



INSTRUCTIONS FOR THE GUIDANCE OF SURVEYORS ON  
**DAMAGE STABILITY**  
**SOLAS 2020 AMENDMENTS**  
**With Explanatory Notes**

MSIS42

Rev 05.23

**Applicable to Internationally Trading Passenger Ships of all Sizes  
&  
Dry Cargo Ships with Gross Tonnage  $\geq$  500  
with Keels Laid on or after 1<sup>st</sup> January 2009**



## AMENDMENTS

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Issue 1 R05.20	New Document	14/05/2020	Andrew Scott Policy Lead, Stability, Load line & Tonnage	Pete Rollason Ship Safety Lead	14/05/2025
Issue 2 R05.23	Updated Document	06/04/2023	Andrew Scott Policy Lead, Stability, Load line & Tonnage	Pete Rollason Ship Safety Lead	06/04/2028

## INTRODUCTION AND HISTORICAL BACKGROUND

The basis text in this document is extracted from the SOLAS Consolidated Edition 2014 which incorporates all SOLAS amendments in effect from 1 July 2014 most notably, from the damage stability aspect, the December 2006 Annex 2 amendments, adopted by IMO resolution MSC.216(82), which entered into force for passenger ships and dry cargo ships with keels laid on or after 1 January 2009.

Commonly known as the SOLAS 2009 amendments, MSC.216(82) substantially revised SOLAS90 Part 1 Chapter II-1 Parts A (General), B (Subdivision and Stability) and B-1 (Subdivision and Damage Stability of Cargo Ships). The amendments resulted in Chapter II-1 being re-organised and revised as follows: -

Part A remained under the title of “General” but the “application” and “definitions” regulations 1 and 2 were substantially revised. Regulation 3, containing definitions relating to Parts C, D and E (machinery and electrical installations) was unaltered except that the definitions of “deadweight” and “lightweight” were moved to revised regulation 2.

Part A-1 relating to the structure of ships was retained. It was not amended by MSC.216(82) but by later amendments under separate resolutions.

Parts B and B-1 were completely changed. A new Part B containing only a new regulation 4 with sub-paragraphs relating to application, alternative methodologies, degree of subdivision and the effectiveness of the subdivision was introduced. The old Part B regulations 4 to 7 on the determination of the subdivision of passenger ships using floodable lengths, factor of subdivision, margin line etc. were removed altogether and regulations 8, 8-1, 8-2 and 8-3 relating to the deterministic assessment of the damage stability of passenger and ro-ro passenger ships were replaced by the new probabilistic regulations and placed in a new Part B-1 under the heading “Stability”.

The new Part B-1 now contains sub-sections on intact stability and the provision of stability information to the master (including, for example Regulation 22 in the old Part B on inclining experiments etc.) along with the new integrated probabilistic regulations for passenger and dry cargo ships. The old dry cargo ship probabilistic subdivision and

damage stability regulations as well as the provision of stability information to the master, openings in watertight bulkheads and external openings formerly in old Part B-1 have been “harmonized” into the new Part B-1.

It is most important to note that the probabilistic damage stability regulations in the SOLAS 2009 amendments Chapter II-1 Part B-1 regulations 6, 7, 7-1, 7-2 and 7-3 relate to internationally trading passenger ships of all sizes but only to dry cargo ships with gross tonnage  $\geq 500$  and length of 80 (or 100) metres and above which do not already comply with subdivision and damage stability regulations in other IMO instruments, as listed in new Part B. The remaining regulations in new Parts B-1, B-2, B-4 and C (35-1) are applicable to all passenger and to dry cargo ships with gross tonnage  $\geq 500$  constructed on or after 1<sup>st</sup> January 2009 except where expressly stated otherwise.

The new Part B-2 regulations 9 to 17-1 (Subdivision, watertight and weathertight integrity) now contains the remaining cargo ship regulations in SOLAS 90 Part B-1 integrated and harmonized with the old passenger and cargo ship regulations 10 to 20-4 covering, for example, double bottoms, watertight bulkheads, openings etc., a process which involved considerable revision and updating to remove anomalies and inconsistencies.

A new Part B-3 was introduced, containing one regulation (18) covering the subdivision load line assignment for passenger ships. This was the old Part B regulation 13, which remains unaltered.

