats (where applicable)

4.6.1 Lifeboats should be either of the partially or totally enclosed type to provide adequate shelter from the anticipated operating environment.

4.6.2 The capacity of lifeboats should be evaluated with regard to operability, accessibility, seating capacity and overall space, considering the needs of persons wearing suitable polar clothing.

4.6.3 Any ice accretion should be regularly removed from the lifeboats, launch area and launching equipment to ensure readiness for launching when required. An icing removal mallet should be available in the vicinity of the lifeboats.

4.6.4 Lifeboat engines should be equipped with a means to ensure they start readily when required at the minimum anticipated operating temperature.

4.6.5 The lifeboat engine fuel oil should be suitable for operation in the minimum anticipated operating temperature.

4.6.6 Lifeboats and containers for group survival equipment in their stowed position should have means to mitigate the freezing of drinking water supplies.

4.6.7 Consideration should be given to the provision of additional emergency rations to account for high rates of energy expenditure under polar conditions.

4.7 Liferafts

4.7.1 Any ice accretion should be regularly removed from the liferafts, cradles, launch area and launching equipment to ensure readiness for launching and inflation when required. An icing removal mallet should be available in the vicinity of the liferafts.

4.7.2 Yachts should carry, in a warm space, in the vicinity of the liferafts, manual inflation pumps that are proven to be effective in PST.

4.7.3 Air or other proven cold temperature gas should be used for the inflation of life-saving equipment according to their environmental conditions of operation.

4.7.4 Consideration should be given to the provision of additional emergency rations to account for high rates of energy expenditure under polar conditions.

CHAPTER 5
FIRE PROTECTION, FIRE DETECTION, FIRE EXTINCTION AND FIRE FIGHTING

5.1 Purpose

This chapter sets out standards for fire safety systems and appliances on yachts to ensure they are effective and operable in polar conditions, and that means of escape remain available so persons on board can safely and swiftly escape under the expected environmental conditions.

5.2 General

5.2.1 Components of fire safety systems and appliances should be designed to ensure availability and effectiveness under PST.

5.2.2 Components of the fire-fighting system and appliances which may be exposed to icing and snow accumulation that could interfere with the proper functioning of that component should be adequately protected.

5.2.3 Local equipment and machinery controls should be arranged so as to avoid freezing, snow accumulation and ice accretion and their location to remain accessible at all times.

5.2.4 The design of fire safety systems and appliances should take into consideration the need for persons to wear bulky and cumbersome polar clothing.

5.2.5 Means should be provided to remove or prevent ice and snow accretion from accesses.

5.2.6 Extinguishing media should be suitable for the intended operation.

5.3 Ventilation

Closing apparatus for ventilation inlets and outlets should be designed and located to protect them from ice or snow accumulation that could interfere with the effective closure of such systems.

5.4 Fire detection and fire-extinguishing systems

5.4.1 Fire-extinguishing systems should be designed or located so that they are not made inaccessible or inoperable by ice or snow accumulation or low temperature such that:

.1 equipment, appliances, systems and extinguishing agents should be protected from freezing for the intended voyage;

.2 precautions should be taken to prevent nozzles, piping and valves of any fire extinguishing system from becoming clogged by impurities, corrosion or ice build-up; and

.3 exhaust gas outlets and pressure vacuum arrangements should be protected from ice build-up that could interfere with effective operation.

5.4.2 Water or foam extinguishers should not be located in any position that is exposed to freezing temperatures. These locations should be provided with extinguishers capable of operation under such conditions.

5.5 Fire pumps and associated equipment

5.5.1 Where a fixed water-based fire-extinguishing system or alternative fire-extinguishing system situated in a space separate from the compartment containing the main fire pumps utilizes its own independent sea suction, this sea suction should be capable of being cleared of ice accumulation.

5.5.2 Fire pumps, including emergency fire pumps, water mist and water spray pumps should, wherever reasonable and practicable, be installed in heated compartment(s) and in any event should be adequately protected from freezing.

5.5.3 Isolating valves should be located so that they are accessible. Any isolating valves located in exposed positions should not be subject to icing from freezing spray. The fire main should be arranged so that exposed sections can be isolated and means of draining exposed sections should be provided.

5.5.4 Hydrants should be positioned or designed to remain operable under all anticipated temperatures. Ice accumulation and freezing should be taken into account.

5.5.5 All hydrants should be equipped with an efficient two-handed valve handle.

5.5.6 In addition, portable and semi-portable extinguishers should be located in positions protected from freezing temperatures, as far as practical. Locations subject to freezing should be provided with extinguishers capable of operation under PST.

5.6 Firefighters' outfits

Sufficient firefighters' outfits, including one spare, should be readily available to the accommodation area and elsewhere as appropriate. Such firefighters' outfits should be stored in warm positions as widely separated as practical.

CHAPTER 6
RADIOCOMMUNICATIONS

6.1 Purpose

This chapter provides standards for effective communication for yachts and survival craft in polar waters during normal operation and in emergency situations.

6.2 General

6.2.1 Communications equipment should be suitable to provide adequate ship-to-ship and ship-to-shore communication at all points along the intended operating routes, taking into account the limitations of communications systems in high latitudes and the anticipated low temperature.

6.2.2 All two-way portable radio communication equipment should be operable at the polar service temperature.

6.2.3 Means for two-way on-scene and SAR coordination communications for search and rescue purposes including aeronautical frequencies should be provided.

6.2.4 Appropriate communication equipment to enable telemedical assistance in polar areas should be provided.

6.2.5 Emergency power for communications equipment provided by battery should be provided with a means whereby the batteries are protected from extreme low temperatures.

6.3 Survival craft and rescue boat communications capabilities

6.3.1 For yachts intended to operate in low air temperature, all rescue boats and lifeboats, whenever released for evacuation, should maintain capability for distress alerting, locating and on-scene communications.

6.3.2 For yachts intended to operate in low air temperature, all other survival craft, whenever released, should maintain capability for transmitting signals for location and on scene communications.

6.3.3 Communication equipment intended for use in survival craft, including liferafts, and rescue boats should be capable of operation during the maximum expected time of rescue.

CHAPTER 7
NAVIGATIONAL EQUIPMENT

7.1 Purpose

This chapter provides for safe navigation in polar waters.

7.2 General

7.2.1 Taking account of the fact that use in high latitudes may affect their performance, navigational equipment and systems for providing reference headings and position fixing should be designed, constructed, and installed to retain their functionality under polar conditions.

7.2.2 Yachts should have means of receiving and displaying current and forecasted information on ice conditions in the intended area of operation.

7.2.3 Sensors, antennas and other navigational equipment should be protected from ice accretion.

7.3 Heading equipment

Yachts should be fitted with two non-magnetic means to determine and display their heading.

7.4 Speed and distance measurement

Yachts should be fitted with at least one appropriate speed and distance measuring system.

7.5 Depth sounding device

Yachts should be fitted with at least two independent echo-sounding devices which provide an indication of the depth of water under the keel. Due account should be taken of the potential for ice interference or damage to any device designed to operate below the waterline.

7.6 Radar installations

7.6.1 Yachts should be fitted with a total of at least two functionally independent radar systems. One of these should operate in the 3 GHz (10 cm, S-band) frequency range.

7.6.2 Radar plotting systems that may be installed should have the capability of operating in both the sea and the ground stabilized mode.

7.7 Electronic positioning and electronic chart systems

7.7.1 Yachts should be provided with an electronic position fixing system.

7.7.2 A satellite system (GPS or GLONASS or equivalent) should be fitted on any yacht intending to navigate in areas outside of reliable coverage by a terrestrial hyperbolic system.

7.8 Automatic identification system (AIS)

Yachts should be provided with automatic identification system (AIS).

7.9 Rudder angle indicator

7.9.1 Separate rudder angle indicators should be provided for each rudder on yachts with more than one independently operable rudder.

7.9.2 In yachts without a rudder, indication should be given of the direction of steering thrust.

7.10 Searchlights and visual signals

7.10.1 Yachts operating in polar waters should be equipped with at least two suitable searchlights which should be controllable from helm positions.

7.10.2 The searchlights described in paragraph 7.9.1 should be installed to provide, as far as is practicable, all-round illumination suitable for docking, astern manoeuvres or emergency towing; and should be fitted with an adequate means of de-icing to ensure proper directional movement.

7.11 Vision enhancement equipment

7.11.1 Yachts should be fitted with a suitable means to de-ice sufficient helm position windows to provide unimpaired forward and astern vision from helm positions.

7.10.2 The windows described in paragraph 7.11.1 should be fitted with an efficient means of clearing melted ice, freezing rain, snow, mist and spray from outside and accumulated condensation from inside. A mechanical means to clear moisture from the outside face of a window should have operating mechanisms protected from freezing or the accumulation of ice that would impair effective operation.

7.11.3 Persons engaged in navigating the yacht should be provided with adequate protection from direct and reflected glare from the sun.

7.11.4 Indicators providing information to the helm positions should be fitted with means of illumination control to ensure readability under all operating conditions.

CHAPTER 8
DRILLS AND EMERGENCY INSTRUCTIONS

8.1 Purpose

This chapter sets out standards to ensure that persons on board yachts are adequately trained and familiar with emergency procedures, their duties, and musters specific to an emergency in polar waters.

8.2 General

8.2.1 Onboard instruction and operation of evacuation, fire and damage control appliances and systems should include appropriate cross training for all persons on board with appropriate emphasis to changes to standard procedure made necessary by operations in polar waters.

8.2.2 Emergency drills should be carried out on a regular basis.

8.2.3 Persons on board undertaking drills should be familiar with and capable in respect of the drills for which they are assigned.

8.3 Evacuation

8.3.1 Evacuation drill scenarios should be varied so that different emergency conditions are simulated, including abandonment into the water, onto the ice if appropriate, or a combination of the two.

8.3.2 Each evacuation drill should include:

.1 exercises in control of persons on board in cold temperatures as appropriate;

.2 checking that all persons on board are suitably dressed;

.3 donning of immersion suits or thermal protective clothing;

.4 testing of emergency lighting for assembling and abandonment; and

.5 giving instructions in the use of the yacht's life-saving appliances and in survival at sea, on the ice or a combination of both, as appropriate.

8.3.3 Rescue boat drills should be conducted as far as is reasonable and practicable.

8.3.4 Each person on board should be given instructions which should include but not necessarily be limited to:

.1 problems of cold shock, hypothermia, first-aid treatment of hypothermia and other appropriate first-aid procedures; and

.2 special instructions necessary for use of the yacht's life-saving appliances in severe weather and severe sea conditions on the ice, or in a combination of water and ice cover.

8.4 Fire drills

Fire drill scenarios should be varied so that emergency conditions are simulated for different compartments of the yacht, with appropriate emphasis on those changes to standard procedures made necessary by operations in polar waters and low temperatures.

8.5 Damage control

Damage control drill scenarios should be varied so that emergency conditions are simulated for different damage conditions with appropriate emphasis to those conditions resultant from operations in polar waters.

CHAPTER 9
OTHER SAFETY MEASURES

9.1 Purpose

This chapter sets out standards for additional emergency equipment that could be carried and other safety measures to improve the safety of yachts and those on board.

9.2 Medical equipment

9.2.1 Yachts should be provided with an adequate number of first-aid kits and equipment with contents suitable to the onboard location and the recognized provisions for safety hazards of such locations.

9.2.2 Medical equipment, medicines and facilities should be considered with a view to the nature of the voyage, yacht operations and the ability to communicate and obtain timely medical aid, medical evacuation, or other medical assistance.

9.2.3 Crews should be provided with appropriate equipment and training to safely evacuate an individual in a medical emergency from the yacht.

9.3 Reserve supplies

9.3.1 Special consideration should be given to the reserve supply of fuel and lubricants taking into account the effect of heavy ice on fuel consumption of the yacht.

9.3.2 Single screw yachts may require special consideration (redundancy) in remote areas where conditions impose a risk of damage to machinery components.

9.4 Voyage planning

When planning a route through polar waters, in order to avoid potential hazards, the master of the yacht should be taking into account the following factors:

.1 any limitations of the hydrographic information and aids to navigation available;

.2 current information on the extent and type of ice and icebergs in the vicinity of the intended route;

.3 statistical information on ice and temperatures from former years;

.4 places of refuge;

.5 current information and measures to be taken when marine mammals are encountered relating to known areas with densities of marine mammals, including seasonal migration areas;

.6 current information on relevant routing systems, speed recommendations and vessel traffic services relating to known areas with densities of marine mammals, including seasonal migration areas;

.7 national and international designated protected areas along the route; and

.8 operation in areas remote from SAR capabilities.

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ANNEX 5

DRAFT MSC CIRCULAR

INTERIM GUIDELINES ON THE SECOND GENERATION INTACT STABILITY CRITERIA

1 The Maritime Safety Committee, at its [102nd session (13 to 22 May 2020)], recognizing that performance-oriented criteria for dynamic stability phenomena in waves needed to be developed and implemented to ensure a uniform international level of safety, as specified in part A, section 1.2 of the International Code on Intact Stability, 2008 (resolution MSC.267(85), as amended), approved the *Interim guidelines on the second generation intact stability criteria*, as set out in the annex.

2 The Committee agreed to keep the Interim guidelines under review, taking into account experience in design and operation of ships gained during their application.

3 Member States are invited to use the annexed Interim guidelines as complementary measures when applying the requirements of the mandatory criteria of part A of the Code and to bring them to the attention of all parties concerned, in particular shipbuilders, shipmasters, shipowners, ship operators and shipping companies, and recount their experience gained through the trial use of these Interim guidelines to the Organization.

ANNEX

INTERIM GUIDELINES ON THE SECOND GENERATION INTACT STABILITY CRITERIA

Preamble

1 In view of a wide variety of ship types, sizes, operational profiles and environmental conditions, the problems related to dynamic stability failures have generally not yet been solved. Administrations should be aware of the fact that some ships are more at risk of encountering critical stability in waves. The Administration may, for a particular ship or group of ships, apply dynamic stability criteria which demonstrate that the safety level of a ship in waves is sufficient.

2 For this purpose, performance-based criteria for assessing five dynamic stability failure modes in waves are provided in these guidelines, namely, dead ship condition, excessive acceleration, pure loss of stability, parametric rolling and surf-riding/broaching.

3 The physics and evaluation methods for these five stability failure modes had not been well understood or developed when the mandatory intact stability criteria were established. As such, the herewith presented dynamic stability criteria utilize the recent progress using best practices and the most advanced scientific tools available, for practical regulatory-oriented application. Accordingly, the background of the dynamic stability criteria is principally based on first principles and latest technology, as opposed to predominant use of casualty records which form the basis of the mandatory intact stability criteria. For this reason, the presented dynamic stability criteria may be considered as the second generation intact stability criteria.

4 The methodologies contained in these Interim guidelines are based on general first-principle approaches derived from the analysis of ship dynamics. However, in the development process, it was also necessary to simplify some of the assessment methodologies and to perform some semi-empirical tuning.

5 In developing the framework of these Interim guidelines, it was recognized that an integrated perspective, combining design methods and operational measures, is the most effective way for properly addressing and continuously improving safety against accidents related to stability for ships in a seaway.

6 Therefore, the second generation intact stability criteria should be used for helping to ensure a uniform international level of safety of ships with respect to dynamic stability failure modes in waves.

Contents

1 GENERAL

1.1 Introduction

1.1.1 *Purpose*

1.1.1.1 The purpose of these Guidelines is to enable the use of the second generation intact stability criteria for the assessment of dynamic stability failure modes in waves, as requested in section 1.2 of Part A of the 2008 Intact Stability (IS) Code. These dynamic stability failure modes are as follows: dead ship condition, excessive acceleration, pure loss of stability, parametric rolling and surf-riding/broaching. In this sense, the overarching aim is to use the latest technology and knowledge on ship dynamics to provide guidance for ship designers on dynamic stability failure modes and to provide operational guidance for ship masters. This is undertaken to further improve the safety level of a ship beyond the mandatory intact stability criteria.

1.1.1.2 The main purpose of these criteria is to enable the use of the latest numerical simulation techniques for evaluating the safety level of a ship from an intact stability viewpoint. By using such tools for simulating the dynamic ship behaviours in a random seaway, the safety level of a ship can be estimated with a probabilistic measure. This approach is hereby called direct stability assessment. However, applying such tools to all new ships that are subject to the 2008 IS Code is not practical due to the limitation of human resources and facilities that are required for experimentally validating the numerical tools. Thus, the vulnerability of a ship can be assessed using simpler vulnerability criteria or more comprehensive direct stability assessment. The guidance for vulnerability criteria and the guidance for direct stability assessment are provided in chapters 2 and 3 of the Interim guidelines, respectively.

1.1.1.3 It is noted that compliance with the criteria contained within part A of the 2008 IS Code, good seamanship, appropriate ship-handling and appropriate operation may avoid the potential danger of excessive roll, excessive lateral accelerations or capsizing due to a dynamic stability failure mode. Mindful of this fact, operational measures for a ship may be provided as an alternative to the vulnerability criteria or direct stability assessment. For this purpose, the guidelines for operational measures are provided in chapter 4 of the Interim guidelines. Whereas the natural order of application is from the vulnerability criteria to direct stability assessment and operational measures, all these alternatives are equivalent in the regulatory sense and any of them can be used independently of others, in the way that is most suitable for the particular design.

1.1.2 *Framework*

1.1.2.1 For the purpose of this framework, the following definitions apply:

.1 *criterion* is a procedure, an algorithm or a formula used for the assessment on the likelihood of a stability failure;

.2 *standard* is a boundary separating acceptable and unacceptable likelihood of a stability failure; and

.3 *rule* (or *regulation*) is a specification of a relationship between a standard and a value produced by a criterion.

1.1.2.2 The second generation intact stability criteria are tools to judge the likelihood of intact stability failures. Intact stability failure is an event that includes the occurrence of very large roll (heel, list) angles or excessive rigid body accelerations, which may result in capsizing or impairs normal operation of the ship and could be dangerous to crew, passengers, cargo or ship equipment. Three subtypes of intact stability failure are included:

.1 heel/list exceeding a prescribed limit;
.2 roll angles exceeding a prescribed limit; and
.3 lateral accelerations exceeding prescribed limit.

1.1.3 *Application logic*

1.1.3.1 The application logic is summarized in figure 1.1.3. Although the user may be guided by a sequential logic of the Interim guidelines (see 1.1.3.2), it is also acceptable that the users apply any alternative design assessment or operational measure option (see 1.1.1.3). For example, a user may wish to immediately commence with the application of direct stability assessment procedures without passing through Levels 1 and 2 of the vulnerability criteria or develop operational measures without performing design assessment.

1.1.3.2 A sequential application logic can be summarized, as follows:

As the simplest options, the vulnerability criteria are presented in two levels: Level 1 and Level 2. The assessment of the five stability failure modes should begin with the use of these levels. Level 1 is an initial check and then, if the ship in a particular loading condition is assessed as not vulnerable for the tested failure mode, the assessment for that failure mode may conclude; otherwise, the design would progress to Level 2. If the ship in a particular loading condition is assessed as not vulnerable for the tested failure mode in Level 2, then the assessment would conclude; otherwise, the design would progress to the application of direct stability assessment, application of operational limitations, revising the design of the ship or discarding the loading condition. If the ship in a particular loading condition is not found acceptable with respect to direct stability assessment procedures, then the logic is that the design would then progress to the application of operational measures or operational guidance, revising the design or discarding the loading condition.

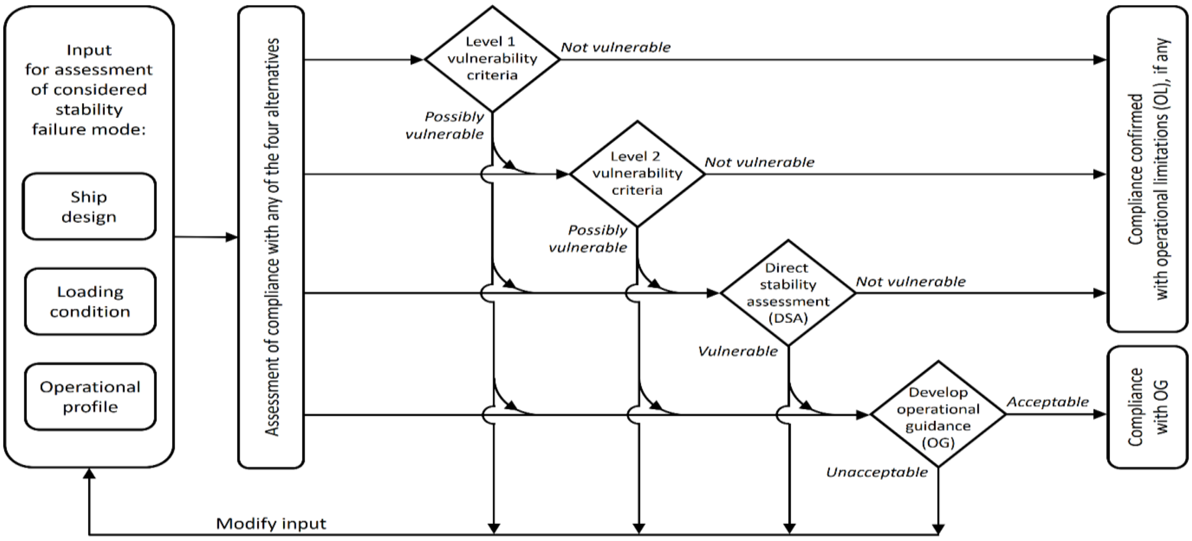

Figure 1.1.3 – Simplified scheme of the application structure of the second generation intact stability criteria. For actual application details, reference is to be made to the text of these Interim guidelines.