A further new Part (B-4, Stability Management) was introduced. Regulation 19 covers damage control information taken largely from old Part B regulations 23 and 23-1. Regulation 20 contains the old Part B regulation 9 on the ballasting of passenger ships. The remaining new regulations 21 to 24 cover the periodical operation and inspection of watertight doors etc. in passenger ships, the prevention and control of water ingress on passenger and cargo ships, special requirements for ro-ro passenger ships and flooding detection systems for passenger ships. A new Regulation (25) for the fitting of water level detectors on single hold cargo ships other than bulk carriers was added and, most recently, Regulation 25-1 was added requiring that multiple hold cargo ships other than bulk carriers and tankers constructed on or after 1<sup>st</sup> January 2024 shall be fitted with water level detectors in each cargo hold intended for dry cargoes.

The old Part B regulation 21 on bilge pumping arrangements was moved to Part C (Machinery Installations) regulation 35-1 where some amendments were made.

It is also important to note the introduction of the following regulations which, from 1<sup>st</sup> January 2020, were retrospectively applied to older passenger ships -

- Revised regulation 8-1.3.2 in the new Part B-1 now requires that all passenger ships constructed before January 1<sup>st</sup> 2014 to which regulation 8-1 applies (including such ships constructed before 1<sup>st</sup> January 2009) must have an onboard

stability computer or shore-based support no later than the first renewal survey after 1<sup>st</sup> January 2025.

- New Regulation 19-1 in Part B-4 requires that all passenger ships constructed before, on or after 1<sup>st</sup> January 2020 shall undergo damage control drills at least every three months full details of which are given in the new regulation.

IMO Resolution A.265(VIII), which, since its introduction in 1973, had been considered as a probabilistic equivalent to all the deterministic SOLAS subdivision and damage stability regulations for passenger ships in force between 1973 and 31 December 2008 was superseded by the SOLAS 2009 amendments, though several of its probabilistic concepts were utilised therein.

The original SOLAS 2009 amendments were accompanied by a set of explanatory notes (ref. resolution MSC.281(85)). In this guidance document, for ease of reference, the explanatory notes relevant to a specific regulation are shown in *red italics* adjacent to the regulation in question.

After 1st January 2009, further amendments were found to be necessary to SOLAS 2009. These were finally approved under IMO Resolution MSC.421(98), adopted on 15<sup>th</sup> June 2017 and Resolution MSC.436(99), adopted on 24<sup>th</sup> May 2018 both for entry into force on 1st January 2020. Known as the SOLAS 2020 amendments, they are applicable to passenger and dry cargo ships constructed on or after 1<sup>st</sup> January 2020.

At the same time as the SOLAS 2020 amendments were agreed, amendments to the accompanying explanatory notes were made and appeared in IMO Resolution MSC.429(98) which was adopted on 9<sup>th</sup> June 2017, also for entry into force on 1<sup>st</sup> January 2020. In this guidance document, the 2020 amendments to the SOLAS 2009 text are **highlighted thus** and the amendments to the explanatory notes are similarly **highlighted**.

At SDC 7 in February 2020 further revisions to the 2020 explanatory notes were agreed (**highlighted thus**) and a consolidated version including all the amendments made to the explanatory notes since 2009 was approved and adopted at MSC 102 on 11 November 2020 under Resolution MSC.429(98)/REV.2.

The highlighting is intended to show clearly which regulations and explanatory notes apply to ships constructed on or after 1<sup>st</sup> January 2009 and which apply to those constructed on or after 1<sup>st</sup> January 2020. This is particularly important for passenger ships and ro-ro passenger ships where the required index “R” was substantially increased for ships constructed after 1<sup>st</sup> January 2020, thereby introducing a step change in the safety levels provided by the two sets of regulations for certain sizes of ship.

Amendments to SOLAS Chapter II-1 and the explanatory notes continued to be made and will enter into force at dates now often specified in the text. In this document these post-2020 SOLAS text amendments are **highlighted thus** and were approved at MSC 101

in May 2019 (see MSC 101/24/Add.1/Annex 25 for details) and adopted at MSC 102/3 (Annex 1). Further amendments to the SOLAS text (see SDC 7/16 Annex 6), consisting of a new Regulation 25-1 as described previously, were agreed at SDC 7 for approval and were later adopted at MSC 102 in November 2020, highlighted thus .

The agenda item covering amendments to SOLAS Chapter II-1 was concluded at SDC 7 so the text as shown in this guidance document will be frozen until a new agenda item on further amendments to SOLAS Chapter II-1 is agreed at some future session of MSC.

On October 3, 2008 the UK notified IMO of an equivalent arrangement under SOLAS regulation I/5 which allowed for the floodable length curves of ro-ro passenger ships fitted with long lower holds to be calculated using an alternative method (see IMO SLS.14/Circ.321). It is emphasized that this remains applicable only to existing UK flag SOLAS90 ships and not to ro-ro passenger ships constructed on or after 1 January 2009.

Since April 2003 all EU flag ro-ro passenger ships and non-EU flag ships operating in EU waters must additionally comply with the Stockholm Agreement (EU Directive 2003/25/EC) (as amended) which was implemented into UK law under SI 2004 No. 2884 and MSN 1790 (both as amended). It was originally intended that these requirements would be revoked on 1 January 2009 but concerns over the safety levels provided by the SOLAS 2009 amendments led to a decision by the EU to retain the Stockholm Agreement to be used in conjunction with the 2009 amendments.

Subsequent amendments to SOLAS 2009, which entered into force on 1 January 2020, still did not completely allay the safety concerns especially for smaller ro-ro passenger ships. At the time of writing (April 2023), the Stockholm Agreement has not been revoked so must continue to be applied to all ro-ro passenger ships constructed on or after 1 January 2009 including those to which the SOLAS 2020 amendments apply.

A decision on the future of the Stockholm Agreement was agreed on March 14 2023 in the European Parliament (ref. P9\_TA(2023)0064 Ro-ro passenger ships: stability requirements). The MCA is in the process of producing a new Merchant Shipping Notice (MSN) to explain these changes as they involve a deviation from SOLAS Chapter II-1 for EU flag ro-ro passenger ships carrying 1350 or fewer persons on board. New UK flag ro-ro passenger ships will have to comply with these amendments in order to trade in EU waters. The date of entry into force of these amendments to the EU Directive 2003/25/EC is not known at the time of writing (April 2023).

The UK has produced a new Statutory Instrument to cover the above changes to SOLAS Chapter II-1. Entitled [SI 2023 No. 0246 - The Merchant Shipping \(Cargo and Passenger Ship Construction and Miscellaneous Amendments\) Regulations 2023](#) it entered into force on 29<sup>th</sup> March 2023.

It will be automatically updated using the ambulatory reference procedure and is accompanied by: -

[MGN 670 \(M\) Ships built on or after 1st January 2009 and engaged on international voyages – guidance on SOLAS chapter II-1](#)

This Marine Guidance Note provides advice and recommendations in relation to the requirements contained in SOLAS Chapter II-1.

[MGN 671 \(M\) Subdivision and damage stability of cargo ships of 80m in length and over](#)

This Note provides advice about the subdivision and damage stability requirements for cargo ships using the probabilistic method, the categories of ship to which those requirements apply and the formulae to be used for calculating the subdivision indices.

Note that MSIS42 does not include any text changes agreed at SDC 9 as, at the time of writing (6 April 2023), these have not yet been approved and adopted at MSC. The next meeting (MSC 107) will take place 31 May to 9 June 2023.

## SOLAS 2009 damage stability regulations - contents

### Part A General

<a href="#">Regulation 1</a>	.....	Application
<a href="#">Regulation 2</a>	.....	Definitions
<a href="#">Regulation 3</a>	.....	Definitions Relating to parts C, D and E

### Part B Subdivision and Stability

<a href="#">Regulation 4</a>	.....	General
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#### Part B-1 Stability

<a href="#">Regulation 5</a>	.....	Intact stability
<a href="#">Regulation 5-1</a>	.....	Stability information to be supplied to the master
<a href="#">Regulation 6</a>	.....	Required subdivision index $R$
<a href="#">Regulation 7</a>	.....	Attained subdivision index $A$
<a href="#">Regulation 7-1</a>	.....	Calculation of the factor $p_i$
<a href="#">Regulation 7-2</a>	.....	Calculation of the factor $s_i$
<a href="#">Regulation 7-3</a>	.....	Permeability
<a href="#">Regulation 8</a>	.....	Special requirements concerning passenger ship stability
<a href="#">Regulation 8-1</a>	.....	System capabilities and operational information after a flooding casualty on passenger ships