1.1.4 *Testing*

1.1.4.1 The second generation intact stability criteria have been developed envisioning a future incorporation into the 2008 IS Code. However, they require testing before using them as mandatory criteria. This is because the robustness of the new criteria is not the same for the different stability failure modes.

Specifically, results obtained in the development process, indicate that:

.1 Level 1 and Level 2 vulnerability criteria for dead ship stability failure mode sometimes provide non-consistent results, i.e. Level 2 may be more conservative than Level 1 for some ships;

.2 vulnerability criteria for excessive acceleration may require further refinements;

.3 Level 2 vulnerability criterion for the pure loss of stability failure mode provides very conservative results for ships with low freeboard; therefore, results of testing for such ships should be treated with care; and

.4 parametric rolling and surf-riding/broaching Level 1 and Level 2 vulnerability criteria have sufficient scientific background and feasible methods for regulatory use.

1.1.4.2 Therefore, these criteria should be used on a trial basis at this stage. Such criteria usage and subsequent reporting are necessary to gain experience and consequently enable the introduction of this approach to the analysis of intact stability. It is also highly recommended to apply the criteria to ships already in service and to compare the results with operational experience.

1.1.5 *Feedback*

1.1.5.1 The second generation intact stability criteria methodology has been developed using the latest technology and scientific knowledge for assessing ship dynamics in waves. The methodology has been tested on a number of sample ships and, to this end, these draft Interim Guidelines are intended to generate data and feedback for a large number of ships.

1.1.5.2 These guidelines have been issued as "Interim guidelines" in order to gain experience in their use. They should be reviewed in order to facilitate future amendments based on the experience gained.

1.1.5.3 Member States and international organizations are invited to submit information, observations, suggestions, comments and recommendations based on the practical experience gained through the application of these Interim guidelines. To support the objective of obtaining robust criteria for regulatory use, suggestions for alternatives to and/or refinements of the criteria elements contained in the Interim guidelines are encouraged. The suggestions should compare the outcomes with the criteria elements included in the Interim guidelines.

1.1.5.4 With such feedback not only on the technical results but also their usability and clarity, the Organization will be able to subsequently refine the second generation intact stability criteria, if necessary.

1.1.6 *Relationship with mandatory criteria*

1.1.6.1 These Interim guidelines are not intended to be used in lieu of the mandatory intact stability criteria contained in the 2008 IS Code. They are intended for use as a guide for ship designers to assess the aspects of ship stability not adequately covered by the mandatory criteria and to provide operational guidance for ship masters. Therefore, they should be used as a supplementary set of stability assessment methods.

1.1.7 *Notes for application*

1.1.7.1 These Interim guidelines are intended to be applied to ships that are also subject to the 2008 IS Code.

1.1.7.2 These Interim guidelines have not been specifically developed for multihulls. Moreover, for ships with an extended low weather deck, additional application provisions are provided in the relevant chapters.

1.2 Definitions

1.2.1 *Loading condition*, in the context of these Interim guidelines, is defined by the mean draught *d*, trim angle θ, metacentric height GM and mass moments of inertia I_{xx}(or natural roll period T_r), I_{yy} and I_{zz}.

1.2.2 *Fully loaded departure condition* means the loading condition, as defined in section 3.4.1 of part B of the 2008 IS Code.

1.2.3 *Sea state* is the stationary condition of the free water surface and wind at a certain location and time, described in these Interim guidelines by the significant wave height H_S, mean zero-crossing wave period T_Z, mean wave direction μ, wave elevation energy spectrum S_{zz}, and mean wind speed, gustiness characteristics and direction. For combined wind sea and swell, significant wave height, mean zero-crossing wave period and mean wave direction may be defined separately for each of the two wave systems.

1.2.4 *Sailing condition* is a short notation for the combination of the ship forward speed V_s and heading relative to mean wave direction μ.

1.2.5 *Assumed situation* is a condition of the ship that refers to the sailing condition combined with sea state. Thus, a situation is defined by the ship forward speed v_0, mean wave direction μ, significant wave height H_S and mean zero-crossing wave period T_Z, direction and gustiness characteristics of wind.

1.2.6 *Design situation* is an assumed situation representative for a particular stability failure mode.

1.2.7 *Wave scatter table* is a table containing the probabilities of each range of sea states encountered in the considered operational area or operational route. In these Interim guidelines, the probabilities contained in a wave scatter table are defined to sum to unity.

1.2.8 *Limited wave scatter table* is a table obtained from the full wave scatter table by removing all sea state ranges with the significant wave height above a certain limit.

1.2.9 O*perational area* and *operational route* are the geographical areas specified for the ship operation. In the context of these Interim guidelines, operational area or operational route are specified by the long-term wave statistics (wave scatter table) and wind statistics.

1.2.10 *Nominal ship forward speed* means the ship speed in calm water under action of the ship's propulsion at a given setting.

1.2.11 *Maximum service speed* means maximum ahead service speed, as defined in SOLAS regulation II-1/3.14.

1.2.12 *Design assessment* corresponds to the application of vulnerability criteria according to chapter 2 or direct stability assessment according to chapter 3 of these Interim guidelines or a combination of the two.

1.2.13 *Operational measures* mean operational limitations or operational guidance.

1.2.14 *Guidelines for vulnerability assessment* means the content of chapter 2 of these Interim guidelines.

1.2.15 *Guidelines for direct stability assessment* means the content of chapter 3 of these Interim guidelines.

1.2.16 *Guidelines for operational measures* means the content of chapter 4 of these Interim guidelines.

1.2.17 *2008 IS Code* means the International Code on Intact Stability, 2008, as amended.

1.2.18 *Mean three-hour maximum amplitude* means the average value of several maximum amplitudes, each of which is determined for an exposure time of three hours.

1.3 Nomenclature

1.3.1 The general nomenclature used in these Interim guidelines is set forth in 1.3.2, 1.3.3, 1.3.4 and 1.3.5. Nomenclature that is specific to a particular section is defined in that location and prevails over the general nomenclature reported here. If not otherwise stated, reference should be made to the nomenclature used in the 2008 IS Code.

1.3.2 General ship characteristics

L	=	length of the ship, as defined in paragraph 2.12 of the introduction part of the 2008 IS Code (m)
B	=	moulded breadth of the ship (m)
B_{wl}	=	moulded breadth at waterline (m)
D	=	moulded depth, as defined in the 2008 IS Code (m)
V_s	=	service speed (m/s)
v_0	=	forward speed (m/s)
Fn	=	Froude number = $V_s / \sqrt{L\ g}$
A_k	=	total overall area of the bilge keels (no other appendages) (m^2)
∇_D	=	volume of displacement at waterline equal to D at zero trim (m^3)
D_p	=	propeller diameter (m);
x_i	=	longitudinal distance from the aft perpendicular to a station i (m), positive forward

1.3.3 Constants

g	=	acceleration due to gravity, taken as 9.81 (m/s^2)
ρ	=	density of salt water, taken as 1025 (kg/m^3)
ρ_{air}	=	density of air, taken as 1.222 (kg/m^3)

1.3.4 Loading condition characteristics

d_{full}	=	draft corresponding to the fully loaded departure condition in calm water (m)
$C_{B,full}$	=	block coefficient of the fully loaded departure condition in calm water
$C_{m,full}$	=	midship section coefficient of the fully loaded departure condition in calm water
d	=	mean draught, i.e. draft amidships corresponding to the loading condition under consideration in calm water (m)
L_{WL}	=	length of the ship on the waterline corresponding to the loading condition under consideration (m)
KB	=	height of the centre of buoyancy above baseline corresponding to the loading condition under consideration (m)
KG	=	height of the centre of gravity above baseline corresponding to the loading condition under consideration (m)
∇	=	volume of displacement corresponding to the loading condition under consideration (m^3)
C_B	=	block coefficient corresponding to the loading condition under consideration (-)
Δ	=	displacement (t)
A_W	=	waterplane area at the draft equal to d (m^2)
I_T	=	transverse moment of inertia of water-plane area (m^4)
I_{xx}	=	dry roll moment of inertia (t m^2)
I_{yy}	=	dry pitch moment of inertia (t m^2)
I_{zz}	=	dry yaw moment of inertia (t m^2)
m	=	mass of the ship (t)
k_{xx}	=	dry roll radius of gyration around axis $x = \sqrt{I_{xx}/m}$ (m)
k_{yy}	=	dry pitch radius of gyration around axis $y = \sqrt{I_{yy}/m}$ (m)
k_{zz}	=	dry yaw radius of gyration around axis $z = \sqrt{I_{zz}/m}$ (m)
GM	=	metacentric height of the loading condition in calm water (m), with or without correction for free surface effect, as required
A_L	=	projected lateral area of the portion of the ship and deck cargo above the waterline (m^2)
Z	=	vertical distance from the centre of A_L to the centre of the underwater lateral area or approximately to a point at one-half the mean draft, d (m)
T_r	=	linear natural roll period in calm water (s)
ω_r	=	natural roll frequency = $2\pi / T_r$ (rad/s)
φ	=	angle of roll, heel, or list (rad or deg)
θ	=	angle of pitch or trim (rad or deg)
ψ	=	angle of yaw, heading or course (rad or deg)

φ_S = stable heel angle under the action of steady heeling moment calculated as the first intersection between the righting lever curve (GZ curve) and the heeling lever curve, (rad or deg)

φ_V = angle of vanishing stability. In presence of a heeling moment, it should be calculated as the second intersection between the righting lever curve (GZ curve) and the applied heeling lever curve (rad or deg)

1.3.5 Environmental condition characteristics

λ = wavelength (m)

H = wave height (m)

H_S = significant wave height for the short-term environmental condition under consideration (m)

s = wave steepness = H/λ

T_Z = mean zero-crossing period for the short-term environmental condition under consideration (s)

T_p = wave period corresponding to peak of spectrum for the short-term environmental condition under consideration (s)

μ = mean wave direction with respect to ship centre plane (deg)

S_{zz} = wave elevation energy spectrum (m^2/(rad/s))

ω = circular frequency (rad/s)

k = wave number = $2\pi/\lambda$ (rad/m);

1.3.6 Other parameters

N_s = number of simulations

f_s = joint probability density of sea state (probability of sea states per unit range of significant wave heights and mean zero-crossing periods) (1/(m/s))

2 Guidelines on vulnerability criteria

2.1 Preface

As described in section 1.2 of part A of the 2008 IS Code, the Administration may for a particular ship or group of ships apply criteria demonstrating that the safety of the ship in waves is sufficient. For this purpose, the criteria for the dynamic stability failure modes in waves have been developed, which address the dead ship condition, excessive acceleration, pure loss of stability, parametric rolling, and surf-riding/broaching failure modes. These criteria should be used for ensuring a uniform international level of safety of ships with respect to these failure modes.

2.2 Assessment of ship vulnerability to the dead ship condition failure mode

2.2.1 Application

2.2.1.1 The provisions given hereunder apply to all ships, except for ships with an extended low weather deck.[1]

2.2.1.2 For each loading condition, a ship that:

.1 meets the standard contained in the criteria contained in 2.2.2 is considered not to be vulnerable to the dead ship condition failure mode; or

.2 does not meet the standard contained in the criteria contained in 2.2.2 should be subject to more detailed assessment of vulnerability to the dead ship condition failure mode by applying the criteria contained in 2.2.3.

2.2.1.3 Alternatively to the criteria contained in 2.2.2 or 2.2.3, for each loading condition a ship may be subject to either:

.1 direct stability assessment for the dead ship condition failure mode that is performed according to the Guidelines for direct stability assessment in chapter 3; or

.2 operational limitations related to operational area or route and season developed in accordance with the Guidelines for operational measures in chapter 4.

2.2.1.4 A detailed assessment of Level 2 vulnerability according to the criteria contained in 2.2.3 may be performed without the requirement to conduct a more simplified assessment in 2.2.2. Similarly, a detailed direct stability assessment as provided in 2.2.1.3.1 may be performed without the requirement to conduct a more simplified assessment in 2.2.2 or 2.2.3.

2.2.1.5 Stability limit information for determining the safe zones as functions of GM, draught and trim is to be provided based on matrix calculations according to the criteria contained in 2.2.2 or 2.2.3, and, if appropriate, direct stability assessment according to the Guidelines for direct stability assessment in chapter 3. If relevant, the stability limit information for determining safe zones should take into account operational limitations related to specific operational areas or routes and specific season according to the Guidelines for operational measures in chapter 4.

2.2.1.6 Reference environmental conditions to be used in the assessment may be modified when introducing operational limitations permitting operation in specific operational areas or routes and, if appropriate, specific season, according to the Guidelines for operational measures in chapter 4.

2.2.1.7 Free surface effects should be accounted for as recommended in chapter 3 of part B of 2008 IS Code.

1 The criteria for this failure mode may not be applicable to a ship with an extended low weather deck due to increased likelihood of water on deck or deck-in-water.

2.2.2 Level 1 vulnerability criterion for the dead ship condition

2.2.2.1 A ship is considered not to be vulnerable to the dead ship condition failure mode, if its ability to withstand the combined effects of beam wind and rolling is demonstrated, with reference to figure 2.2.2.1, as follows:

.1 the ship is subjected to a steady wind pressure acting perpendicular to the ship's centreline which results in a steady wind heeling lever, l_{w1};

.2 from the resultant angle of equilibrium, φ_0 , the ship is assumed to roll owing to wave action to an angle of roll, φ_1, to windward; and the angle of heel under action of steady wind, φ_0, should not exceed 16° or 80% of the angle of deck edge immersion, whichever is less;

.3 the ship is then subjected to a gust wind pressure which results in a gust wind heeling lever, l_{w2} ; and

.4 under these circumstances, area b should be equal to or greater than area a, as indicated in figure 2.2.2.1,

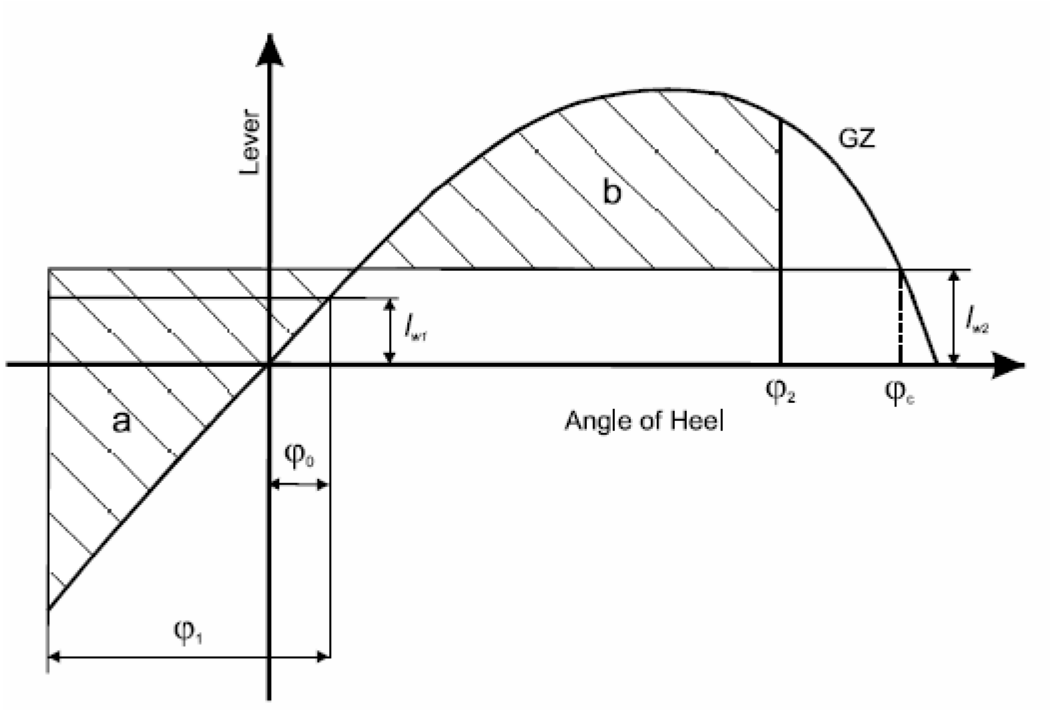

Figure 2.2.2.1 – Definition of area *a* and area *b*

where the angles in figure 2.2.2.1 are defined as follows:

φ_0 = angle of heel under action of steady wind (deg)

φ_1 = angle of roll to windward due to wave action (deg)(see 2.2.2.1.2 and 2.2.2.4)[2]

φ_2 = angle of downflooding, φ_f, or 50° or φ_c, whichever is least,

2 Refer to the *Explanatory Notes to the 2008 IS Code* (MSC.1/Circ.1281).

where:

φ_f = angle of heel at which openings in the hull, superstructures or deck houses which cannot be closed weathertight immerse. In applying this criterion, small openings through which progressive flooding cannot take place need not be considered as open.

φ_c = angle of second intercept between wind heeling lever l_{w2} and GZ curves.

2.2.2.2 The wind heeling levers l_{w1} and l_{w2} referred to in 2.2.2.1.1 and 2.2.2.1.3 are constant values at all angles of inclination and should be calculated as follows:

$$l_{w1} = \frac{P \cdot A_L \cdot Z}{1000 \cdot g \cdot \Delta} \text{(m)} \quad \text{and}$$

$$l_{w2} = 1.5 \cdot l_{w1} \text{(m)}$$

where:

P = wind pressure of 504 (Pa). The value of P used for ships with operational limitations according to 2.2.1.6 may be reduced.

2.2.2.3 Alternative means for determining the wind heeling lever, l_{w1}, may be used as an equivalent to the calculation in 2.2.2.2. When such alternative tests are carried out, reference should be made to the Guidelines developed by the Organization.[3] The wind velocity used in the tests should be 26 m/s in full scale with uniform velocity profile. The value of wind velocity used for ships with operational limitations according to 2.2.1.6 may be reduced.

2.2.2.4 The angle of roll, φ_1, referred to in 2.2.2.1 should be calculated as follows:

$$\varphi_1 = 109 \cdot k \cdot X_1 \cdot X_2 \cdot \sqrt{r \cdot s} \text{ (deg)}$$

where:

X_1 = factor as shown in table 2.2.2.4-1

X_2 = factor as shown in table 2.2.2.4-2

k = factor as follows:

k = 1.0 for a round-bilged ship having no bilge or bar keels

k = 0.7 for a ship having sharp bilges

k = as shown in table 2.2.2.4-3 for a ship having bilge keels, a bar keel, or both

r = 0.73 + 0.6 OG / d, where: $OG = KG - d$

s = wave steepness shown in table 2.2.2.4-4

A_k = total overall area of bilge keels or area of the lateral projection of the bar keel or sum of these areas (m^2)

[3] Refer to the *Interim guidelines for alternative assessment of the weather criterion* (MSC.1/Circ.1200).

The angle of roll, φ_1, for ships with anti-rolling devices should be determined without taking into account the operation of these devices unless the Administration is satisfied with the proof that the devices are effective even with sudden shutdown of their supplied power.

Table 2.2.2.4-1 – Values of factor X_1

B/d	X_1
≤ 2.4	1.0
2.5	0.98
2.6	0.96
2.7	0.95
2.8	0.93
2.9	0.91
3.0	0.90
3.1	0.88
3.2	0.86
3.4	0.82
≥ 3.5	0.80

Table 2.2.2.4-2 – Values of factor X_2

C_B	X_2
≤ 0.45	0.75
0.50	0.82
0.55	0.89
0.60	0.95
0.65	0.97
≥ 0.70	1.00

Table 2.2.2.4-3 – Values of factor k

$\frac{A_k \cdot 100}{L_{WL} \cdot B}$	k
0	1.0
1.0	0.98
1.5	0.95
2.0	0.88
2.5	0.79
3.0	0.74
3.5	0.72
≥ 4.0	0.70

Table 2.2.2.4-4 – Values of wave steepness, s

Natural roll period, T_r (s)	Wave steepness factor, s
≤ 6	0.100
7	0.098
8	0.093
12	0.065
14	0.053
16	0.044

18	0.038
20	0.032
22	0.028
24	0.025
26	0.023
28	0.021
≥ 30	0.020

(Intermediate values in these tables should be obtained by linear interpolation.)