#### Part B-2 Subdivision, Watertight and Weathertight Integrity

<a href="#">Regulation 9</a>	.....	Double bottoms in passenger ships and cargo ships other than tankers
<a href="#">Regulation 10</a>	.....	Construction of watertight bulkheads
<a href="#">Regulation 11</a>	.....	Initial Testing of Watertight Bulkheads etc.
<a href="#">Regulation 12</a>	.....	Peak and machinery space bulkheads, shaft tunnels, etc.
<a href="#">Regulation 13</a>	.....	Openings in watertight bulkheads boundaries below the bulkhead deck in passenger ships
<a href="#">Regulation 13-1</a>	.....	Openings in watertight bulkheads and internal decks in cargo ships
<a href="#">Regulation 14</a>	.....	Passenger ships carrying goods vehicles and accompanying personnel
<a href="#">Regulation 15</a>	.....	Openings in the shell plating below the bulkhead deck of passenger ships and the freeboard deck of cargo ships
<a href="#">Regulation 15-1</a>	.....	External openings in cargo ships
<a href="#">Regulation 16</a>	.....	Construction and initial tests of watertight closures
<a href="#">Regulation 16-1</a>	.....	Construction and initial tests of watertight decks, trunks etc.
<a href="#">Regulation 17</a>	.....	Internal watertight integrity of passenger ships above the bulkhead deck
<a href="#">Regulation 17-1</a>	.....	Integrity of the hull and superstructure, damage prevention and control on ro-ro passenger ships

**Part B-3 Subdivision Load Line Assignment for Passenger Ships**

[Regulation 18](#) ..... Assigning, marking and recording of subdivision load lines for passenger ships

**Part B-4 Stability Management**

[Regulation 19](#) .....Damage control information

[Regulation 19-1](#) .....Damage control drills for passenger ships

[Regulation 20](#) .....Loading of ships

[Regulation 21](#) .....Periodical operation and inspection of watertight doors, etc. in passenger ships

[Regulation 22](#) .....**Prevention and control of water ingress, etc.**

[Regulation 22-1](#) ..... Flooding detection systems for passenger ships carrying 36 or more persons

[Regulation 23](#) .....**Special requirements for ro-ro passenger ships**

[Regulation 24](#) ..... Additional requirements for prevention and control of water ingress, etc., in cargo ships

[Regulation 25](#) ... Water level detectors on single hold cargo ships other than bulk carriers

[Regulation 25-1](#) ..... Water level detectors on multiple hold cargo ships other than bulk carriers and tankers

**Part C Machinery Installations**

[Regulation 35-1](#) .....Bilge pumping arrangements

[Appendix](#) **Guidelines for the preparation of subdivision and damage stability calculations**

Only the regulations with subject matter **highlighted above** have explanatory notes.

The contents pages for the regulations and explanatory notes (below) are hyper-linked.

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

**Part A – INTRODUCTION**

**Part B – GUIDANCE ON INDIVIDUAL SOLAS CHAPTER II-1 SUBDIVISION AND  
DAMAGE STABILITY REGULATIONS**

Regulation 1	Application; EN <a href="#">1.3</a>
Regulation 2	Definitions; EN <a href="#">2.1</a> , <a href="#">2.6</a> , <a href="#">2.11</a> , <a href="#">2.19</a>
Regulation 4	General; EN <a href="#">4.5</a>
Regulation 5	Intact stability; EN <a href="#">5.2</a> , <a href="#">5.4</a> , <a href="#">5.5</a>
Regulation 5-1	Stability information to be supplied to the master; EN <a href="#">5-1.3</a> , <a href="#">5-1.4</a> <a href="#">5-1.5</a> , <a href="#">5-1.6</a>
Regulation 6	Required subdivision index R; EN <a href="#">6.1</a>
Regulation 7	Attained subdivision index A; EN <a href="#">7.1</a> , <a href="#">7.2</a> , <a href="#">7.5</a> , <a href="#">7.6</a> , <a href="#">7.7</a>
Regulation 7-1	Calculation of the factor p; <a href="#">General</a> , <a href="#">7-1.1.1</a> , <a href="#">7-1.1.2</a>
Regulation 7-2	Calculation of the factor s; <a href="#">General</a> , EN <a href="#">7-2.1</a> EN 7-2.2 <a href="#">intermediate stages of flooding</a> , <a href="#">flooding boundaries</a> , <a href="#">sequential flooding computation</a> , <a href="#">cross-flooding / equalization</a> , <a href="#">alternatives</a> EN <a href="#">7-2.3</a> , <a href="#">7-2.4.1.2</a> , EN <a href="#">7-2.5.2.1</a> <a href="#">Unprotected openings</a> ; <a href="#">Weathertight openings</a> EN <a href="#">7-2.5.2.2</a> , <a href="#">7-2.5.3.1</a> , <a href="#">7-2.6</a> , <a href="#">7-2.6.1</a>
Regulation 7-3	Permeability; EN <a href="#">7.3.2</a> , <a href="#">7.3.3</a>
Regulation 8	Special requirements concerning passenger ship stability; EN <a href="#">8.1</a>
Regulation 8-1	System capabilities and operational information after a flooding casualty on passenger ships; EN <a href="#">8-1.2</a>
Regulation 9	Double bottoms in passenger ships and cargo ships other than tankers; EN <a href="#">9.1</a> , <a href="#">9.2</a> , <a href="#">9.3.2.2</a> , <a href="#">9.6</a> , <a href="#">9.7</a> , <a href="#">9.8</a> , <a href="#">9.9</a>
Regulation 10	Construction of watertight bulkheads; EN <a href="#">10.1</a>
Regulation 12	Peak and machinery space bulkheads, shaft tunnels, etc. EN <a href="#">12.6.1</a> , <a href="#">12.10</a> , <a href="#">12.11</a>
Regulation 13	Openings in watertight <a href="#">boundaries</a> <a href="#">bulkheads</a> below the bulkhead deck in passenger ships; <a href="#">General</a> – steps in the bulkhead deck, EN <a href="#">13.2.3</a> , <a href="#">13.4</a>
Regulation 13-1	Openings in watertight bulkheads and internal decks in cargo ships; EN <a href="#">13-1.1</a>
Regulation 15	Openings in the shell plating below the bulkhead deck of passenger ships and the freeboard deck of cargo ships <a href="#">General</a> – steps in the bulkhead deck and freeboard deck,
Regulation 15-1	External openings in cargo ships; <a href="#">General</a> , EN <a href="#">15-1.1</a>
Regulation 16	Construction and initial tests of watertight closures; EN <a href="#">16.2</a>
Regulation 17	Internal watertight integrity of passenger ships above the bulkhead Deck; <a href="#">General</a> , EN <a href="#">17.1</a> , <a href="#">17.3</a>
Regulation 17-1	<a href="#">Integrity of the hull and superstructure, damage prevention and control on ro-ro passenger ships</a> ; <a href="#">General</a>
Regulation 22	Prevention and control of water ingress, etc.; <a href="#">General</a>
Regulation 23	<a href="#">Special requirements for ro-ro passenger ships</a>
<a href="#">Appendix</a>	<a href="#">Guidelines for the preparation of subdivision and damage stability Calculations</a>

## **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 these 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 the 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 Due 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 of 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 a 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, calculation 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:*

$$A = \sum p_i \cdot s_i$$

*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<sub>i</sub>" 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 their own probability of occurrence.*

*13.4 The value of "s<sub>i</sub>" 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 the ship.*

## **PART B**

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

*The explanatory notes have been integrated into the regulation text for ease of reference.*

## AMENDMENTS TO THE INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1974, AS AMENDED

### CHAPTER II-1 CONSTRUCTION -STRUCTURE, SUBDIVISION AND STABILITY, MACHINERY AND ELECTRICAL INSTALLATIONS

The text in the 2014 SOLAS Consolidated edition of parts A, B, B-1, B-2, B-4 and Regulation 35-1 of part C of Chapter II-1 is replaced by the following:

#### “PART A GENERAL

#### Regulation 1 Application

1.1 Unless expressly provided otherwise, this chapter shall apply to ships the keels of which are laid or which are at a similar stage of construction on or after 1 January 2009.

1.1.1 Unless expressly provided otherwise, parts B, B-1, B-2 and B-4 of this chapter shall only apply to ships:

- .1 for which the building contract is placed on or after 1 January 2020; or
- .2 in the absence of a building contract, the keel of which is laid or which are at a similar stage of construction on or after 1 July 2020; or
- .3 the delivery of which is on or after 1 January 2024.