2.2.2.5 For ships subject to operational limitations according to 2.2.1.6, the wave steepness, s, in table 2.2.2.4-4 may be modified.

2.2.2.6 For any ship, the angle of roll, φ_1, may also be determined by alternative means on the basis of the Guidelines developed by the Organization.[4]

2.2.3 Level 2 vulnerability criterion for the dead ship condition

2.2.3.1 A ship is considered not to be vulnerable to the dead ship condition failure mode if:

$$C \le R_{DS0}$$

where:

R_{DS0} = 0.06;

C = long-term probability index that measures the vulnerability of the ship to a stability failure in the dead ship condition based on the probability of occurrence of short-term environmental conditions, as specified according to 2.2.3.2.

2.2.3.2 The value of C is calculated as a weighted average from a set of short-term environmental conditions, as follows:

$$\mathrm{C} = \sum_{i=1}^{N} W_i C_{s,i}$$

where:

W_i = weighting factor for the short-term environmental condition, as specified in 2.7.2;

$C_{s,i}$ = short-term dead ship stability failure index for the short-term environmental condition under consideration, calculated as specified in 2.2.3.2.1;

N = total number of short-term environmental conditions, according to 2.7.2.

[4] Refer to the procedure described in the *Interim guidelines for alternative assessment of the weather criterion* (MSC.1/Circ.1200).

2.2.3.2.1 The short-term dead ship stability failure index, $C_{s,i}$, for the short-term environmental condition under consideration, is a measure of the probability that the ship will exceed specified heel angles at least once in the exposure time considered, taking into account an effective relative angle between the ship and the waves. Each index, $C_{s,i}$, is calculated according to the following formula:

$C_{S,i}$ = 1, if either:

.1 the mean wind heeling lever $\bar{l}_{wind,tot}$ (according to 2.2.3.2.2) exceeds the righting lever, GZ, at each angle of heel to leeward, or

.2 the stable heel angle under the action of steady wind, $\varphi_{S,}$, is greater than the angle of failure to leeward, $\varphi_{fail,+,}$; and

= $1 - \exp(-r_{EA}\, T_{exp})$, otherwise;

where:

Heel angles are to be taken as positive to leeward and negative to windward;

T_{exp} = exposure time, to be taken as equal to $3600\ s$;

r_{EA} = $\frac{1}{T_{z,C_S}} \cdot \left[\exp\left(-\frac{1}{2 \cdot RI_{EA+}^2} \right) + \exp\left(-\frac{1}{2 \cdot RI_{EA-}^2} \right) \right]$ (1/s);

RI_{EA+} = $\frac{\sigma_{C_S}}{\delta\phi_{res,EA+}}$;

RI_{EA-} = $\frac{\sigma_{C_S}}{\delta\phi_{res,EA-}}$;

T_{z,C_S} = reference average zero-crossing period of the effective relative roll motion under the action of wind and waves determined according to 2.2.3.2.3 (s);

σ_{C_S} = standard deviation of the effective relative roll motion under the action of wind and waves determined according to 2.2.3.2.3 (rad);

$\delta\varphi_{res,EA+}$ = range of residual stability to the leeward equivalent area limit angle, to be calculated as

$\varphi_{EA+} - \varphi_S$ (rad);

$\delta\varphi_{res,EA-}$ = range of residual stability to the windward equivalent area limit angle, to be calculated as

$\varphi_S - \varphi_{EA-}$ (rad);

φ_{EA+} = equivalent area virtual limit angle to leeward, to be calculated as

$$\varphi_{EA+} = \varphi_S + \left(\frac{2 \cdot A_{res,+}}{GM_{res}} \right)^{1/2} \text{ (rad);}$$

φ_{EA-} = equivalent area virtual limit angle to windward, to be calculated as

$$\phi_{EA-} = \phi_S - \left(\frac{2 \cdot A_{res,-}}{GM_{res}} \right)^{1/2} \text{ (rad);}$$

φ_S = stable heel angle due to the mean wind heeling lever, $\bar{l}_{wind,tot}$, determined according to 2.2.3.2.2 (rad);

$A_{res,+}$ = area under the residual righting lever curve (i.e., $GZ - \bar{l}_{wind,tot}$) from φ_S to $\varphi_{fail,+}$ (m rad);

$A_{res,-}$ = area under the residual righting lever curve (i.e., $GZ - \bar{l}_{wind,tot}$) from $\varphi_{fail,-}$ to φ_S (m rad) ;

GM_{res} = residual metacentric height, to be taken as the slope of the residual righting lever curve (i.e., $GZ - \bar{l}_{wind,tot}$) at φ_S (m);

$\varphi_{fail,+}$ = angle of failure to leeward, to be taken as $\min\{\varphi_{VW,+}, \varphi_{crit,+}\}$ (rad);

$\varphi_{fail,-}$ = angle of failure to windward, to be taken as $\max\{\varphi_{VW,-}, \varphi_{crit,-}\}$ (rad);

$\varphi_{VW,+}$ = angle of second intercept to leeward between the mean wind heeling lever $\bar{l}_{wind,tot}$ and the GZ curve;

$\varphi_{VW,-}$ = angle of second intercept to windward between the mean wind heeling lever $\bar{l}_{wind,tot}$ and the GZ curve;

$\varphi_{crit,+}$ = critical angle to leeward, to be taken as $\min\{\varphi_{f,+}, 50\deg\}$ (rad);

$\varphi_{crit,-}$ = critical angle to windward, to be taken as $\max\{\varphi_{f,-}, -50\deg\}$ (rad);

$\varphi_{f,+}$, $\varphi_{f,-}$ = angles of downflooding to leeward and windward, respectively, in accordance with the definition of "angle of downflooding" in the 2008 IS Code, Part A, 2.3.1 (rad);

2.2.3.2.2 The mean wind heeling lever $\bar{l}_{wind,tot}$ is a constant value at all angles of heel and is calculated according to the following formula:

$$\bar{l}_{wind,tot} = \frac{\overline{M}_{wind,tot}}{\rho \cdot g \cdot \nabla} \text{ (m)}$$

where:

$\overline{M}_{wind,tot}$ = mean wind heeling moment, to be calculated as

$$\frac{1}{2}\rho_{air} \cdot U_w^2 \cdot C_{whm} \cdot A_L \cdot Z \qquad \text{(N m);}$$

U_w = mean wind speed, to be calculated as

$$\left(\frac{H_S}{0.06717}\right)^{2/3} \quad \text{(m/s)}$$

Different expressions can be used when considering alternative environmental conditions, in accordance with 2.2.1.6;

C_{whm} = wind heeling moment coefficient, to be taken as equal to 1.22 or as determined by other methods;

H_S = significant wave height for the short-term environmental condition under consideration, according to 2.7.2.

2.2.3.2.3 For the short-term environmental condition under consideration, the reference average zero-crossing period of the effective relative roll motion, T_{Z,C_S}, and the corresponding standard deviation, σ_{C_S}, to be used in the calculation of the short-term dead ship stability failure index, $C_{S,i}$, are determined using the spectrum of the effective relative roll motion under to the action of wind and waves, in accordance with the following formulae:

$$\sigma_{C_S} = \left(m_0\right)^{1/2} \quad \text{(rad)}$$

$$T_{z,C_S} = 2\pi \cdot \left(m_0 / m_2\right)^{1/2} \quad \text{(s)}$$

where:

m_o = area under the spectrum $S\left(\omega\right)$ (rad²);

m_2 = area under the function of $\omega^2 \cdot S(\omega)$ (rad⁴/s²);

$S\left(\omega\right)$ = spectrum of the effective relative roll angle, to be calculated as follows:

$$H_{rel}^2(\omega) \cdot S_{\alpha\alpha,c}(\omega) + H^2(\omega) \cdot \frac{S_{\delta M_{wind,tot}}(\omega)}{(\rho \cdot g \cdot \nabla \cdot GM)^2} \quad \text{(rad}^2\text{/(rad/s))}$$

$$H_{rel}^2\left(\omega\right) = \frac{\omega^4 + \left(2 \cdot \mu_e \cdot \omega\right)^2}{(\omega_{0,e}^2 - \omega^2)^2 + \left(2 \cdot \mu_e \cdot \omega\right)^2}$$

$$H^2\left(\omega\right) = \frac{\omega_0^4}{(\omega_{0,e}^2 - \omega^2)^2 + \left(2 \cdot \mu_e \cdot \omega\right)^2}$$

$S_{\alpha\alpha,c}\left(\omega\right)$ = spectrum of the effective wave slope, to be calculated as

$$r^2\left(\omega\right) \cdot S_{\alpha\alpha}\left(\omega\right) \quad \text{(rad}^2\text{/(rad/s))}$$

$S_{\alpha\alpha}\left(\omega\right)$ = spectrum of the wave slope, to be calculated as

$$\frac{\omega^4}{g^2} \cdot S_{zz}(\omega) \qquad \text{(rad}^2\text{/(rad/s))}$$

$S_{zz}(\omega)$ = sea wave elevation energy spectrum (m²/(rad/s)). The standard expression for $S_{zz}(\omega)$ is defined in 2.7.2.1.1.

Different expressions can be used when considering alternative environmental conditions, in accordance with 2.2.1.6;

$S_{\delta M_{wind,tot}}(\omega)$ = spectrum of moment due to the action of the gust, to be calculated as

$$\left[\rho_{air} \cdot U_w \cdot C_{whm} \cdot A_L \cdot Z\right]^2 \cdot \chi^2(\omega) \cdot S_v(\omega) \quad \text{((N m)}^2\text{/(rad/s))}$$

$\chi(\omega)$ = standard aerodynamic admittance function, to be taken as a constant equal to 1.0;

$S_v(\omega)$ = gustiness spectrum. The standard expression for $S_v(\omega)$ is as follows:

$$4 \cdot K \cdot \frac{U_w^2}{\omega} \cdot \frac{X_D^2}{\left(1+X_D^2\right)^{\frac{4}{3}}} \qquad \text{((m/s)}^2\text{/(rad/s))}$$

with $K = 0.003$ and $X_D = 600 \cdot \omega / (\pi \cdot U_w)$. Different expressions can be used when considering alternative environmental conditions in accordance with 2.2.1.6;

μ_e = equivalent linear roll damping coefficient (1/s), calculated according to the stochastic linearization method. This coefficient depends on linear and nonlinear roll damping coefficients and on the specific roll velocity standard deviation in the considered short-term environmental conditions;

$\omega_{0,e}(\varphi_S)$ = modified roll natural frequency close to the heel angle, φ_S, to be calculated as:

$$\omega_0 \cdot \left(\frac{GM_{res}}{GM}\right)^{1/2} \quad \text{(rad/s);}$$

ω_0 = upright natural roll frequency = $2\pi/T_r$ (rad/s);

$r(\omega)$ = effective wave slope function determined according to 2.2.3.2.4;

and other variables as defined in 2.2.3.2.1 and 2.2.3.2.2.

2.2.3.2.4 The effective wave slope function, $r(\omega)$, should be specified using a reliable method, based on computations or derived from experimental data,[5] and accepted by the Administration.

2.2.3.2.5 In the absence of sufficient information, the recommended methodology for the estimation of the effective wave slope function should be used, which is based on the following assumptions and approximations:

.1 The underwater part of each transverse section of the ship is substituted by an "equivalent underwater section" having, in general, the same breadth at waterline and the same underwater sectional area of the original section.

However:

.1 sections having zero breadth at waterline, such as those in the region of the bulbous bow, are neglected; and

.2 the draught of the "equivalent underwater section" is limited to the ship sectional draught.

.2 The effective wave slope coefficient for each wave frequency is determined by using the "equivalent underwater sections" considering only the undisturbed linear wave pressure.

.3 For each section a formula is applied which is exact for rectangles.

2.2.3.2.6 The recommended methodology is applied considering the actual trim of the ship. The recommended methodology for the estimation of the effective wave slope is applicable only to monohull ships. For a ship that does not fall in this category, alternative prediction methods should be applied.

2.3 Assessment of ship vulnerability to the excessive acceleration failure mode

2.3.1 Application

2.3.1.1 The provisions given hereunder apply to each ship in each loading condition provided that:

.1 the distance from the waterline to the highest location along the length of the ship where passengers or crew may be present exceeds 70% of the breadth of the ship; and

.2 the metacentric height exceeds 8% of the breadth of the ship.

2.3.1.2 For each loading condition and location along the length of the ship where passengers or crew may be present, a ship that:

.1 meets the standard contained in the criteria contained in 2.3.2 is considered not to be vulnerable to the excessive acceleration failure mode; and

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[5] Refer to the procedure described in *the Interim guidelines for alternative assessment of the weather criterion* (MSC.1/Circ.1200) for guidance.

.2 does not meet the standard contained in the criteria contained in 2.3.2 should be subject to more detailed assessment of vulnerability to the excessive acceleration failure mode by applying the criteria contained in 2.3.3.

2.3.1.3 Alternatively to the criteria contained in 2.3.2 or 2.3.3, for each loading condition a ship may be subject to either:

.1 direct stability assessment for the excessive acceleration failure mode that is performed in accordance with chapter 3; or

.2 operational measures developed in accordance with chapter 4.

2.3.1.4 A detailed assessment of Level 2 vulnerability according to the criteria contained in 2.3.3 may be performed without the requirement to perform a more simplified assessment in 2.3.2. Similarly, a detailed direct stability assessment as provided in 2.3.1.3.1 may be performed without the requirement to perform a more simplified assessment in 2.3.2 or 2.3.3.

2.3.1.5 Stability limit information for determining the safe zones as functions of GM, draught and trim is to be provided based on matrix calculations according to the criteria contained in sections 2.3.2 or 2.3.3 and, if appropriate, direct stability assessment according to the provisions in chapter 3 on direct stability assessment. If relevant, the stability limit information for determining safe zones should take into account operational measures or operational guidance according to the provisions in chapter 4 on operational measures.

2.3.1.6 Reference environmental conditions to be used in the assessment may be modified, according to the Guidelines for operational measures in chapter 4.

2.3.1.7 Free surface corrections should not be applied.

2.3.2 Level 1 vulnerability criterion for the excessive acceleration failure mode

2.3.2.1 A ship is considered not to be vulnerable to the excessive acceleration stability failure mode if, for each loading condition and location along the length of the ship where passengers or crew may be present,

$$\varphi \cdot k_L \cdot \left(g + 4\pi^2 h_r / T_r^2\right) \le R_{EA1}$$

where:

R_{EA1} = 4.64 (m/s^2)

φ = characteristic roll amplitude (rad) = 4.43 $r\,s$ / $\delta_\varphi^{0.5}$;

k_L = factor taking into account simultaneous action of roll, yaw and pitch motions,

= 1.125 – 0.625 x/L, if $x < 0.2\,L$,

= 1.0, if $0.2\,L \le x \le 0.65\,L$,

= 0.527 + 0.727 x/L, if $x > 0.65\,L$;

x = longitudinal distance (m) of the location where passengers or crew may be present from the aft end of L;

h_r = height above the assumed roll axis of the location where passengers or crew may be present (m), for which definition, the roll axis may be assumed to be located at the midpoint between the waterline and the vertical centre of gravity;

r = effective wave slope coefficient = $\dfrac{K_1 + K_2 + (OG)(F)}{\dfrac{B^2}{12 C_B d} - \dfrac{C_B d}{2} - OG}$;

K_1 = $g\,\beta\,T_r^2\,(\tau + \tau\,\tilde{T} - 1/\tilde{T})\,/\,(4\,\pi^2)$;

K_2 = $g\,\tau\,T_r^2\,(\beta - \cos\tilde{B})\,/\,(4\,\pi^2)$;

OG = $KG - d$;

F = $\beta\,(\tau - 1/\tilde{T})$;

β = $\sin(\tilde{B})\,/\,\tilde{B}$;

τ = $\exp(-\tilde{T})\,/\,\tilde{T}$;

$\tilde{B}$ = $2\,\pi^2\,B\,/\,(g\,T_r^2)$;

$\tilde{T}$ = $4\,\pi^2\,C_B\,d\,/\,(g\,T_r^2)$;

s = wave steepness as a function of the natural roll period T_r (see 2.7.1), as determined from table 2.3.2.1; and

δ_φ = non-dimensional logarithmic decrement of roll decay.

Table 2.3.2.1 – Values of wave steepness, s
(Intermediate values in the table should be obtained by linear interpolation)

Natural roll period, T_r (s)	Wave steepness, s
≤ 6	0.100
7	0.098
8	0.093
12	0.065
14	0.053
16	0.044
18	0.038
20	0.032
22	0.028
24	0.025
26	0.023
28	0.021
≥ 30	0.020

2.3.3 Level 2 vulnerability criterion for the excessive acceleration failure mode

2.3.3.1 A ship in a loading condition is considered not to be vulnerable to the excessive acceleration stability failure mode if, for each location along the length of the ship where passengers or crew may be present:

$$C \le R_{EA2}$$

where:

R_{EA2} = 0.00039;

C = long-term probability index that measures the vulnerability of the ship to a stability failure due to excessive acceleration for the loading condition and location under consideration based on the probability of occurrence of short-term environmental conditions, as specified according to 2.3.3.2.

2.3.3.2 The value of C is calculated as a weighted average from a set of short-term environmental conditions, as follows:

$$C = \sum_{i=1}^{N} W_i C_{S,i}$$

where:

W_i = weighting factor for the short-term environmental condition, as specified in 2.7.2;

$C_{S,i}$ = short-term excessive acceleration failure index for the short-term environmental condition under consideration, calculated as specified in 2.3.3.2.1;

N = total number of short-term environmental conditions, according to 2.7.2.

2.3.3.2.1 The short-term excessive acceleration failure index, $C_{S,i}$, for the loading condition, location and for the short-term environmental condition under consideration is a measure of the probability that the ship will exceed a specified lateral acceleration, calculated according to the following formula:

$C_{S,i}$ = $\exp(-R_2^2 / (2\,\sigma_{LAi}^2))$;

where:

R_2 = 9.81 (m/s^2);

σ_{LAi} = standard deviation of the lateral acceleration at zero speed and in a beam seaway determined according to 2.3.3.2.2 (m/s^2);

2.3.3.2.2 The standard deviation of the lateral acceleration at zero speed and in a beam seaway, σ_{LAi}, is determined using the spectrum of roll motion due to the action of waves. The square of this standard deviation is calculated according to the following formula:

$$\sigma_{LAi}^2 = \frac{3}{4}\sum_{j=1}^{N}\left(a_y(\omega_j)\right)^2 S_{zz}(\omega_j)\Delta\omega$$

where:

$\Delta\omega$ = interval of wave frequency (rad/s) = $(\omega_2 - \omega_1) / N$ (rad/s);

ω_2 = upper frequency limit of the wave spectrum in the evaluation range = $\min((25 / T_r),2.0)$ (rad/s);

ω_1 = lower frequency limit of the wave spectrum in the evaluation range = $\max((0.5 / T_r),0.2)$ (rad/s);

N = number of intervals of wave frequency in the evaluation range, not to be taken less than 100;

ω_j = wave frequency at the mid-point of the considered frequency interval = $\omega_1 + ((2j - 1) / 2)\,\Delta\omega$ (rad/s);

$S_{zz}(\omega_j)$ = sea wave elevation spectrum (m²/(rad/s)). The standard expression for $S_{zz}(\omega)$ is defined in 2.7.2.1.1;

$a_y(\omega_j)$ = lateral acceleration = $k_L(g + h_r \cdot \omega_j^2) \cdot \varphi_a(\omega_j)$ per unit wave amplitude ((m/s²)/m);

k_L, h_r = as defined in 2.3.2.1;

$\varphi_a(\omega_j)$ = roll amplitude in regular beam waves of unit amplitude and circular frequency ω_j at zero speed, = $(\varphi_r(\omega_j)^2 + \varphi_i(\omega_j)^2)^{0.5}$ (rad/m);

$$\varphi_r(\omega_j) = \frac{a\left(\frac{\rho g \nabla GM}{1000} - J_{T,roll}\omega_j^2\right) + bB_e\omega_j}{\left(\frac{\rho g \nabla GM}{1000} - J_{T,roll}\omega_j^2\right)^2 + (B_e\omega_j)^2} \quad \text{(rad/m)};$$

$$\varphi_i(\omega_j) = \frac{b\left(\frac{\rho g \nabla GM}{1000} - J_{T,roll}\omega_j^2\right) - aB_e\omega_j}{\left(\frac{\rho g \nabla GM}{1000} - J_{T,roll}\omega_j^2\right)^2 + (B_e\omega_j)^2} \quad \text{(rad/m)};$$

a, b = cosine and sine components, respectively, of the Froude-Krylov roll moment in regular beam waves of unit amplitude (kN·m/m), calculated directly or using an appropriate approximation;

B_e = equivalent linear roll damping factor (kN m s), with $B_e = 2J_{T,roll}\mu_e$ where μ_e (1/s) is the equivalent linear roll damping coefficient;

$J_{T,roll}$ = roll moment of inertia comprising added inertia = $\frac{1}{1000}\frac{\rho\, g\, \nabla\, GM\, T_r^2}{4\pi^2}$ (t·m²).

Other suitable formulations for the numerical integration in the range from ω_1 to ω_2 can be used as an alternative.

2.4 Assessment of ship vulnerability to the pure loss of stability failure mode

2.4.1 Application

2.4.1.1 The provisions given hereunder apply to all ships, except for ships with an extended low weather deck,[6] for which the Froude number, Fn, corresponding to the service speed exceeds 0.24.

2.4.1.2 For each loading condition, a ship that:

.1 meets the standard contained in the criteria contained in 2.4.2 is considered not to be vulnerable to the pure loss of stability failure mode; and

.2 does not meet the standard contained in the criteria contained in 2.4.2 should be subject to more detailed assessment of vulnerability to the pure loss of stability failure mode by applying the criteria contained in 2.4.3.

6 The criteria for this failure mode may not be applicable to a ship with an extended low weather deck due to increased likelihood of water on deck or deck-in-water.

2.4.1.3 Alternatively to the criteria contained in 2.4.2 or 2.4.3, for each loading condition a ship may be subject to either:

.1 direct stability assessment for the pure loss of stability failure mode that is performed according to the Guidelines for direct stability assessment in chapter 3; or

.2 operational measures according to the Guidelines for operational measures in chapter 4.

2.4.1.4 A detailed assessment of Level 2 vulnerability according to the criteria contained in 2.4.3 may be performed without the requirement to perform a more simplified assessment in 2.4.2. Similarly, a detailed direct stability assessment, as provided in 2.4.1.3.1, may be performed without the requirement to perform a more simplified assessment in 2.4.2 or 2.4.3.

2.4.1.5 Stability limit information for determining the safe zones as functions of *GM*, draught and trim is to be provided based on matrix calculations according to the criteria contained in sections 2.4.2 or 2.4.3 and, if appropriate, direct stability assessment according to the provisions in chapter 3 on direct stability assessment. If relevant, the stability limit information for determining safe zones should take into account operational measures according to the provisions in chapter 4.

2.4.1.6 Reference environmental conditions to be used in the assessment may be modified, according to the Guidelines for operational measures in chapter 4.

2.4.1.7 Free surface effect should be accounted for as recommended in chapter 3 of part B of the 2008 IS Code.

2.4.2 Level 1 vulnerability criterion for the pure loss of stability failure mode

2.4.2.1 A ship is considered not to be vulnerable to the pure loss of stability failure mode, if

$$GM_{\min} \geq R_{PLA} \text{ and } \frac{\nabla_D - \nabla}{A_W(D-d)} \geq 1.0$$

where:

R_{PLA} = 0.05 (m);

$GM_{\min}$ = minimum value of the metacentric height (m) calculated as provided in 2.4.2.2.

2.4.2.2 As provided by 2.4.2.1, $GM_{\min}$ should be determined according to:

$$GM_{\min} = KB + \frac{I_{TL}}{\nabla} - KG$$

where:

I_{TL} = transverse moment of inertia of the waterplane at the draft d_L (m^4);

d_L = $d - \delta d_L$ (m);

δd_L = $\min(d - 0.25d_{full}, \frac{L \cdot s_W}{2})$ (m);

and $d - 0.25d_{full}$ should not be taken less than zero;

s_W = 0.0334;

2.4.2.3 The use of the simplified conservative estimation of $GM_{\min}$ described in 2.4.2.2 without initial trim effect can be applied for ships having non-even keel condition.

2.4.3 Level 2 vulnerability criteria for the pure loss of stability failure mode

2.4.3.1 A ship is considered not to be vulnerable to the pure loss of stability failure mode if, when underway at the service speed, V_S,

$$\max\left(CR_1, CR_2\right) \leq R_{PL0}$$

where:

R_{PL0} = 0.06;

CR_1, CR_2 = criteria calculated according to 2.4.3.2.

2.4.3.2 Each of the two criteria, CR_1 and CR_2 in 2.4.3.1, represents a weighted average of certain stability parameters for a ship considered to be statically positioned in waves of defined height, H_i, and length, λ_i, obtained according to 2.4.3.2.2. CR_1 and CR_2 are calculated as follows:

$$CR_1 = \sum_{i=1}^{N} W_i C1_i$$

$$CR_2 = \sum_{i=1}^{N} W_i C2_i$$

where:

CR_1 = weighted criterion 1, computed using Criterion 1, $C1_i$, as evaluated according to 2.4.3.3;

CR_2 = weighted criterion 2, computed using Criterion 2, $C2_i$, as evaluated according to 2.4.3.4;

W_i = weighting factor for the short-term environmental condition, as specified in 2.4.3.2.2;

N = total number of wave cases for which $C1_i$ and $C2_i$ are evaluated, according to 2.4.3.2.2.

2.4.3.2.1 For calculating the restoring moment in waves, the following wavelength and wave heights should be used:

Length $\lambda = L$; and

Height $h = 0.01 \cdot iL \quad i = 0,1,...,10$.

The index for the two criteria, based on φ_v and φ_s, should be calculated according to the formulations given in 2.4.3.3 and 2.4.3.4, respectively. This is undertaken for the loading condition under consideration and the ship assumed to be balanced in sinkage and trim in a series of waves with the characteristics as described above.

In these waves to be studied, the wave crest is to be centred amidships, and at *0.1L*, *0.2L*, *0.3L*, *0.4L* and *0.5L* forward and *0.1L*, *0.2L*, *0.3L* and *0.4L* aft thereof.

2.4.3.2.2 For each combination of H_s and T_z specified in 2.7.2, W_i is obtained as the value in table 2.7.2.1.2 divided by the amount of observations given in this table, which is associated with a H_i as calculated in 2.4.3.2.3 below and λ_i is taken as equal to L. The indices for each H_i

should be linearly interpolated from the relationship between h used in 2.4.3.2.1 and the indices obtained in 2.4.3.2.1 above.

2.4.3.2.3 The 3% largest effective wave height, H_i, for use in the evaluation of the requirements is calculated by filtering waves within the ship length. For this purpose, an appropriate wave spectrum shape should be assumed.

2.4.3.3 *Criterion 1*

Criterion 1, $C1_i$, is a criterion based on the calculation of the angle of vanishing stability, φ_V , as provided in the following formula:

$$C1_i = \begin{cases} 1 & \varphi_V < K_{PL1} \\ 0 & otherwise \end{cases}$$

where:

K_{PL1} = 30 (deg)

The angle of vanishing stability, φ_V, should be determined as the minimum value calculated, as provided in 2.4.3.2.1, 2.4.3.2.2 and 2.4.3.2.3 for the ship without consideration of the angle of downflooding.

2.4.3.4 *Criterion 2*

Criterion 2, $C2_i$, is a criterion based on the calculation of the angle of heel, φ_{sw}, under action of heeling lever specified by l_{PL2} as provided in the following formula:

$$C2_i = \begin{cases} 1 & \varphi_{sw} > K_{PL2} \\ 0 & \text{otherwise} \end{cases}$$

where:

K_{PL2}	=	15 degrees for passenger ships; and
	=	25 degrees for all other ship types
l_{PL2}	=	8(H_i/λ) dFn^2 (m);
H_i	=	as provided in 2.4.3.2.2 and 2.4.3.2.3;
λ	=	as provided in 2.4.3.2.2;

The angle of heel, φ_{sw}, should be determined as the maximum value calculated as provided in 2.4.3.2.1, 2.4.3.2.2 and 2.4.3.2.3, for the ship without consideration of the angle of downflooding.

2.5 Assessment of ship vulnerability to the parametric rolling failure mode

2.5.1 Application

2.5.1.1 For each loading condition, a ship that:

.1 meets the standard contained in the criteria contained in 2.5.2 is considered not to be vulnerable to the parametric rolling failure mode;

.2 does not meet the standard contained in the criteria contained in 2.5.2 should be subject to more detailed assessment of vulnerability to the parametric rolling failure mode by applying the criteria contained in 2.5.3.

2.5.1.2 Alternatively to the criteria contained in 2.5.2 or 2.5.3, for each loading condition a ship may be subject to either:

.1 a direct stability assessment for the parametric rolling failure mode that is performed according to the Guidelines for direct stability assessment in chapter 3; or

.2 operational measures for the parametric rolling failure mode according to the Guidelines for operational measures in chapter 4.

2.5.1.3 A detailed assessment of Level 2 vulnerability according to the criteria contained in 2.5.3 may be performed without the requirement to perform a more simplified assessment in 2.5.2. Similarly, a detailed direct stability assessment as provided in 2.5.1.3.1 may be performed without the requirement to perform a more simplified assessment in 2.5.2 or 2.5.3.

2.5.1.4 Stability limit information for determining the safe zones as functions of GM, draught and trim is to be provided based on matrix calculations according to the criteria contained in 2.5.2 or 2.5.3 and, if appropriate, direct stability assessment according to the provisions in chapter 3 on direct stability assessment. If relevant, the stability limit information for determining safe zones should take into account operational measures according to the provisions in chapter 4.

2.5.1.5 Reference environmental conditions to be used in the assessment may be modified, according to the Guidelines for operational measures in chapter 4.

2.5.1.6 Free surface effects should be accounted for as recommended in chapter 3 of part B of 2008 IS Code.

2.5.2 Level 1 vulnerability criterion for the parametric rolling failure mode

2.5.2.1 A ship is considered not to be vulnerable to the parametric rolling failure mode if

$$\frac{\delta GM_1}{GM} \leq R_{PR} \quad \text{and} \quad \frac{\nabla_D - \nabla}{A_W(D-d)} \geq 1.0$$

where:

R_{PR} = 1.87, if the ship has a sharp bilge; and, otherwise,

= $0.17 + 0.425\left(\frac{100A_k}{LB}\right)$, if $C_{m,full} > 0.96$;

= $0.17 + \left(10.625 \times C_{m,\,full} - 9.775\right)\left(\frac{100A_k}{LB}\right)$, if $0.94 \le C_{m,full} \le 0.96$;

= $0.17 + 0.2125\left(\frac{100A_k}{LB}\right)$, if $C_{m,full} < 0.94$; and

for each formula, $\left(\frac{100A_k}{LB}\right)$ should not exceed 4;

δGM_1 = amplitude of the variation of the metacentric height (m) calculated as provided in 2.5.2.2.

2.5.2.2 As provided by 2.5.2.1, δGM_1 should be determined according to:

$$\delta GM_1 = \frac{I_{TH} - I_{TL}}{2\nabla}$$

where:

δd_H = $\min(D - d, \frac{L \cdot S_W}{2})$ (m);

δd_L = $\min(d - 0.25 d_{full}, \frac{L \cdot S_W}{2})$ (m);

and $d - 0.25 d_{full}$ should not be taken less than zero;

d_H = $d + \delta d_H$ (m);

d_L = $d - \delta d_L$ (m);

S_W = 0.0167;

I_{TH} = transverse moment of inertia of the waterplane at the draft d_H (m^4); and

I_{TL} = transverse moment of inertia of the waterplane at the draft d_L (m^4).

2.5.2.3 The use of the simplified conservative estimation of δGM_1 described in 2.5.2.2, without initial trim effect, can be applied for ships having a non-even keel condition.

2.5.3 Level 2 vulnerability criteria for the parametric rolling failure mode

2.5.3.1 A ship is considered not to be vulnerable to the parametric rolling failure mode, if

.1 $C1 \le R_{PR1}$; or

.2 $C2 \le R_{PR2}$;

where:

R_{PR1} = 0.06;

R_{PR2} = 0.025;

$C1$ = criterion calculated according to 2.5.3.2;

$C2$ = criterion calculated according to 2.5.3.3.

2.5.3.2 The value for $C1$ is calculated as a weighted average from a set of waves specified in 2.5.3.2.3, as:

$$C1 = \sum_{i=1}^{N} W_i C_i$$

where:

W_i = weighting factor for the respective wave specified in 2.5.3.2.3;

C_i = 0, if the requirements of either the variation of GM in waves contained in 2.5.3.2.1 or the ship speed in waves contained in 2.5.3.2.2 is satisfied; and

= 1, if not;

N = the number of wave cases evaluated, as specified in 2.5.3.2.3.

2.5.3.2.1 For each wave specified in 2.5.3.2.3, the requirement for the variation of GM in waves is satisfied if:

$$GM(H_i, \lambda_i) > 0 \quad and \quad \frac{\delta GM(H_i, \lambda_i)}{GM(H_i, \lambda_i)} < R_{PR}$$

where:

R_{PR} = as defined in 2.5.2.1;

$\delta GM(H_i, \lambda_i)$ = one-half the difference between the maximum and minimum values of the metacentric height calculated for the ship (m), corresponding to the loading condition under consideration, considering the ship to be balanced in sinkage and trim on a series of waves characterized by a wave height H_i, and a wavelength λ_i ;

$GM(H_i, \lambda_i)$ = the average value of the metacentric height calculated for the ship (m), corresponding to the loading condition under consideration, considering the ship to be balanced in sinkage and trim on a series of waves characterized by a wave height H_i, and a wavelength λ_i;

H_i = wave height specified in 2.5.3.2.3 (m); and

λ_i = wavelength specified in 2.5.3.2.3 (m).

2.5.3.2.2 For each wave specified in 2.5.3.2.3, the requirement for the ship speed in waves is satisfied if:

$$V_{PRi} > V_s$$

where:

V_{PRi} = the reference ship speed (m/s) corresponding to parametric resonance conditions, when $GM(H_i, \lambda_i)$>0:

$$= \left| \frac{2\lambda_i}{T_r} \cdot \sqrt{\frac{GM(H_i, \lambda_i)}{GM}} - \sqrt{g \frac{\lambda_i}{2\pi}} \right|$$

$GM(H_i, \lambda_i)$ = as defined in 2.5.3.2.1 (m);

λ_i = wavelength specified in 2.5.3.2.3 (m);

$| \; |$ = the absolute value operation.

2.5.3.2.3 The specified wave cases for evaluation of the requirements contained in 2.5.3.2.1 and 2.5.3.2.2 are presented in table 2.5.3.2.3. In table 2.5.3.2.3, W_i, H_i, λ_i are as defined in 2.5.3.2.

Table 2.5.3.2.3
Wave cases for parametric rolling evaluation

Wave case number	Weight factor W_i	Wavelength λ_i (m)	Wave height H_i (m)
1	0.000013	22.574	0.350
2	0.001654	37.316	0.495
3	0.020912	55.743	0.857
4	0.092799	77.857	1.295
5	0.199218	103.655	1.732
6	0.248788	133.139	2.205
7	0.208699	166.309	2.697
8	0.128984	203.164	3.176
9	0.062446	243.705	3.625
10	0.024790	287.931	4.040
11	0.008367	335.843	4.421
12	0.002473	387.440	4.769
13	0.000658	442.723	5.097
14	0.000158	501.691	5.370
15	0.000034	564.345	5.621
16	0.000007	630.684	5.950

2.5.3.2.4 In the calculation of $\delta GM(H_i, \lambda_i)$ and $GM(H_i, \lambda_i)$ in 2.5.3.2.1, the wave crest should be located amidships, and at 0.1 λ_i, 0.2 λ_i, 0.3 λ_i, 0.4 λ_i, and 0.5 λ_i forward and 0.1 λ_i, 0.2 λ_i, 0.3 λ_i, and 0.4 λ_i aft thereof.

2.5.3.3 The value of $C2$ is calculated as an average of values of $C2(Fn_i,\beta_i)$, each of which is a weighted average from the set of waves specified in 2.5.3.4.2, for each set of Froude numbers and wave directions specified:

$$C2 = \left[\sum_{i=1}^{12} C2\left(Fn_i,\beta_h\right)+\frac{1}{2}\left\{C2(0,\beta_h)+C2\left(0,\beta_f\right)\right\}+\sum_{i=1}^{12} C2\left(Fn_i,\beta_f\right)\right]/25$$

where:

$C2(Fn_i,\beta_h)$ = $C2(Fn,\beta)$ calculated as specified in 2.5.3.3.1 with the ship proceeding in head waves with a speed equal to V_i;

$C2(Fn_i,\beta_f)$ = $C2(Fn,\beta)$ calculated as specified in 2.5.3.3.1 with the ship proceeding in following waves with a speed equal to V_i;

Fn_i = $V_i / \sqrt{L\,g}$, Froude number corresponding to ship speed V_i;

V_i = $V_s \cdot K_i$, ship speed (m/s); and

K_i = as obtained from table 2.5.3.3.

Table 2.5.3.3

Speed factor, K_i

i	K_i
1	1.0
2	0.991
3	0.966
4	0.924
5	0.866
6	0.793
7	0.707
8	0.609
9	0.500
10	0.383
11	0.259
12	0.131

2.5.3.3.1 The weighted criteria $C2(Fn_i,\beta)$ are calculated as a weighted average of the short-term parametric rolling failure index considering the set of waves specified in 2.5.3.4.2, for a given Froude number and wave direction, as follows:

$$C2(Fn_i,\beta) = \sum_{i=1}^{N} W_i C_{S,i}$$

where:

W_i = weighting factor for the respective wave cases specified in 2.5.3.4.2;

$C_{S,i}$ = 1, if the maximum roll angle evaluated according to 2.5.3.4 exceeds 25 degrees, and

= 0, otherwise;

N = total number of wave cases for which the maximum roll angle is evaluated for a combination of speed and heading.

2.5.3.4 The maximum roll angle in head and following waves is evaluated as recommended in 2.5.3.4.1 for each speed, V_i, defined in 2.5.3.3. For each evaluation, the calculation of stability in waves should assume the ship to be balanced in sinkage and trim on a series of waves with the following characteristics:

wavelength, $\lambda = L$;
wave height, $h_j = 0.01 \cdot jL,\ \ \text{where j} = 0,1,...,10$.

For each wave height, h_j, the maximum roll angle is evaluated.

2.5.3.4.1 The evaluation of roll angle should be carried out using the time domain simulation method with GZ calculated in waves.

2.5.3.4.2 W_i is obtained as the value in table 2.7.2.1.2 divided by the number of observations given in the table. Each cell of the table corresponds to an average zero-crossing wave period, T_z, and a significant wave height, H_s. With these two values, a representative wave height, Hr_i, should be calculated by filtering waves within the ship length. The maximum roll angle, corresponding to the representative wave height, Hr_i, is obtained by linear interpolation of the maximum roll angles for different wave heights, h_j, obtained in 2.5.3.4. This maximum roll angle should be used for the evaluation of $C_{S,i}$ in 2.5.3.3.1.

2.6 Assessment of ship vulnerability to the surf-riding/broaching failure mode

2.6.1 Application

2.6.1.1 For each loading condition, a ship that:

.1 meets the standard contained in the criteria contained in 2.6.2 is considered not to be vulnerable to the surf-riding/broaching failure mode;

.2 does not meet the standard contained in the criteria in 2.6.2 should be subject to either:

.1 the procedures of ship handling on how to avoid dangerous conditions for surf-riding/broaching, as recommended in section 4.2.1 of the *Revised guidance to the master for avoiding dangerous situations in adverse weather and sea conditions* (MSC.1/Circ.1228), subject to the approval of the Administration; or

.2 more detailed assessment of vulnerability to the surf-riding/broaching failure mode by applying the criteria contained in 2.6.3.

2.6.1.2 Alternatively to the criteria contained in 2.6.2 or 2.6.3, for each loading condition a ship may be subject to either:

.1 direct stability assessment for the surf-riding/broaching failure mode that is performed according to the Guidelines for direct stability assessment in chapter 3; or

.2 operational measures based on the Guidelines for operational measures in chapter 4.

2.6.1.3 A detailed assessment of Level 2 vulnerability according to the criteria contained in 2.6.3 may be performed without the requirement to perform a more simplified assessment in 2.6.2. Similarly, a detailed direct stability assessment as provided in 2.6.1.3.1 may be performed without the requirement to conduct a more simplified assessment in 2.6.2 or 2.6.3.

2.6.1.4 For ships that do not meet the standard contained in 2.6.2 and which are not applying MSC.1/Circ.1228 according to 2.6.1.1 above, relevant consistent safety information should be provided according to the criteria contained in either 2.6.3 of these Guidelines, Guidelines for direct stability assessment in chapter 3 or Guidelines for operational measures in chapter 4, as appropriate.

2.6.1.5 Reference environmental conditions to be used in the assessment may be modified according to the Guidelines for operational measures in chapter 4.

2.6.2 Level 1 vulnerability criteria for the surf-riding/broaching failure mode

2.6.2.1 A ship is considered not to be vulnerable to the surf-riding/broaching failure mode if:

.1 $L \geq 200$ m; or

.2 $Fn \leq 0.3$.

2.6.3 Level 2 vulnerability criterion for the surf-riding/broaching failure mode

2.6.3.1 A ship is considered not to be vulnerable to the surf-riding/broaching failure mode if

$$C \leq R_{SR}$$

where:

R_{SR} = 0.005;

C = criterion calculated according to 2.6.3.2.

2.6.3.2 The value of C is calculated as

$$C = \sum_{H_S} \sum_{T_Z} \left(W2(H_S, T_Z) \sum_{i=0}^{N_\lambda} \sum_{j=0}^{N_a} w_{ij} C2_{ij} \right)$$

where:

$W2(H_s, T_z)$ = weighting factor of short-term sea state specified in 2.7.2.1 as a function of the significant wave height, H_S, and the zero-crossing wave period, T_Z, in which $W2(H_s, T_z)$ is equal to the number of occurrences of the combination divided by the total number of occurrences in the table, and it corresponds to the factor W_i specified in 2.7.2;

w_{ij} = statistical weight of a wave specified in 2.6.3.3 with steepness $(H/\lambda)_j$ and wavelength to ship length ratio $(\lambda/L)_i$ calculated with the joint distribution of local wave steepness and lengths, which is, with specified discretization $N_\lambda = 80$ and $N_a = 100$; and

$C2_{ij}$ = coefficient specified in 2.6.3.4.

2.6.3.3 The value of w_{ij} should be calculated using the following formula:

$$w_{ij} = 4 \frac{\sqrt{g}}{\pi \nu} \frac{L^{5/2} T_{01}}{(H_s)^3} s_j^2 r_i^{3/2} \left(\frac{\sqrt{1+\nu^2}}{1+\sqrt{1+\nu^2}} \right) \Delta r \Delta s \cdot exp \left[-2 \left(\frac{L \cdot r_i \cdot s_j}{H_s} \right)^2 \left\{ 1 + \frac{1}{\nu^2} \left(1 - \sqrt{\frac{g T_{01}^2}{2\pi r_i L}} \right)^2 \right\} \right]$$

where:

ν = 0.425;

T_{01} = 1.086 T_z;

s_j = $(H/\lambda)_j$ = wave steepness varying from 0.03 to 0.15 with increment $\Delta s = 0.0012$; and

r_i = $(\lambda/L)_i$ = wavelength to ship length ratio varying from 1.0 to 3.0 with increment $\Delta r = 0.025$.

2.6.3.4 The value of $C2_{ij}$ is calculated for each wave, as follows:

$$C2_{ij} = \begin{cases} 1 & if \quad Fn > Fn_{cr}(r_j, s_i) \\ 0 & if \quad Fn \le Fn_{cr}(r_j, s_i) \end{cases}$$

where:

Fn_{cr} = critical Froude number corresponding to the threshold of surf-riding (surf-riding occurring under any initial condition) which should be calculated in accordance with 2.6.3.4.1 for the regular wave with steepness s_j and wavelength to ship length ratio r_i.

2.6.3.4.1 The critical Froude number, Fn_{cr}, is calculated as

$$Fn_{cr} = u_{cr} / \sqrt{L\,g}$$

where the critical nominal ship speed, u_{cr} (m/s), is determined according to 2.6.3.4.2.

2.6.3.4.2 The critical nominal ship speed, u_{cr}, is determined by solving the following equation with the critical propulsor revolutions, n_{cr}:

$$T_e(u_{cr}; n_{cr}) - R(u_{cr}) = 0$$

where:

$R(u_{cr})$ = calm water resistance (N) of the ship at the ship speed of u_{cr}, see 2.6.3.4.3;

$T_e(u_{cr}; n_{cr})$ = thrust (N) delivered by the ship's propulsor(s) in calm water determined in accordance with 2.6.3.4.4; and

n_{cr} = commanded number of revolutions of propulsor(s) (1/s) corresponding to the threshold of surf-riding (surf-riding occurs under any initial conditions), see 2.6.3.4.6.

2.6.3.4.3 The calm water resistance, $R(u)$, is approximated based on available data with a polynomial fit suitable to represent the characteristics of the resistance for the ship in question. The fit should be appropriate to ensure the resistance is continuously increasing as a function of speed in the appropriate range.

2.6.3.4.4 For a ship using one propeller as the main propulsor, the propulsor thrust, $T_e(u;n)$, in calm water may be approximated using a second degree polynomial:

$$T_e(u;n) = (1 - t_p)\rho n^2 D_p^{\,4}\left\{\kappa_0 + \kappa_1 J + \kappa_2 J^2\right\} \text{ (N)}$$

where:

u = speed of the ship (m/s) in calm water;

n = commanded number of revolutions of propulsor (1/s);

t_p = approximate thrust deduction factor;

w_p = approximate wake fraction;

$\kappa_0, \kappa_1, \kappa_2$ = approximation coefficients for the approximated propeller thrust coefficient in calm water;

J = $\dfrac{u(1-w_p)}{nD_P}$ = advance ratio.

In case of a ship having multiple propellers, the overall thrust can be calculated by summing the effect of the individual propellers calculated as indicated above.

For a ship using a propulsor(s) other than a propeller(s), the propulsor thrust should be evaluated by a method appropriate to the type of propulsor used.

2.6.3.4.5 The amplitude of wave surging force for each wave is calculated as:

$$f_{ij} = \rho g k_i \frac{H_{ij}}{2}\sqrt{Fc_i^2 + Fs_i^2} \text{ (N)}$$

where:

k_i = wave number = $\dfrac{2\pi}{r_i L}$ (1/m);

H_{ij} = wave height = $s_j r_i L$ (m);

s_j ,r_i = as defined in 2.6.3.3;

$F_{c_i} = \sum_{m=1}^{N} \delta x_m \, S(x_m) \sin(k_i \, x_m) \exp(-0.5 k_i \cdot d(x_m))$

$$F_{s_i} = \sum_{m=1}^{N} \delta x_m \, S(x_m) \cos(k_i \, x_m) \exp(-0.5 k_i \cdot d(x_m))$$

F_{Ci} and F_{Si} are parts of the Froude-Krylov component of the wave surging force (m)

X_m = longitudinal distance from the midship to a station (m), positive for a bow section;

δx_m = length of the ship strip associated with station m (m);

$d(x_m)$ = draft at station m in calm water (m);

$S(x_m)$ = area of submerged portion of the ship at station m in calm water (m^2);

N = number of stations; and

m = index of a station.

2.6.3.4.6 The critical number of revolutions of the propulsor corresponding to the surf-riding threshold, n_{cr} (r_j, s_i), can be determined by solving the following quadratic equation:

$$2\pi \frac{T_e(c_i, n_{cr}) - R(c_i)}{f_{ij}} + 8a_0 n_{cr} + 8a_1 - 4\pi a_2 + \frac{64}{3}a_3 - 12\pi a_4 + \frac{1024}{15}a_5 = 0$$

where:

$$a_0 = -\frac{\tau_1}{\sqrt{f_{ij} \cdot k_i \cdot (M + M_x)}};$$

$$a_1 = \frac{r_1 + 2r_2c_i + 3r_3c_i^2 + 4r_4c_i^3 + 5r_5c_i^4 - 2\tau_2c_i}{\sqrt{f_{ij} \cdot k_i \cdot (M + M_x)}};$$

$$a_2 = \frac{r_2 + 3r_3c_i + 6r_4c_i^2 + 10r_5c_i^3 - \tau_2}{k_i \cdot (M + M_x)};$$

$$a_3 = \frac{r_3 + 4r_4c_i + 10r_5c_i^2}{\sqrt{k_i^3 (M + M_x)^3}} \cdot \sqrt{f_{ij}};$$

$$a_4 = \frac{r_4 + 5r_5c_i}{k_i^2 (M + M_x)^2} f_{ij};$$

$$a_5 = \frac{r_5}{\sqrt{k_i^5 (M + M_x)^5}} \sqrt{f_{ij}^3};$$

r_1, r_2, r_3, r_4, r_5= regression coefficients for the calm water resistance under a fifth degree polynomial approximation $R(u) \approx r_1u + r_2u^2 + r_3u^3 + r_4u^4 + r_5u^5$.

M = mass of the ship (kg);

M_x = added mass of the ship in surge (kg). In absence of ship specific data, M_x may be assumed to be 0.1 M;

c_i = $\sqrt{\frac{g}{k_i}}$ = wave celerity (m/s).

$$\tau_1 = \kappa_1(1 - t_p)(1 - w_p)\rho D_p^3$$

$$\tau_2 = \kappa_2(1 - t_p)(1 - w_p)^2\rho D_p^2$$

2.7 Parameters common to stability failure mode assessments

2.7.1 Inertial properties of a ship and natural period of roll motion

2.7.1.1 In the absence of direct calculations, the roll moment of inertia of the ship comprising the effect of added inertia, $J_{T,roll}$, may be estimated as follows:

$$J_{T,roll} = \frac{1}{1000} \frac{\rho \, g \, \nabla \, GM \, T_r^2}{4\pi^2} \text{ (t·m}^2\text{)}$$

2.7.1.2 The natural roll period, T_r, in a given loading condition, in the absence of sufficient information, direct calculation or measurement, may be approximated using the formulae given in part A, 2.3 of the 2008 IS Code, which is repeated below,

$$T_r = \frac{2 \cdot C \cdot B}{\sqrt{GM}}, \text{ where } C = 0.373 + 0.023\left(B/d\right) - 0.043\left(L_{WL}/100\right),$$

or its alternatives.

2.7.2 Environmental data

2.7.2.1 A set of standard environmental conditions are assumed. The characterization of the standard environmental conditions refers to both the short-term and the long-term. The short-term characterization is given in terms of the spectrum of sea elevation, known as the spectral density of the sea wave elevation. The long-term characterization is given in terms of a wave scatter table. The standard short-term and long-term characterizations are given in 2.7.2.1.1 and 2.7.2.1.2, respectively.

2.7.2.1.1 The spectral density of sea wave elevation, $S_{zz}(\omega)$, is provided by the Bretschneider wave energy spectrum as a function of the wave frequency, ω, as follows:

$$S_{zz}(\omega) = \frac{H_S^2}{4\pi} \cdot \left(\frac{2\pi}{T_Z}\right)^4 \omega^{-5} \exp\left(-\frac{1}{\pi}\left(\frac{2\pi}{T_Z}\right)^4 \omega^{-4}\right)$$

2.7.2.1.2 The long-term characterization of the standard environmental conditions (used in unrestricted service) is given by means of a wave scatter table. The wave scatter table contains the number of occurrences W_i within each range of significant wave height H_s and zero crossing wave period T_z in 100,000 observations. The wave scatter table, given in table 2.7.2.1.2, specifies factors W_i as functions of H_s and T_z values which represent the mean values of corresponding ranges.[7]

Table 2.7.2.1.2 Wave scatter table

Number of occurrences: 100 000 / T_z (s) = average zero-crossing wave period / H_s (m) = significant wave height

Tz (s) ►	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5
Hs (m) ▼																
0.5	1.3	133.7	865.6	1186.0	634.2	186.3	36.9	5.6	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1.5	0.0	29.3	986.0	4976.0	7738.0	5569.7	2375.7	703.5	160.7	30.5	5.1	0.8	0.1	0.0	0.0	0.0
2.5	0.0	2.2	197.5	2158.8	6230.0	7449.5	4860.4	2066.0	644.5	160.2	33.7	6.3	1.1	0.2	0.0	0.0
3.5	0.0	0.2	34.9	695.5	3226.5	5675.0	5099.1	2838.0	1114.1	337.7	84.3	18.2	3.5	0.6	0.1	0.0
4.5	0.0	0.0	6.0	196.1	1354.3	3288.5	3857.5	2685.5	1275.2	455.1	130.9	31.9	6.9	1.3	0.2	0.0
5.5	0.0	0.0	1.0	51.0	498.4	1602.9	2372.7	2008.3	1126.0	463.6	150.9	41.0	9.7	2.1	0.4	0.1
6.5	0.0	0.0	0.2	12.6	167.0	690.3	1257.9	1268.6	825.9	386.8	140.8	42.2	10.9	2.5	0.5	0.1
7.5	0.0	0.0	0.0	3.0	52.1	270.1	594.4	703.2	524.9	276.7	111.7	36.7	10.2	2.5	0.6	0.1
8.5	0.0	0.0	0.0	0.7	15.4	97.9	255.9	350.6	296.9	174.6	77.6	27.7	8.4	2.2	0.5	0.1
9.5	0.0	0.0	0.0	0.2	4.3	33.2	101.9	159.9	152.2	99.2	48.3	18.7	6.1	1.7	0.4	0.1
10.5	0.0	0.0	0.0	0.0	1.2	10.7	37.9	67.5	71.7	51.5	27.3	11.4	4.0	1.2	0.3	0.1
11.5	0.0	0.0	0.0	0.0	0.3	3.3	13.3	26.6	31.4	24.7	14.2	6.4	2.4	0.7	0.2	0.1
12.5	0.0	0.0	0.0	0.0	0.1	1.0	4.4	9.9	12.8	11.0	6.8	3.3	1.3	0.4	0.1	0.0
13.5	0.0	0.0	0.0	0.0	0.0	0.3	1.4	3.5	5.0	4.6	3.1	1.6	0.7	0.2	0.1	0.0
14.5	0.0	0.0	0.0	0.0	0.0	0.1	0.4	1.2	1.8	1.8	1.3	0.7	0.3	0.1	0.0	0.0
15.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.6	0.7	0.5	0.3	0.1	0.1	0.0	0.0

[7] Refer to International Association of Classification Societies (IACS) Recommendation No.34 (Corr. Nov.2001).

Number of occurrences: 100 000 / T_z (s) = average zero-crossing wave period / H_s (m) = significant wave height																
Tz (s) ► Hs (m) ▼	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5
16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.0

2.7.2.2 Alternative environmental conditions can be used for ships subject to operational measures according to chapter 4 and should be accepted by the Administration.

2.7.2.2.1 Such alternative environmental conditions should specify the short-term characteristics of wind and sea state, together with the probability of occurrence of each short-term environmental condition.

2.7.2.2.2 The short-term sea state characteristics should be given in terms of a sea elevation spectrum. The short-term wind state should be given in terms of a mean wind speed and a gustiness spectrum.

2.7.2.2.3 The long-term characterization of the environmental condition should be given in terms of probability of occurrence of each short-term condition. The probability of occurrence of each short-term environmental condition corresponds to the weighting factor, W_i. The set of short-term environmental conditions and corresponding weighting factors should be such that the sum of the weighting factors, i.e. the probabilities of occurrence, is unity.

2.7.3 Other common parameters

2.7.3.1 Active means of motion reduction, such as active anti-roll fins and anti-roll tanks, can significantly reduce roll motions in seaway. However, the safety of the ship should be ensured in cases of failure of such devices, therefore, the vulnerability assessment according to these Interim guidelines should be conducted with such devices inactive or retracted, if they are retractable.

3 Guidelines for direct stability failure assessment

3.1 Objective

3.1.1 These Guidelines provide specifications for direct stability assessment procedures for the following stability failure modes:

.1 dead ship condition;
.2 excessive acceleration;
.3 pure loss of stability;
.4 parametric rolling; and
.5 surf-riding/broaching.

3.1.2 The criteria, procedures and standards recommended in these guidelines ensure a safety level corresponding to the average stability failure rate not exceeding $2.6 \cdot 10^{-3}$ per ship per year.

3.1.3 Direct stability assessment procedures are intended to employ latest technology while being sufficiently practical to be uniformly accepted and applied using currently available infrastructure.

3.1.4 The provisions given hereunder apply to all ships and all failure modes. However, the provisions for both the dead ship condition and pure loss of stability failure modes should not apply to ships with an extended low weather deck.

3.2 Requirements

3.2.1 The failure event is defined as:

.1 *exceedance of roll angle*, defined as: 40 degrees, angle of vanishing stability in calm water or angle of submergence of unprotected openings in calm water, whichever is less; or

.2 *exceedance of lateral acceleration* of 9.81 m/s^2, at the highest location along the length of the ship where passengers or crew may be present.

The Administrations may define stricter requirements, if deemed necessary.

3.2.2 Active means of motion reduction, such as active anti-roll fins and anti-roll tanks, can significantly reduce roll motions in seaway. However, the safety of the ship should be ensured in cases of failure of such devices, therefore, the vulnerability assessment according to these Interim guidelines should be conducted with such devices inactive or retracted, if they are retractable.

3.2.3 The procedure for direct stability assessment consists of two major components:

.1 a method that adequately replicates ship motions in waves (see 3.3); and

.2 a prescribed procedure that identifies the process by which input values are obtained for the assessment, how the output values are processed, and how the results are evaluated (see 3.5).

3.3 Requirements for a method that adequately predicts ship motions

3.3.1 General considerations

3.3.1.1 The motion of ships in waves can be predicted by means of numerical simulations or model tests.

3.3.1.2 The choice between numerical simulations, model tests or their combination should be agreed with the Administration on a case-by-case basis taking into account these Interim guidelines.

3.3.1.3 The procedures, calibrations and proper application of technology involved in the conduct of model tests should follow "Recommended Procedures, Model Tests on Intact Stability, 7.5-02-07-04.1" issued by the International Towing Tank Conference (ITTC) in 2008. Users may follow recent amended versions of the Recommended Procedures at the time of execution of tests, if deemed necessary.

3.3.1.4 Numerical simulation of ship motions may be defined as the numerical solution of the motion equations of a ship sailing in waves including or excluding the effect of wind (see 3.3.2).

3.3.2 General requirements

3.3.2.1 Modelling of waves

3.3.2.1.1 The mathematical model of waves should be consistent and appropriate for the calculation of the forces.

3.3.2.1.2 Modelling of irregular waves should be statistically and hydrodynamically valid. Caution should be exercised to avoid a self-repetition effect.

3.*3.2.2* *Modelling of roll damping: avoiding duplication*

3.3.2.2.1 Roll damping forces should include wave, lift, vortex (i.e. eddy-making) and skin friction components.

3.3.2.2.2 The data to be used for the calibration of roll damping may be defined from:

.1 roll decay or forced roll test;

.2 CFD computations, if sufficient agreement with experimental results in terms of roll damping is demonstrated;

.3 existing databases of measurements or CFD computations for similar ships, if suitable range is available; or

.4 empirical formulae, applied within their applicability limits.

3.3.2.2.3 If the wave component of roll damping is already included in the calculation of radiation forces, measures should be taken to avoid including these effects more than once.

3.3.2.2.4 Similarly, if any components of roll damping (e.g. cross-flow drag) are directly computed whereas others are taken from the calibration data, similar measures should be taken to exclude these directly computed elements from the calibration data used.

3.3.2.2.5 Consideration of the essential roll damping elements more than once can be avoided through use of an iterative calibration procedure in which the roll decay or forced roll tests are replicated in numerical simulations. The results should be determined to be reasonably close to the original calibration model test data set.

3.*3.2.3* *Mathematical modelling of forces and moments*

3.3.2.3.1 The Froude-Krylov forces should be calculated using body-exact formulations at least for the dead ship condition, pure loss of stability and parametric rolling failure modes, for instance using panel or strip-theory approaches.

3.3.2.3.2 Radiation and diffraction forces should be represented in one of three ways: one is to use approximate coefficients and the other two involve either a body linear formulation or a body-exact solution of the appropriate boundary-value problem.

3.3.2.3.3 Resistance forces should include wave, vortex and skin friction components. The preferred source for these data is a model test. The added resistance in waves can be approximated, if this element is not already included in the calculation of diffraction and radiation forces. If the radiation and diffraction forces are calculated as a solution of the hull boundary-value problem, measures must be taken to avoid including these effects more than once.

3.3.2.3.4 Hydrodynamic reaction sway forces, roll moment and yaw moments could be approximated, based on:

.1 Coefficients derived from model tests in calm water with planar motion mechanism (PMM) or in stationary circular tests, by means of a rotating arm or an *x-y* carriage.[8]

.2 CFD computations, provided that sufficient agreement is demonstrated with a model experiment in terms of values of sway force and yaw moment. If the radiation and diffraction forces are calculated as a solution of the hull boundary-value problem, measures must be taken to avoid including these effects more than once.

.3 Empirical database or empirical formulae, used within their applicability range.

3.3.2.3.5 Thrust may be obtained by use of a coefficient-based model with approximate coefficients to account for propulsor-hull interactions.

3.3.3 Requirements for particular stability failure modes

3.3.3.1 For the dead ship condition failure mode:

.1 Ship motion simulations should include at least the following four degrees of freedom: sway, heave, roll and pitch.

.2 Three-component aerodynamic forces and moments generated on topside surfaces may be evaluated using model test results. CFD results may be admitted upon demonstration of sufficient agreement with a model experiment in terms of values of aerodynamic force and moments. Empirical data or formulae could be applied within their applicability range.

3.3.3.2 For the excessive acceleration failure mode, the ship motion simulations should include at least the following three degrees of freedom: heave, pitch and roll. If sway motion is not modelled, consideration should be given to accurate reproduction of lateral acceleration.

3.3.3.3 For the pure loss of stability failure mode, ship motion simulations should include at least the following four degrees of freedom: surge, sway, roll and yaw. For those degrees of freedom not included in the dynamic modelling, static equilibrium should be assumed.

3.3.3.4 For the parametric rolling failure mode, ship motion simulations should include at least the following three degrees of freedom: heave, roll and pitch.

3.3.3.5 For the surf-riding/broaching failure mode:

.1 Ship motion simulations should include at least the following four degrees of freedom: surge, sway, roll and yaw. For those degrees of freedom not included in the dynamic modelling, static equilibrium should be assumed.

.2 Hydrodynamic forces due to vortex shedding from a hull should be properly modelled. This should include hydrodynamic lift forces and moments due to the coexistence of wave particle velocity and ship forward velocity, other than manoeuvring forces and moments in calm water.

[8] The captive model test procedure should be based on the ITTC recommended procedure 7.5-02-06-02, issued in 2014, as amended. The stationary circular test by means of an *x-y* carriage can reproduce a circular model motion with any specified drift angle by combining the motion of an *x-y* carriage and a turn table.

3.3.3.6 For the pure loss of stability and surf-riding/broaching failure modes, an appropriate autopilot should be used.

3.3.3.7 For the pure loss of stability and surf-riding/broaching failure modes, the initial condition should be set with a sufficiently small forward speed in order to avoid artificial surf-riding, which cannot occur for a self-propelled ship.

3.4 Requirements for validation of software for numerical simulation of ship motions

3.4.1 Validation

3.4.1.1 Validation is the process of determining the degree to which a numerical simulation is an accurate representation of the real physical world from the perspective of each intended use of the model or simulation.

3.4.1.2 Different physical phenomena are responsible for different modes of stability failure. Therefore, the validation of software for the numerical simulation of ship motions is failure-mode specific.

3.4.1.3 The validation data should be compatible with the general characteristics of the ship for which the direct stability assessment is intended to be carried out.

3.4.1.4 The process of validation should be performed in two phases: one qualitative and the other quantitative. In the qualitative phase, the objective is to demonstrate that the software is capable of reproducing the relevant physics of the failure mode considered. The objective of the quantitative phase is to determine the degree to which the software is capable of predicting the specific failure mode considered.

3.4.2 Qualitative validation requirements

Table 3.4.2 – Requirements and acceptance criteria for qualitative validation

Item	Required for	Objective	Acceptance criteria
Periodic properties of roll oscillator	Software where hydrostatic and Froude-Krylov forces are calculated with body exact formulation	Demonstrate consistency between calculated roll backbone curve (dependence of roll frequency in calm water on roll amplitude) and GZ curve in calm water	Based on the shape of calculated backbone curve. The backbone curve must follow a trend which is consistent with the righting lever
Response curve of roll oscillator	Software where hydrostatic and Froude-Krylov forces are calculated with body exact formulation	Demonstrate consistency between the calculated roll backbone curve and the calculated roll response curve (dependence of amplitude of excited roll motion on the frequency of excitation)	Based on the shape of the roll response curve. The roll response curve must "fold around" the backbone curve and may show hysteresis when the magnitude of excitation is increased
Change of stability in waves	Software where hydrostatic and Froude-Krylov forces	Demonstrate capability to reproduce wave pass effect	Typically in head and following waves, the stability decreases when

	are calculated with body exact formulation. Additional capability to track the instantaneous GZ curve in waves may be required		the wave crest is located near the midship section (within the quarter of length) and the stability increases when the wave trough is located near the midship section (within the quarter of length)
Principal parametric resonance	Software where hydrostatic and Froude-Krylov forces are calculated with a body exact formulation	Demonstrate capability to reproduce principal parametric resonance	Usually, observing an increase and stabilization of amplitude of roll oscillation in exact following or head seas when encounter frequency is about twice of natural roll frequency

Table 3.4.2 (continued) – Requirements and acceptance criteria for qualitative validation

Item	Required for	Objective	Acceptance criteria
Surf-riding equilibrium	Software for numerical simulation of surf-riding/ broaching	Demonstrate capability to reproduce surf-riding, while yaw is fixed.	Observing sailing with the speed equal to wave celerity when the propeller RPM is set for the speed in calm water which is less than the wave celerity. The horizontal position of centre of gravity is expected to be located near a wave trough
Heel during turn	Software for numerical simulation of surf-riding/ broaching	Demonstrate capability to reproduce heel caused by turn	Observing development of heel angle during the turn
Turn in calm water	Software for numerical simulation of surf-riding/ broaching	Demonstrate correct modelling of manoeuvring forces	Observing correct direction of turn with large rudder angles
Straight captive run in stern quartering waves	Software for numerical simulation of surf-riding/ broaching	Demonstrate correct modelling of wave forces including effect of wave particle velocity	Observing correct tendency of phase difference of wave force to incident waves
Heel caused by drift and wind	Software for numerical simulation of ship motions in dead ship condition	Demonstrate capability to reproduce heel caused by a moment created by aerodynamic load and drag caused by drift	Observing slowly developed heel angle after applying aerodynamic load

3.4.3 Quantitative validation requirements

3.4.3.1 There are two objectives of quantitative validation of numerical simulation. The first is to find the degree to which the results of numerical simulation differ from the model test results. The results of a model test carried out in accordance with 3.3.1.3 should be recognized as reference values. The second objective is to judge if the observed difference between simulations and model tests is sufficiently small or conservative for direct stability assessment to be performed for the considered failure modes.

Table 3.4.3 – Indicative requirements and acceptance criteria for quantitative validation

Item	Required for	Objective	Acceptance criteria
Response curve for parametric rolling in regular waves	Parametric rolling	Demonstrate agreement between numerical simulation and model tests regarding amplitude of the roll response	Maximum (over encounter frequency) roll amplitude should not be underpredicted by more than 10%, if the amplitude is below the angle of maximum GZ or 20% otherwise. Underprediction less than 2 degrees may be disregarded.
Response curve for synchronous roll in regular waves	All modes	Demonstrate agreement between numerical simulation and model tests regarding amplitude of the roll response	Maximum (over encounter frequency) roll amplitude should not be underpredicted for more than 10%, if the amplitude is below the angle of maximum GZ or 20% otherwise. Under-prediction less than 2 degrees may be disregarded.
Variance test for synchronous roll	Software for numerical simulation of dead ship condition and excessive acceleration	Demonstrate correct (in terms of statistics) modelling of roll response in irregular waves	Reproduction of experimental results either within 95% confidence interval or conservative
Variance test for parametric rolling	Software for numerical simulation of parametric rolling	Demonstrate correct (in terms of statistics) modelling of roll response in irregular waves	Reproduction of experimental results either within 95% confidence interval or conservative
Wave conditions for surf-riding and broaching	Software for numerical simulation of surf-riding/ broaching	Demonstrate correct modelling of surf-riding/ broaching dynamics in regular waves	Wave steepness causing surf-riding and broaching at the wavelength 0.75 – 1.5 of ship length is within 15% of difference between model tests and numerical simulations. Speed settings are also within 15% difference between model tests and numerical simulations.

3.5 Procedures for direct stability assessment

3.5.1 General description

3.5.1.1 The procedures for direct stability assessment contain a description of the necessary calculations of ship motions including the choice of input data, pre- and post-processing.

3.5.1.2 The direct stability assessment procedure is aimed at the estimation of a likelihood of a stability failure in an irregular wave environment and because the stability failures may be rare, the direct stability assessment procedure may require a solution of the problem of rarity. This arises when the mean time to stability failure is very long in comparison with the natural roll period that serves as a main timescale for the roll motion process. The solution of the problem of rarity essentially requires a statistical extrapolation; for this reason, the validation must be performed for all elements of the direct stability assessment procedure.

3.5.1.3 These Guidelines provide two general approaches to circumvent the problem of rarity, namely assessment in design situations and assessment using deterministic criteria. Mathematical techniques are provided that reduce the required number of simulations or simulation time and can be used to accelerate assessment for both, the full assessment and the assessment performed in design situations.

3.5.2 Verification of failure modes

3.5.2.1 Once a failure is identified in a numerical simulation, it is necessary to examine whether it can be regarded as a failure mode for which the numerical method is validated and direct assessment is intended. The suggested judging criteria for this purpose are provided below.

3.5.2.2 If the local period of the obtained roll motion in following waves or in stern quartering waves is nearly equal to the local wave encounter period and the maximum roll angle occurs nearly at the relative wave position in which the metacentric height becomes the smallest, it can be regarded as pure loss of stability failure.

3.5.2.3 If the local period of the obtained roll motion is nearly equal to twice the local wave encounter period and is nearly equal to the ship natural roll period, it can be regarded as the parametric rolling stability failure considered in the vulnerability criteria, which is sometimes called as "principal parametric rolling". Other types of parametric rolling may occur with much smaller probability, which are not addressed by the second generation intact stability criteria.

3.5.2.4 The condition when the ship cannot keep a straight course despite the application of maximum steering efforts is known as broaching. The second generation intact stability criteria address broaching associated with surf-riding. Other types of broaching may occur at slower speed but are not considered here because the centrifugal force, due to such slow-speed broaching which could induce heel, is much smaller. The broaching associated with surf-riding can be identified if both the yaw angle and yaw angular velocity increase over time under the application of the maximum opposite rudder deflection.

3.5.2.5 If the local period of the obtained roll motion in beam waves is nearly equal to the local wave encounter period, it can be regarded as harmonic rolling, which is relevant to the dead ship condition failure mode, as well as the excessive acceleration failure mode.

3.5.3 Environmental and sailing conditions

3.5.3.1 General approaches for selection of environmental and sailing conditions

3.5.3.1.1 The sea states chosen for the direct stability assessment must be representative for the intended service of the ship.

3.5.3.1.2 Sea states are defined by the type of wave spectrum and statistical data of its integral characteristics, such as the significant wave height and the mean zero-crossing wave period. For ships of unrestricted service, the environment should be described by the wave scatter table shown in table 2.7.2.1.2. For ships of restricted service, the wave scatter table accepted by the Administration should be used.

3.5.3.1.3 It is recommended to use the Bretschneider wave energy spectrum (see 2.7.2.1.1) and cosine-squared wave energy spreading with respect to the mean wave direction. If short-crested waves are considered impracticable in model tests or numerical simulations, long-crested waves can be used.

3.5.3.1.4 For a given set of environmental conditions, the assessment can be performed using any of the following equivalent alternatives:

.1 full probabilistic assessment according to 3.5.3.2;

.2 assessment in design situations using probabilistic criteria according to 3.5.3.3; or

.3 assessment in design situations using deterministic criteria according to 3.5.3.4.

3.5.3.2 Full probabilistic assessment

3.5.3.2.1 In this approach, the criterion used is the estimate of the mean long-term rate of stability failures, which is calculated as a weighted average over all relevant sea states, wave directions with respect to the ship heading and ship forward speeds, for each addressed loading condition.

3.5.3.2.2 To satisfy the requirements of this assessment, this criterion should not exceed the standard of $2.6 \cdot 10^{-8}$ (1/s).

3.5.3.2.3 The probabilities of the sea states are defined according to the wave scatter table (see 3.5.3.1). For the excessive accelerations, pure loss of stability, parametric rolling and surf-riding/broaching failure modes, the mean wave directions with respect to the ship heading are assumed uniformly distributed and the ship forward speed should be regarded as uniformly distributed from zero to the maximum service speed. For the dead ship condition failure mode, beam waves and wind should be assumed and the ship forward speed should be taken as zero.

3.5.3.3 Assessment in design situations using probabilistic criteria

3.5.3.3.1 Compared to the full probabilistic assessment, this approach significantly reduces the required simulation time and number of simulations since the assessment is conducted in fewer design situations. These design situations are specified for each stability failure mode as combinations of the ship forward speed, mean wave direction with respect to the ship heading, significant wave height and mean zero-crossing wave period for each addressed loading condition.

3.5.3.3.2 In this approach, the criterion is the maximum (over the design situations corresponding to a particular stability failure mode) stability failure rate, defined in each design situation as the upper boundary of its 95%-confidence interval.

3.5.3.3.3 To satisfy the requirements of this assessment, this criterion should not exceed the threshold corresponding to one stability failure every 2 hours in full scale in design sea states with probability density 10^{-5} (m·s)$^{-1}$.

3.5.3.3.4 Table 3.5.3.3.4 shows the design situations for particular stability failure modes, including mean wave direction with respect to the ship heading, ship forward speed and range of wave periods; and the step of the zero-crossing wave period in the specified ranges should not exceed 1.0 s.

Table 3.5.3.3.4 – Design situations for each stability failure mode

Stability failure mode	Wave directions	Forward speeds	Wave period
Dead ship condition	Beam wind and waves	Zero	T_z/T_r from 0.7 to 1.3
Excessive acceleration	Beam	Zero	Tz/Tr from 0.7 to 1.3
Pure loss of stability	Following	Maximum nominal service speed	Tp corresponding to wavelengths comparable to ship length
Parametric rolling	Head and following	Zero	All wave periods in the wave scatter table
Surf-riding/broaching	Following	Maximum nominal service speed	Tp corresponding to wavelengths in the range from 1.0*L* to 1.5*L*

3.5.3.3.5 For each mean zero-crossing wave period, the significant wave height is selected according to the probability density of the sea state, as specified in 3.5.3.3.3. For unrestricted service, the significant wave heights are shown in table 3.5.3.3.5 depending on the mean zero-crossing wave period.

Table 3.5.3.3.5 – Significant wave heights for design sea states with probability density 10^{-5} (m·s)$^{-1}$ for unrestricted service

T_z (s)	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5
H_s (m)	2.8	5.5	8.2	10.6	12.5	13.8	14.6	15.1	15.1	14.8	14.1	12.9	10.9

3.5.3.4 Assessment in design situations using deterministic criteria

3.5.3.4.1 A probabilistic assessment may require a long simulation time even when using design situations and this can make it difficult to use model tests rather than numerical simulations. Applying deterministic criteria, such as the mean three-hour maximum roll amplitude, may reduce the required simulation time and this may make it easier to use model tests with, or instead of, numerical simulations. However, the inaccuracy of this approach needs to be balanced by additional conservativeness.

3.5.3.4.2 In this approach, the criteria are the greatest (with respect to all design situations for a particular stability failure mode) mean three-hour maximum roll amplitude and lateral acceleration for each addressed loading condition.

3.5.3.4.3 To satisfy the requirements of this assessment, these criteria should not exceed half of the values in the definition of stability failure in 3.2.1.

3.5.3.4.4 The simulations or model tests for each design situation should comprise at least 15 hours in full scale. This duration can be divided into several parts. The results should be post-processed to provide at least five values of the three-hour maximum amplitude of roll angle or lateral acceleration, which are averaged to define the mean three-hour maximum amplitudes.

3.5.3.4.5 This approach uses design situations with the same mean wave directions with respect to the ship heading, the same ship forward speeds and the same ranges of the mean zero-crossing wave periods as the assessment in design situations using probabilistic criteria (see 3.5.3.3).

3.5.3.4.6 For each mean zero-crossing wave period, the significant wave height is selected according to the probability density of the sea state equal to $7 \cdot 10^{-5}$ $(m \cdot s)^{-1}$. Table 3.5.3.4.6 shows these significant wave heights for unrestricted service depending on the mean zero-crossing wave period.

Table 3.5.3.4.6 Significant wave heights, in metres, for design sea states with probability density $7 \cdot 10^{-5}$ $(m \cdot s)^{-1}$ for assessment using deterministic criteria for unrestricted service

T_z (s)	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5
H_s (m)	2.0	4.4	6.9	9.1	10.9	12.1	12.8	13.1	13.0	12.5	11.3	9.0

3.5.4 Direct counting procedure

3.5.4.1 The direct counting procedure uses ship motions resulting from multiple independent realisations of an irregular seaway to estimate the rate of stability failure, *r*.

3.5.4.2 The procedure used for direct counting should provide the upper boundary of the 95% confidence interval of the estimated rate of stability failure. This upper boundary is the one which is used in direct stability assessment and operational measures.

3.5.4.3 The counting procedure should ensure independence of the counted stability failure events.

3.5.4.4 The failure rate *r* and associated confidence interval can be estimated:

.1 by carrying out a simulation for each realisation of an irregular seaway only until the first stability failure; or

.2 on the basis of a set of independent simulations with fixed specified exposure time t_{exp} (s), under the assumption that the relation between the probability p of failure within t_{exp} and the failure rate r is $p = 1 – \exp(-r \cdot t_{exp})$.

3.5.4.5 Alternatively to direct counting, extrapolation procedures can be used as specified in section 3.5.5.

3.5.5 Extrapolation procedures

3.5.5.1 The extrapolation procedures to be used with these Guidelines should only include those procedures that have been successfully validated and applied and which should also include a detailed description of their application.

3.*5.5.*2 *Cautions*

3.5.5.2.1 The extrapolation method may be applied as an alternative to the direct counting procedure.

3.5.5.2.2 Caution should be exercised because uncertainty increases, as the extrapolation is associated with additional assumptions used for describing ship motions in waves.

3.5.5.2.3 The statistical uncertainty of the extrapolated values should be provided in a form of boundaries of the confidence interval evaluated with a confidence level of 95%.

3.5.5.2.4 To control the uncertainty caused by nonlinearity, the principle of separation may be used. Extrapolation methods based on the principle of separation consist of at least two numerical procedures addressing different aspects of the problem: "non-rare" and "rare".

3.5.5.2.5 The "non-rare" procedure focuses on the estimation of ship motions or waves of small-to-moderate level for which the stability failure events can be characterized statistically with acceptable uncertainty.

3.5.5.2.6 The "rare" procedure focuses on ship motions of moderate-to-severe level for which numerical simulation are rarely required. Large motions may be separated from the rest of the time domain data to obtain practical estimates of these motions.

3.5.5.2.7 Different extrapolation methods based on the separation principle may use different assumptions on how the separation is introduced.

3.*5.5.*3 *Extrapolation over wave height*

3.5.5.3.1 Extrapolation of the mean time to stability failure or mean rate of stability failures over significant wave height is a technique allowing the reduction of the required simulation time by performing numerical simulations or model tests at greater significant wave heights than those required in the assessment and extrapolating the results to lower significant wave heights.

3.5.5.3.2 The extrapolation is based on the approximation $\ln T = A + B/H_s^2$, where T (s) is the mean time to stability failure; H_s (m) is the significant wave height; and A, B are coefficients which do not depend on the significant wave height but depend on the other parameters specifying the situation (wave period, wave direction and ship forward speed).

3.5.5.3.3 The extrapolation can be performed when at least three values of the stability failure rate are available. These values should be obtained by direct counting for a range of significant wave heights of at least 2 m. Each of the values used in the extrapolation should correspond to the upper boundary of the 95%-confidence interval of stability failure rate and not exceed 5% of the reciprocal natural roll period of the ship. The results should be checked for the presence of outliers and non-conservative extrapolation and corrected, when necessary, by adding or removing points used for extrapolation.

*3.5.5.*4 *Other extrapolation procedures*

3.5.5.4.1 Other extrapolation procedures may be used, taking into account 3.5.5.1 and 3.5.5.2. Such procedures may include those listed below and others:

.1 envelope peak-over-threshold (EPOT);
.2 split-time/motion perturbation method (MPM); and
.3 critical wave method.

3*.5.6.* *Validation of extrapolation procedures*

3.5.6.1 Extrapolation procedures used for direct stability assessment should be validated.

3.5.6.2 Validation of an extrapolation procedure is a demonstration that the extrapolated value is in reasonable statistical agreement with the result of the direct counting, if such volume of data would be available.

3.5.6.3 The data for validation of the extrapolation procedure may be produced by a mathematical model of reduced complexity (e.g. a set of ordinary differential equations instead of a numerical solution of a boundary value problem) or by running the full mathematical model on significantly more severe environmental and/or more onerous loading conditions. The objective is to decrease the computational cost by which a large data set can be obtained (the validation data set). Physical experiments can be used for the same purpose.

3.5.6.4 The direct counting procedure applied to the validation data set should produce the "true value". The extrapolation procedure applied to a minimally required fraction of the validation data set should re-produce the "true value" within 95% confidence.

3.5.6.5 Validation of the extrapolation procedure should be performed for 50 statistically independent data sets and evaluated for a number of ship speeds, relative wave headings and sea states.

3.5.6.6 A comparison should be made between the extrapolation and the "true value" for each data set. The comparison should be considered successful if the extrapolation confidence interval and the confidence interval of the "true value" overlap.

3.5.6.7 The validation should be considered successful if at least 88% of individual data set comparisons are successful.

4 Guidelines for operational measures

4.1 General principles

4.1.1 A combined consideration of design and operational aspects can effectively be used to achieve a sufficient safety level. In application, this principle requires guidance to be provided for the preparation of operational measures, consistent with the design assessment requirements.

4.1.2 Whereas the principles used in these Guidelines can be applied to consider any operational problems related to ship behaviour in a seaway, detailed procedures in these Guidelines cover the following stability failure modes:

.1 dead ship condition;
.2 excessive acceleration;
.3 pure loss of stability;
.4 parametric rolling; and
.5 surf-riding/broaching.

4.1.3 These Guidelines consider the operational limitations and operational guidance, which are defined in 4.3.1. Either operational limitations or operational guidance can be used for the following four stability failure modes: excessive acceleration, pure loss of stability, parametric rolling and surf-riding/broaching. For the dead ship condition failure mode, only operational limitations related to areas or routes and season (4.3.1.1 and 4.5.1) can be applied. This means that neither operational limitations related to maximum significant wave height nor operational guidance are applicable because the ship's main propulsion plant and auxiliaries are inoperable. This means that the ship is neither able to avoid heavy weather nor control speed and course.

4.1.4 Operational limitations and operational guidance should provide at least the same level of safety as that provided by the procedures and standards given by the Guidelines for vulnerability criteria in chapter 2 or the direct stability assessment in chapter 3. In particular, the safety level of those loading conditions that fail design assessment requirements in chapter 2 or chapter 3 should become sufficient if all combinations of the sailing condition and sea state that are not recommended by these operational measures are removed from the design assessment.

4.1.5 Whereas the principle in 4.1.4 can be directly used to prepare operational measures ensuring a required safety level, more detailed procedures were developed as described in these Guidelines for convenience of ship designers and Administrations. Using the procedures and standards described herein corresponds to setting a safety level in accordance with the Guidelines for direct stability assessment in chapter 3.

4.1.6 Although the application of operational measures can reduce the likelihood of stability failure to a desired low level, a loading condition for which too many situations should be avoided to achieve the required safety level should not be considered as acceptable. Therefore, from practical and regulatory perspectives, operational measures should not be considered as always sufficient for any loading condition.

4.1.7 In case operational measures are provided for particular failure mode(s) based on these Guidelines, they may be applied instead of the relevant provisions in the guidance provided in MSC.1/Circ.1228.

4.2 Stability failures

4.2.1 The definition of stability failure should be consistent with those used in either the Guidelines for vulnerability criteria in chapter 2 or the Guidelines for direct stability assessment in chapter 3.

4.2.2 The provisions given hereunder apply to all ships, except for ships with an extended low weather deck when considering the dead ship condition failure mode or the pure loss of stability failure mode.

4.3 Operational measures

4.3.1 These Guidelines consider the following ship specific operational measures:

.1 *Operational limitations* which define the limits on a ship's operation in a considered loading condition, are as follows:

.1 *Operational limitations related to areas or routes and season* permit operation in specific operational areas (either geographical areas or specific types of operational areas like sheltered waters) or routes and, if appropriate, the specific season. For the operational area, route and season, the environmental conditions are specified by the wave scatter table and corresponding wind statistics.

.2 *Operational limitations related to maximum significant wave height* permit operation in conditions up to a maximum significant wave height. The environmental conditions are specified by the combination of the wave scatter table related to operational area or route and season, and corresponding wind statistics. The wave scatter table limited to a specific significant wave height is referred to as a *limited wave scatter table*.

.2 *Operational guidance* which defines the combinations of ship speed and heading relative to mean wave direction that are not recommended and that should be avoided in each relevant sea state.

4.3.2 The operational measures specified in 4.3.1 require different amount of information and planning in their application, as follows:

.1 operational limitations related to areas or routes and season do not require weather data during the operation of the ship and thus do not need any specific information and planning;

.2 operational limitations related to maximum significant wave height need a forecast for the significant wave height and the availability of appropriate routing in a sufficient time before encountering possible storm conditions; and

.3 operational guidance requires detailed forecast information about wave energy spectrum and wind characteristics, together with means for indicating combinations of ship speed and heading relative to mean wave direction that should be avoided, which should be available for safe routeing in a sufficient time before encountering possible storm conditions.

4.3.3 The operational measures specified in 4.3.1 can be combined, e.g. operational limitations can be applied up to a certain significant wave height and operational guidance for greater significant wave heights. When operational limitations are combined with operational guidance, the requirements for operational guidance apply.

4.4 Acceptance of operational measures

4.4.1 Operational limitations and operational guidance should be accepted by the Administration according to these Guidelines.

4.4.2 Acceptance of a loading condition for unrestricted operation, limited operation or operation using onboard operational guidance should be performed following these Guidelines in combination with the design assessment requirements according to chapter 2 or chapter 3. A loading condition is considered as:

.1 *acceptable for unrestricted operation*, if it satisfies the design assessment requirements for all five stability failure modes specified in 4.1.2;

.2 *acceptable for limited operation*, if it is provided with operational limitations for one or more stability failure modes specified in 4.1.2 for unrestricted operation and satisfies the design assessment requirements for the remaining stability failure modes;

.3 *acceptable for operation using onboard operational guidance*, if it is provided with operational guidance for one or more stability failure modes specified in 4.1.2 for unrestricted operation and is either provided with operational limitations for unrestricted operation or satisfies the design assessment requirements for the remaining stability failure modes;

.4 *acceptable for operation in a specified area or on a specified route during a specified season*, if it is provided with operational limitations for one or more stability failure modes specified in 4.1.2 for this area or route and season, and satisfies the design assessment requirements for the remaining stability failure modes;

.5 *acceptable for limited operation in a specified area or on a specified route during a specified season*, if it is provided with operational limitations for one or more stability failure modes specified in 4.1.2 for a given significant wave height limit for this area or route and season, and either has operational limitations without specification of maximum operational significant wave height for this area or route and season, or satisfies the design assessment requirements for the remaining stability failure modes; and

.6 *acceptable for operation using onboard operational guidance in a specified area or on a specified route during a specified season*, if it is provided with operational guidance for one or more stability failure modes specified in 4.1.2 for this area or route and season and is either provided with operational limitations for this area or route and season or satisfies the design assessment requirements for the remaining stability failure modes.

4.4.3 Application of the operational limitations related to maximum significant wave height or operational guidance can reduce the stability failure rate to any low level. However, if too many sailing conditions in too many sea states should be avoided for a certain loading condition, such loading condition cannot be considered as acceptable in practical operation. Therefore:

.1 A loading condition cannot be considered as acceptable if the ratio of the total duration of all situations which should be avoided to the total operational time, is greater than 0.2. In the calculation of this ratio, the situations that should be avoided include those defined by:

.1 operational limitations related to maximum significant wave height; or

.2 operational guidance.

.2 In the calculation of the ratio in 4.4.3.1, the probabilities of the sea states are taken according to the full wave scatter table. Wave headings are assumed uniformly distributed and the ship forward speed is assumed uniformly distributed between zero and the maximum service speed.

4.4.4 Active means of motion reduction, such as active anti-roll fins and anti-roll tanks, can significantly reduce roll motions in seaway. Therefore, if such devices are not considered in the development and application of the operational measures, the advice to the ship master may be suboptimal or misleading. On the other hand, the safety of the ship with specific reference to aspects addressed by the present Guidelines should be ensured also in cases of failure of such devices. Therefore, it is recommended that the development, application and acceptance of the operational measures is done both with operating and inactive (or retracted, if retractable) anti-roll devices.

4.4.5 Operational guidance can indicate some sailing conditions as safe with respect to roll motion but they may be unattainable due to limits of the propulsion and steering systems of the ship or undesirable due to other problems, such as excessive vertical motions or accelerations and slamming. For example, for parametric rolling in bow waves, roll motions may reduce with increasing forward speed, but high speeds in bow waves could be either unattainable or could lead to excessive vertical motions or loads. Neglecting this contradiction can lead to misleading operational guidance or even put the ship in danger if in some sea state all sailing conditions, acceptable from the point of view of roll motions, are unattainable or dangerous because of other reasons.

4.5 Preparation procedures

4.5.1 Operational limitations related to areas or routes and season

4.5.1.1 Operational limitations are prepared following the design assessment procedures in chapter 2 or chapter 3 with modified environmental conditions assumed in operation. The modification of the reference environmental conditions is based on the wave scatter table for a specified area or a specified route during a specified season and corresponding wind statistics, acceptable to the Administration.

4.5.1.2 The environmental conditions applied in the preparation of the operational limitations related to specified areas or specified routes during a specified season should be consistent with the corresponding vulnerability criteria if the preparation is based on the Guidelines for vulnerability assessment in chapter 2. If the preparation is based on direct stability assessment these environmental conditions should be consistent with the Guidelines for direct stability assessment in chapter 3. Other environmental conditions may be applied, as appropriate.

4.5.1.3 For some Level 1 and Level 2 vulnerability assessment procedures, regular wave cases should be defined, based on the wave statistics.

4.5.2 Operational limitations related to maximum significant wave height

4.5.2.1 Operational limitations related to maximum significant wave height are developed using design assessment procedures in chapter 2 or chapter 3 for a specific environment, which is defined by cutting the wave scatter table for a specified area or a specified route during a specified season at a specified significant wave height and by corresponding modification of wind statistics.

4.5.2.2 The environmental conditions applied in the preparation of the operational limitations related to maximum significant wave height should be consistent with the corresponding vulnerability criteria, if the preparation is based on the Guidelines for vulnerability assessment in chapter 2. If the preparation is based on the direct stability assessment, these conditions should be consistent with the Guidelines for direct stability assessment in chapter 3. Other environmental conditions may be applied, as appropriate.

4.5.2.3 For certain Level 1 and Level 2 vulnerability assessment procedures, definition of the corresponding regular wave cases is required; this is done in the same way as for operational limitations without specification of maximum operational significant wave height.

4.5.3 *General principles of preparation of operational guidance*

4.5.3.1 Operational guidance should indicate all sailing conditions that should be avoided for each range of sea states in the relevant wave scatter table.

4.5.3.2 Operational guidance should ensure that the considered loading condition satisfies the design assessment requirements in chapter 2 or chapter 3 after removing from the design assessment all sailing conditions that should be avoided. To simplify the preparation and acceptance of operational guidance, three equivalent approaches, recommended for the preparation of operational guidance, are considered below in detail. These approaches are based on:

.1 probabilistic motion criteria and standards (referred to as probabilistic operational guidance);

.2 deterministic motion criteria and standards (referred to as deterministic operational guidance); and

.3 simplified motion criteria and standards (referred to as simplified operational guidance).

4.5.3.3 Operational guidance should clearly indicate acceptable and unacceptable sailing conditions for each relevant sea state and may be presented in the form of a polar diagram.

4.5.3.4 Other forms different from polar diagrams could be used for displaying operational guidance, provided that equivalent information is included.

4.5.4 Probabilistic operational guidance

4.5.4.1 This type of operational guidance uses probabilistic criteria, such as the probability of stability failure during a specified time or the rate of stability failures, and corresponding probabilistic thresholds to distinguish sailing conditions which should be avoided.

4.5.4.2 Sailing conditions that should be avoided are those for which:

$r > 10^{-6}\ s^{-1}$;

where r (s^{-1}) is the upper boundary of the 95% confidence interval of the stability failure rate.

4.5.4.3 Procedures and numerical methods applied for the determination of the failure rate as referred to in 4.5.4.2 should satisfy the recommendations of the Guidelines for direct stability assessment in chapter 3.

4.5.4.4 If a certain assumed situation should be avoided, assessment for higher significant wave heights, with other parameters unchanged, is not required. Conversely, if a certain assumed situation does not have to be avoided, assessment for lower significant wave heights, with other parameters unchanged, is not required.

4.5.5 Deterministic operational guidance

4.5.5.1 Using deterministic criteria, such as maximum roll amplitude in a given exposure time, represent a simpler but less accurate approach than using probabilistic criteria. Therefore, in order to provide an equivalent safety level, the thresholds for deterministic criteria are conservatively selected.

4.5.5.2 Deterministic operational guidance can be prepared using only model tests, only numerical simulations or their combination. Numerical methods applied in such simulations should satisfy the recommendations of the Guidelines for direct stability assessment in chapter 3.

4.5.5.3 Sailing conditions that should be avoided are those for which:

$$\alpha \cdot x_{3h} > x_{lim},$$

where $\alpha = 2$ is the scaling factor, x_{3h} is the mean three-hour maximum roll or lateral acceleration amplitude and x_{lim} is the corresponding stability failure threshold, as defined in the Guidelines for direct stability assessment in 3.2.1.

4.5.5.4 To define the mean three-hour maximum amplitude, the total recommended duration of a test or simulation is 15 hours at full scale for each considered situation.

4.5.5.5 If a certain assumed situation should be avoided, an assessment for higher significant wave heights, with other parameters unchanged, is not required. Conversely, if a certain assumed situation does not have to be avoided, an assessment for lower significant wave heights, with other parameters unchanged, is not required.

4.5.6 Simplified operational guidance

4.5.6.1 Whereas probabilistic and deterministic operational guidance provides accurate and detailed recommendations for the ship forward speed and course in each sea state, it requires model tests or numerical methods of high accuracy. Therefore, simpler conservative approaches may be used to develop operational guidance for acceptable forward speed and course when it is deemed practicable.

4.5.6.2 In principle, any simple conservative estimations for the sailing conditions that should be avoided in each relevant sea state, can be used if they are shown to provide a superior safety level compared to the design assessment requirements. In particular, Level 1 or Level 2 vulnerability criteria of the Guidelines for vulnerability assessment in chapter 2 can be used. Some examples of recommended approaches based on Level 1 and Level 2 vulnerability criteria are included below:

.1 For the excessive acceleration stability failure mode, all forward speeds should be avoided in all sea states where $C_{S,i} > 10^{-6}$, where $C_{S,i}$ is defined according to 2.3.3.2.1 of the Guidelines for vulnerability assessment. The transfer function $a_y(\omega)$ defined in 2.3.3.2.2 is multiplied by the absolute value of the sine of the wave heading angle μ and calculated by replacing the wave frequency ω_j with wave encounter frequency ω_{ej}.

.2 For the pure loss of stability failure mode, nominal ship forward speed of the ship of $0.752 \cdot L^{1/2}$ m/s or greater, should be avoided in following to beam wave directions in sea states for which $\max(C1_i, C2_i) = 1$, where $C1_i$ and $C2_i$ are defined in 2.4.3.3 and 2.4.3.4, respectively, of the Guidelines for vulnerability assessment.

.3 For the parametric rolling stability failure mode, forward speed, for which $C_{S,i}(v_s, H_s, T_z)$, defined according to 2.5.3.3.1 of the Guidelines for vulnerability assessment, is equal to 1, should be avoided in all wave directions and all sea states.

.4 For the surf-riding/broaching failure mode, either:

.1 nominal ship speed of $0.94 \cdot L^{1/2}$ (m/s), or greater, should be avoided when the wavelength, based on mean wave period, is greater than 80% of the ship length, the significant wave height is greater than 4% of the ship length L (m) and the heading angle μ (deg) from the wave direction is less than 45 degrees; or

.2 alternatively, the critical nominal ship speed provided by the Level 2 vulnerability criteria (see 2.6.3.4.2) or above should be avoided in following to beam wave directions in sea states for which $c_{HT} > 0.005$, where c_{HT} is calculated as:

$$c_{HT}(H_s, T_z) = \sum_{i=1}^{N_\lambda} \sum_{j=1}^{N_a} w_{ij}(H_s, T_z) C2_{ij}$$

where $w_{ij}(H_s, T_z)$ and $C2_{ij}$ should be calculated based on the level 2 vulnerability criteria in 2.6.3.2, but with the diffraction component of the wave force taken into account.

4.6 Application

4.6.1 Operational guidance should be provided as easily accessible and understandable information in graphical form which clearly indicates unacceptable sailing conditions for a given sea state, as well as the relevant stability failure modes. Automatic alert systems can be used for the cases when sailing conditions are close to or within the areas of unacceptable sailing conditions.

4.6.2 Unacceptable sailing conditions are derived from the pre-defined databases of probabilistic, deterministic or simplified safety criteria, stored as functions of the ship forward speed and ship heading with respect to the mean wave direction for relevant sea states. These sea states are specified by using as input the actual significant wave height, mean zero-crossing wave period, mean wave direction and ship course.

4.6.3 The effect of non-parallel wave systems (cross sea) can be reproduced using these pre-defined databases by combining separate responses to the wind sea and swell which correspond to the significant wave height, mean zero-crossing wave period and mean wave direction of each of these wave systems by:

.1 summing the rate of stability failures for each of these wave systems when using probabilistic operational guidance;

.2 summing the maximum responses to each of these wave systems when using deterministic operational guidance; and

.3 overlaying the unacceptable sailing conditions for each of these wave systems when using simplified operational guidance.

The procedure described above is meant to be a practical approximation tool for addressing cross sea conditions starting from pre-calculations based on simpler standard sea states. However, such a procedure is an approximate one and sea states encountered in the ship's operation can be characterized by complex spectra combining multiple wind sea and swell systems. Therefore, particular caution is recommended to be exercised during operation when making use of operational guidance developed according to the described procedure, if the sea state is characterized by complex combinations of wind sea and swell systems.

4.6.4 The master should ensure that the ship, at any time during the voyage and considering the available weather forecasts, satisfies the operational limitations related to maximum significant wave height or operational guidance.

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ANNEX 6

DRAFT AMENDMENTS TO SOLAS CHAPTER II-1

The following new regulation 25-1 is added after existing regulation 25:

"Regulation 25-1

Water level detectors on multiple hold cargo ships other than bulk carriers and tankers

1 Multiple hold cargo ships other than bulk carriers and tankers constructed on or after [1 January 2024] shall be fitted with water level detectors* in each cargo hold intended for dry cargoes. Water level detectors are not required for cargo holds located entirely above the freeboard deck.

2 The water level detectors required by paragraph 1 shall:

.1 give audible and visual alarms at the navigation bridge, one when the water level above the bottom of any cargo hold reaches a height of not less than 0.3 m, and another at a height not less than 15% of the depth of the cargo hold but not more than 2 m; and

.2 be fitted in the aft end of the cargo holds. For cargo holds which are occasionally used for water ballast, an alarm overriding device may be installed. The visual alarms shall clearly discriminate between the two different water levels detected in each hold."

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* Refer to the *Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers (resolution MSC.188(79))*.

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APPENDIX 1*

CHECK/MONITORING SHEET FOR THE PROCESSING OF AMENDMENTS TO THE CONVENTION AND RELATED MANDATORY INSTRUMENTS (PROPOSAL/DEVELOPMENT)

Part III – Process monitoring to be completed during the work process at the sub-committee and checked as part of the final approval process by the Committee (Refer to section 3.2.1.3)**

1	The sub-committee, at an initial engagement, has allocated sufficient time for technical research and discussion before the target completion date, especially on issues needing to be addressed by more than one sub-committee and for which the timing of relevant sub-committees meetings and exchanges of the result of consideration needed to be carefully examined.	yes
2	The scope of application agreed at the proposal stage was not changed without the approval of the Committee.	yes
3	The technical base document/draft amendment addresses the proposal's issue(s) through the suggested instrument(s); where it does not, the sub-committee offers the Committee an alternative method of addressing the problem raised by the proposal.	yes
4	Due attention has been paid to the *Interim guidelines for the systematic application of the grandfather clauses* (MSC/Circ.765-MEPC/Circ.315).	yes
5	All references have been examined against the text that will be valid if the proposed amendment enters into force.	yes
6	The location of the insertion or modified text is correct for the text that will be valid when the proposed text enters into force on a four-year cycle of entry into force, as other relevant amendments adopted might enter into force on the same date.	yes
7	There are no inconsistencies in respect of scope of application between the technical regulation and the application statement contained in regulation 1 or 2 of the relevant chapter, and application is specifically addressed for existing and/or new ships, as necessary.	yes
8	Where a new term has been introduced into a regulation and a clear definition is necessary, the definition is given in the article of the Convention or at the beginning of the chapter.	n/a
9	Where any of the terms "fitted", "provided", "installed" or "installation" are used, consideration has been given to clarifying the intended meaning of the term.	yes
10	All necessary related and consequential amendments to other existing instruments, including non-mandatory instruments, in particular to the forms of certificates and records of equipment required in the instrument being amended, have been examined and included as part of the proposed amendment(s).	n/a

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Part III – Process monitoring to be completed during the work process at the sub-committee and checked as part of the final approval process by the Committee (Refer to section 3.2.1.3)**

11	The forms of certificates and records of equipment have been harmonized, where appropriate, between the Convention and its Protocols.	n/a
12	It is confirmed that the amendment is being made to a currently valid text and that no other bodies are concurrently proposing changes to the same text.	yes
13	All entry-into-force criteria (building contract, keel laying and delivery) have been considered and addressed.	yes
14	Other impacts of the implementation of the proposed/approved amendment have been fully analysed, including consequential amendments to the "application" and "definition" regulations of the chapter.	yes
15	The amendments presented for adoption clearly indicate changes made with respect to the original text, so as to facilitate their consideration.	yes
16	For amendments to mandatory instruments, the relationship between the Convention and the related instrument has been observed and addressed, as appropriate.	n/a
17	The related record format has been completed or updated, as appropriate.	yes

** Part III should be completed by the drafting/working group that prepared the draft text using "yes", "no" or "not applicable".

APPENDIX 2*

RECORDS FOR REGULATORY DEVELOPMENT

The following records should be created and kept updated for each regulatory development.

The records can be completed by providing references to paragraphs of related documents containing the relevant information, proposals, discussions and decisions.

1 Title (number and title of regulation(s))
New SOLAS regulation chapter II-1/25-1 (Water level detectors on multiple hold cargo ships other than bulk carriers and tankers)
2 Origin of the requirement (original proposal document)
MSC 100/17/2
3 Main reason for the development (extract from the proposal document)
The results of the casualty investigation of the United States flagged cargo steamship **El Faro** (IMO GISIS number C0010070-R02) resulted in USCG MBI Safety Recommendation #1-High Water Alarms which recommended to amend the applicability of SOLAS Chapter II-1/25 to include all new and existing multi-hold cargo ships (MSC 100/17/2, paragraphs 4 and 8). The compelling need was established by the Submitter with respect to any failure to mitigate substantial water ingress to a ship's cargo hold could result in progressive stability problems for any cargo ship. High water level detectors installed in cargo holds, with associated audible and visual alarms on the bridge, will provide early indication of water ingress to those spaces and enable the crew to take necessary damage control actions. The proposal for water detection devices and alarms, when combined with the existing requirements for bilge pumping systems, will enable early mitigation of a flooding event. (MSC 100/17/2, paragraphs 11 and 12).
4 Related output
Development of amendments to SOLAS chapter II-1 to include requirements for water level detectors on non-bulk carrier cargo ships with multiple cargo holds (OW 30)
5 History of the discussion (approval of work programmes, sessions of sub-committees, including CG/DG/WG arrangements)
MSC 100 agreed to include in its post-biennial agenda an output on "Development of amendments to SOLAS chapter II-1 to include requirements for water level detectors on non-bulk carrier cargo ships with multiple cargo holds", with two sessions needed to complete the item, assigning the SDC Sub-Committee as the coordinating organ, in association with the SSE Sub-Committee as and when requested by the SDC Sub-Committee (MSC 100/20, paragraph 17.3). **MSC 101** agreed to the proposal of SDC 6 to lift the output from the post-biennial agenda of the Committee to the biennial agenda for the 2020-2021 biennium and to include it in the provisional agenda for SDC 7.

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SDC 7 considered two documents submitted under this output (agenda item 7) and finalized draft new SOLAS regulation II-1/25-1. The Sub-Committee also considered the application to existing ship upon the expected entry into force on 1 January 2024.	
6	**Impact on other instruments (e.g. codes, performance standards, guidance circulars, certificates/records format, etc.)**
N/A	
7	**Technical background**
7.1	**Scope and objective (to cross check with items 4 and 5 in part II of the checklist)**
The amendments expand upon existing SOLAS regulation II-1/25 on Water level detectors on single hold cargo ships other than bulk carriers and to require water level detection devices and associated alarms for the cargo holds of non-bulk carrier cargo ships with multiple cargo holds.	
7.2	**Technical/operational background and rationale (summary of FSA study, etc., if available or, engineering challenge posed, etc.)**
Recommendations from the **SS El Faro** casualty investigation report.	
7.3	**Source/derivation of requirement (non-mandatory instrument, industry standard, national/regional requirement)**
SOLAS regulation II-1/25.	
7.4	**Short summary of requirement (what is the new requirement – in short and lay terms)**
See paragraph 7.1 above.	
7.5	**Points of discussions (controversial points and conclusion)**
.1	Establishment of application provisions with respect to existing/new ships.
.2	SDC 7 noted that, with regard to single hold cargo ships, there might be a need to review regulation 25 in the future, in order to consider water level detector requirements for ships that comply with the damage stability requirements and, subsequently, agreed to invite any interested Member States and international organizations to submit proposals to MSC for a new output.

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ANNEX 7

DRAFT AMENDMENTS TO THE 2011 ESP CODE*

ANNEX TO THE INTERNATIONAL CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF BULK CARRIERS AND OIL TANKERS, 2011 (2011 ESP CODE)

ANNEX B

CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF OIL TANKERS

Part A

CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF DOUBLE-HULL OIL TANKERS

1 The column entitled "Renewal Survey No.1" in annex 2 of part A of annex B of the 2011 ESP Code, as amended by resolution MSC.461(101), is amended as follows:

"1 ~~One section of deck plating for the full beam of the ship within the cargo area~~

~~2 Measurements, for general assessment and recording of corrosion pattern, of those structural members subject to close-up survey according to annex 1~~

~~3~~ Suspect areas"

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* Tracked changes are indicated using "strikeout" for deleted text and "grey shading" to highlight all modifications and new insertions, including deleted text.

ANNEX 8*

DRAFT AMENDMENTS TO MARPOL ANNEX I

CHAPTER 4 – REQUIREMENTS FOR THE CARGO AREA OF OIL TANKERS

PART A – CONSTRUCTION

Regulation 28 – Subdivision and damage stability

1 Paragraph 3.1 is replaced with the following:

"3 Oil tankers shall be regarded as complying with the damage stability criteria if the following requirements are met:

.1 The final waterline, taking into account sinkage, heel and trim, shall be below the lower edge of any opening through which progressive flooding may take place. Such openings shall include air-pipes and those which are closed by means of weathertight doors or hatch covers and may exclude those openings closed by means of watertight manhole covers and flush scuttles, small watertight cargo tank hatch covers which maintain the high integrity of the deck, remotely operated sliding watertight ~~sliding~~ doors, hinged watertight access doors with open/closed indication locally and at the navigation bridge and be of the quick-acting or single-action type that are normally closed at sea, hinged watertight doors that are permanently closed at sea, and sidescuttles of the non-opening type."

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ANNEX 9*

DRAFT AMENDMENTS TO THE 1988 LL PROTOCOL

1 Regulation 27(13)(a) is replaced with the following:

"(13) The condition of equilibrium after flooding shall be regarded as satisfactory provided:

(a) The final waterline after flooding, taking into account sinkage, heel and trim, is below the lower edge of any opening through which progressive downflooding may take place. Such openings shall include air pipes, ventilators (even if they comply with regulation 19(4)) and openings which are closed by means of weathertight doors (even if they comply with regulation 12) or hatch covers (even if they comply with regulation 16(1) through (5)), and may exclude those openings closed by means of manhole covers and flush scuttles (which comply with regulation 18), cargo hatch covers of the type described in regulation 27(2), *remotely operated sliding watertight doors*, hinged watertight access doors with open/closed indication locally and at the navigation bridge and be of the quick-acting or single-action type that are normally closed at sea, hinged watertight doors that are permanently closed at sea, and sidescuttles of the non-opening type (which comply with regulation 23). ~~However,~~ ~~i~~In the case of doors separating a main machinery space from a steering gear compartment, watertight doors may be of a hinged, quick-acting type kept closed at sea whilst not in use, provided also that the lower sill of such doors is above the summer load waterline."

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ANNEX 10*

DRAFT AMENDMENTS TO THE IBC CODE

CHAPTER 2
SHIP SURVIVAL CAPABILITY AND LOCATION OF CARGO TANKS

1 The existing paragraph 2.9.2.1 is replaced with the following:

"2.9.2 In any stage of flooding:

.1 the waterline, taking into account sinkage, heel and trim, shall be below the lower edge of any opening through which progressive flooding or downflooding may take place. Such openings shall include air pipes and openings which are closed by means of weathertight doors or hatch covers and may exclude those openings closed by means of watertight manhole covers and watertight flush scuttles, small watertight cargo tank hatch covers which maintain the high integrity of the deck, remotely operated sliding watertight ~~sliding~~ doors, hinged watertight access doors with open/closed indication locally and at the navigation bridge and be of the quick-acting or single-action type that are normally closed at sea, hinged watertight doors that are permanently closed at sea, and sidescuttles of the non-opening type;"

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ANNEX 11*

DRAFT AMENDMENTS TO THE IGC CODE

CHAPTER 2
SHIP SURVIVAL CAPABILITY AND LOCATION OF CARGO TANKS

1 The existing text of paragraph 2.7.1.1 is replaced with the following:

"**2.7.1 In any stage of flooding:**

.1 the waterline, taking into account sinkage, heel and trim, shall be below the lower edge of any opening through which progressive flooding or downflooding may take place. Such openings shall include air pipes and openings that are closed by means of weathertight doors or hatch covers and may exclude those openings closed by means of watertight manhole covers and watertight flush scuttles, small watertight cargo tank hatch covers that maintain the high integrity of the deck, remotely operated sliding watertight ~~sliding~~ doors, hinged watertight access doors with open/closed indication locally and at the navigation bridge and be of the quick-acting or single-action type that are normally closed at sea, hinged watertight doors that are permanently closed at sea, and sidescuttles of the non-opening type;"

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ANNEX 12

BIENNIAL STATUS REPORT AND OUTPUTS ON THE COMMITTEE'S POST-BIENNIAL AGENDA THAT FALL UNDER THE PURVIEW OF THE SUB-COMMITTEE

Sub-Committee on Ship Design and Construction (SDC)									
Reference to SD, if applicable	**Output number**	**Description**	**Target completion year**	**Parent organ(s)**	**Associated organ(s)**	**Coordinating organ**	**Status of output for Year 1**	**Status of output for Year 2**	**References**
1. Improve implementation	1.3 (NEW)	Validated model training courses	Continuous	MSC / MEPC	III / HTW / PPR / CCC / SDC / SSE / NCSR	HTW	No work requested		MSC 100/20, paragraphs 10.3 to 10.6, and 17.25
1. Improve implementation	1.13	Review of mandatory requirements in the SOLAS, MARPOL and Load Line Conventions and the IBC and IGC Codes regarding watertight doors on cargo ships	2021	MSC / MEPC	CCC	SDC	Completed		MSC 101/24, paragraph 21.25 SDC 7/16, section 13
2. Integrate new and advancing technologies in the regulatory framework	2.3	Amendments to the IGF Code and development of guidelines for low-flashpoint fuels	2021	MSC	HTW / PPR / SDC / SSE	CCC	No work requested		MSC 94/21, paragraphs 18.5 and 18.6; MSC 96/25, paragraphs 10.1 to 10.3; MSC 97/22, paragraph 19.2
2. Integrate new and advancing technologies in the regulatory framework	2.4	Mandatory instrument and/or provisions addressing safety standards for the carriage of more than 12 industrial personnel on	2021	MSC	SDC		In progress		MSC 95/22, paragraph 19.25; MSC 96/25, paragraphs 7.10 and 7.12; MSC 97/22, paragraphs 6.22 and 6.23; MSC 99/22,

Sub-Committee on Ship Design and Construction (SDC)									
Reference to SD, if applicable	**Output number**	**Description**	**Target completion year**	**Parent organ(s)**	**Associated organ(s)**	**Coordinating organ**	**Status of output for Year 1**	**Status of output for Year 2**	**References**
		board vessels engaged on international voyages							paragraphs 10.17 and 10.18; MSC 101/24, paragraphs 12.17 to 12.19 SDC 7/16, section 6
2. Integrate new and advancing technologies in the regulatory framework	2.6	~~Finalization of second generation intact stability criteria~~ Development of Explanatory Notes to the *Interim guidelines on second generation intact stability criteria*	2021	MSC	SDC		In progress		MSC 85/26, paragraphs 12.7 and 23.42; SDC 7/16, section 5
Note: After completion of the work on the draft Interim guidelines on second generation intact stability criteria, SDC 7 proposed to rename the output to develop the associated draft Explanatory Notes									
2. Integrate new and advancing technologies in the regulatory framework	2.8	Development of guidelines for cold ironing of ships and of amendments to SOLAS chapters II-1 and II-2	2020	MSC	III / HTW / SDC	SSE	No work requested		MSC 98/23, paragraph 20.36
6. Ensure regulatory effectiveness	6.1	Unified interpretation of provisions of IMO safety, security, and environment-related conventions	Continuous	MSC / MEPC	III / PPR / CCC / SDC / SSE / NCSR		Ongoing		MSC 76/23, paragraph 20.3; MSC 78/26, paragraph 22.12; SDC 7/16, section 11

Sub-Committee on Ship Design and Construction (SDC)									
Reference to SD, if applicable	**Output number**	**Description**	**Target completion year**	**Parent organ(s)**	**Associated organ(s)**	**Coordinating organ**	**Status of output for Year 1**	**Status of output for Year 2**	**References**
6. Ensure regulatory effectiveness	6.15	Role of the human element	Continuous	MSC / MEPC	III / PPR / CCC / SDC / SSE / NCSR	HTW	Ongoing		MSC 89/25, paragraphs 10.10, 10.16 and 22.39, and annex 21; MSC 100/20, paragraph 10.8
OW. Other work	OW 2	Amendments to the 2011 ESP Code	Continuous	MSC	SDC		Ongoing		MSC 92/26, paragraph 13.31; SDC 7/16, section 10
OW. Other work	OW 30	Development of amendments to SOLAS chapter II-1 to include requirements for water level detectors on non-bulk carrier cargo ships with multiple cargo holds	2021	MSC	SSE	SDC	Completed		MSC 100, paragraphs 17.2 to 17.4; SDC 7/16, section 7
OW. Other work	OW 31	Mandatory application of the Performance standard for protective coatings for void spaces on bulk carriers and oil tankers	2021	MSC		SDC	In progress		MSC 76/23, paragraphs 20.41.2 and 20.48; DE 50/27, section 4 SDC 7/16, section 8
Note: SDC 6 proposed and MSC 101 agreed to move the output from the post-biennial agenda to the provisional agenda of SDC 7									
OW. Other work	OW 32	Performance standard for protective coatings for void spaces on all types of ships	2021	MSC		SDC	In progress		MSC 76/23, paragraphs 20.41.2 and 20.48 SDC 7/16, section 9
Note: SDC 6 proposed and MSC 101 agreed to move the output from the post-biennial agenda to the provisional agenda of SDC 7									

Sub-Committee on Ship Design and Construction (SDC)									
Reference to SD, if applicable	**Output number**	**Description**	**Target completion year**	**Parent organ(s)**	**Associated organ(s)**	**Coordinating organ**	**Status of output for Year 1**	**Status of output for Year 2**	**References**
OW. Other work	OW 36	Review SOLAS chapter II-2 and associated codes to minimize the incidence and consequences of fires on ro-ro spaces and special category spaces of new and existing ro-ro passenger ships	2021	MSC	HTW / SDC	SSE	No work requested		MSC 97/22, paragraph 19.19; MSC 98/23, paragraph 12.42
OW. Other work	OW 40	Safety measures for non-SOLAS ships operating in polar waters	2021	MSC	SDC		In progress		MSC 98/23, paragraphs 10.29, 20.31.1 and 20.31.2, and annex 38; MSC 99/22, paragraphs 7.16 and 20.13.1; MSC 101/24, paragraph 7.9 SDC 7/16, section 4
OW. Other work	OW 41	Amendments to the Explanatory Notes to SOLAS chapter II-1 subdivision and damage stability regulations (resolution MSC.429(98))	2020	MSC	SDC		Completed		MSC 96/25, paragraph 23.23; SDC 5/15, section 5; SDC 6/13, section 4; SDC 7/16, section 3
OW. Other work	OW 43	Consequential work related to the new International Code for	2021	MSC	SSE / NCSR	SDC	Ongoing		MSC 93/22, paragraphs 10.44,

Sub-Committee on Ship Design and Construction (SDC)									
Reference to SD, if applicable	**Output number**	**Description**	**Target completion year**	**Parent organ(s)**	**Associated organ(s)**	**Coordinating organ**	**Status of output for Year 1**	**Status of output for Year 2**	**References**
		Ships Operating in Polar Waters							10.50 and 20.12; MSC 96/25, paragraph 3.77; MSC 97/22, paragraphs 8.32 and 19.25

OUTPUTS ON THE COMMITTEE'S POST-BIENNIAL AGENDA THAT FALL UNDER THE PURVIEW OF THE SUB-COMMITTEE

SHIP DESIGN AND CONSTRUCTION (SDC)								
ACCEPTED POST-BIENNIAL OUTPUTS				**Parent organ(s)**	**Associated organ(s)**	**Coordinating organ**	**Timescale (sessions)**	**Reference**
Number	**Biennium**	**Reference to strategic direction, if applicable**	**Description**					
152	2016-2017	SD 2 (Integrate new and advancing technologies in the regulatory framework)	Guidelines for use of Fibre Reinforced Plastics (FRP) within ship structures	MSC	SDC		2	MSC 98/23, paragraph 10.22 SDC 7/16, section 13

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ANNEX 13

PROPOSED PROVISIONAL AGENDA FOR SDC 8

Opening of the session

1 Adoption of the agenda

2 Decisions of other IMO bodies

3 Safety measures for non-SOLAS ships operating in polar waters (OW 40)

4 Mandatory instrument and/or provisions addressing safety standards for the carriage of more than 12 industrial personnel on board vessels engaged on international voyages (2.4)

5 Development of Explanatory Notes to the *Interim guidelines on second generation intact stability criteria* (2.6)*

6 Amendments to the 2011 ESP Code

7 Mandatory application of the Performance standard for protective coatings for void spaces on bulk carriers and oil tankers (OW 31)

8 Performance standard for protective coatings for void spaces on all types of ships (OW 32)

9 Unified interpretation to provisions of IMO safety, security, and environment-related conventions (6.1)

10 Biennial status report and provisional agenda for SDC 9

11 Election of Chair and Vice-Chair for 2022

12 Any other business

13 Report to the Maritime Safety Committee

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* Renaming of output subject to approval by MSC 102.

ANNEX 14*

DRAFT RESOLUTION MSC.62(67)/REV.1

GUIDELINES FOR SAFE ACCESS TO TANKER BOWS

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO that it adopted, by resolution MSC.57(67), regulation II-1/3-3 of the International Convention for the Safety of Life at Sea (SOLAS), 1974, which requires that all tankers, including gas carriers and chemical tankers, shall be provided with means, based on guidelines developed by the Organization, to enable the crew to gain safe access to the bow even in severe weather conditions,

NOTING that it adopted, by resolution MSC.62(67), Guidelines for safe access to tanker bows, which provide guidance for tankers on how to ensure that the crew can gain safe access to the bow even in severe weather conditions,

HAVING CONSIDERED, at its 102nd session, the recommendation made by the Sub-Committee on Ship Design and Construction at its seventh session,

1 ADOPTS the Revised Guidelines for safe access to tanker bows, set out in the Annex to the present resolution;

2 RECOMMENDS that all Governments concerned take appropriate steps to implement the Revised Guidelines;

3 REVOKES resolution MSC.62(67).

* Track changes in the annex indicate "strikeout" for deleted text and "grey shading" to highlight all modifications and new insertions, including deleted text.

ANNEX

REVISED GUIDELINES FOR SAFE ACCESS TO TANKER BOWS

Gangway and access

1 Tankers, including oil tankers as defined in SOLAS regulation II-1/2.12, chemical tankers as defined in regulation VII/8.2 and gas carriers as defined in regulation VII/11.2, should be provided with means to enable the crew to gain safe access to the bow even in severe weather conditions. For tankers constructed on or after 1 July 1998, the access should be by means of either a walkway on the deck or a permanently constructed gangway of substantial strength at or above the level of the superstructure deck, or at the first tier of a deckhouse, which should:

.1 be not less than 1 m in width, situated on or as near as practicable to the centre line of the ship and located so as not to hinder easy access across working areas of the deck;

.2 be fitted at each side throughout its length with a foot-stop and guard rails supported by stanchions. Such rails should consist of no less than 3 courses, the lowest being not more than 230 mm and the uppermost being at least 1 m above the gangway or walkway, and no intermediate opening should be more than 380 mm in height. Stanchions should be at intervals of not more than 1.5 m. A permanent walkway located at the freeboard deck level, on or as near as practicable to the centre line of the ship, need not be fitted with foot-stops;

.3 be constructed of fire resistant and non-slip material;

.4 have openings, with ladders where appropriate, to and from the deck. Openings should not be more than 40 m apart;

.5 if the length of exposed deck to be traversed exceeds 70 m, have shelters of substantial construction set in way of the gangways or walkways at intervals not exceeding 45 m. Every such shelter should be capable of accommodating at least one person and be so constructed as to afford weather protection on the forward, port and starboard sides; and

.6 if obstructed by pipes or other fittings of a permanent nature, be provided with means of passage over such obstruction.

2 The Administration may accept alternative or modified arrangements for tankers with space constraint, such as small tankers, or tankers with large freeboard, such as gas carriers, provided that such alternative or modified arrangements achieve an equivalent level of safety for access to the bow.

3 Arrangements already approved by the Administration for tankers constructed before 1 July 1998 may be accepted, provided that such existing arrangements achieve an equivalent level of safety for access to the bow.

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ANNEX 15*

DRAFT AMENDMENTS TO THE 1988 LL PROTOCOL

1 Regulation 22(1)(g) is replaced with the following:

"(g) Table 22.1 provides the acceptable arrangements of scuppers~~, inlets~~ and discharges."

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