1.1.2 Unless expressly provided otherwise, for ships not subject to the provisions of subparagraph 1.1.1 but constructed on or after 1 January 2009, the Administration shall

- .1 ensure that the requirements for parts B, B-1, B-2 and B-4 which are applicable under chapter II-1 of the International Convention for the Safety of Life at Sea, 1974, as amended by resolutions MSC.216(82), MSC.269(85) and MSC.325(90) are complied with; and
- .2 ensure that the requirements of regulations 8-1.3 and 19-1 are complied with

- 1.2 For the purpose of this chapter, the term *a similar stage of construction* means the stage at which:
- .1 construction identifiable with a specific ship begins; and
  - .2 assembly of that ship has commenced comprising at least 50 tonnes or one per cent of the estimated mass of all structural material, whichever is less.
- 1.3 For the purpose of this chapter:
- .1 the expression *ships constructed* means ships the keels of which are laid or which are at a similar stage of construction;
  - .2 the expression *ships constructed on or after 1 January 2024* means ships:
    - .1 for which the building contract is placed on or after 1 January 2024; or
    - .2 in the absence of a building contract, the keel of which is laid or which are at a similar stage of construction on or after 1 July 2024; or
    - .3 the delivery of which is on or after 1 January 2028.
  - .23 the expression *all ships* means ships constructed before, on or after 1 January 2009;
  - .34 a cargo ship, whenever built, which is converted to a passenger ship shall be treated as a passenger ship constructed on the date on which such a conversion commences;
- Paragraph 1.3.4 in the 2014 Consolidated Edition concerning alterations and modifications of a major character to cargo ships is deleted.
- 2 Unless expressly provided otherwise, for ships constructed before 1 January 2009, the Administration shall:
- .1 ensure that the requirements which are applicable under chapter II-1 of the International Convention for the Safety of Life at Sea, 1974, as amended by resolutions MSC.1(XLV), MSC.6(48), MSC.11(55), MSC.12(56), MSC.13(57), MSC.19(58), MSC.26(60), MSC.27(61), Resolution 1 of the 1995 SOLAS Conference, MSC.47(66), MSC.57(67), MSC.65(68), MSC.69(69), MSC.99(73), MSC.134(76), MSC.151(78) and MSC.170(79) are complied with; and
  - .2 ensure that the requirements of regulation 19-1 are complied with.

3 All ships which undergo repairs, alterations, modifications and outfitting related thereto shall continue to comply with at least the requirements previously applicable to these ships. Such ships, if constructed before the date on which any relevant amendments enter into force, shall, as a rule, comply with the requirements for ships constructed on or after that date to at least the same extent as they did before undergoing such repairs, alterations, modifications or outfitting. Repairs, alterations and modifications of a major character and outfitting related thereto shall meet the requirements for ships constructed on or after the date on which any relevant amendments enter into force, in so far as the Administration deems reasonable and practicable.

### **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, except in the case of a cargo ship being converted to a passenger ship.*

2 *If a passenger ship constructed on or after 1 January 2009 but before the applicable dates in regulation 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 must 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.*

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\* *References to regulations in these Guidelines are to regulations of SOLAS chapter II-1, unless expressly provided otherwise.*

4 The Administration of a State may, if it considers that the sheltered nature and conditions of the voyage are such as to render the application of any specific requirements of this chapter unreasonable or unnecessary, exempt from those requirements individual ships or classes of ships entitled to fly the flag of that State which, in the course of their voyage, do not proceed more than 20 miles from the nearest land.

5 In the case of passenger ships which are employed in special trades for the carriage of large numbers of special trade passengers, such as the pilgrim trade, the Administration of the State whose flag such ships are entitled to fly, if satisfied that it is impracticable to enforce compliance with the requirements of this chapter, may exempt such ships from those requirements, provided that they comply fully with the provisions of:

- .1 the rules annexed to the Special Trade Passenger Ships Agreement, 1971; and
- .2 the rules annexed to the Protocol on Space Requirements for Special Trade Passenger Ships, 1973.

#### **MCA Guidance - Part A Regulation 1; Application**

**It is to be noted that if a ship has certification as a Passenger Ship only, the requirements of the regulations are still to be complied with even when, for the time being, it may be carrying less than 13 passengers. The exception to this is when the ship is also certificated other than as a passenger ship.**

#### **MCA Guidance - Exemptions**

**Pleasure vessels will only be considered for exemption on an individual case basis.**

### **Regulation 2 Definitions**

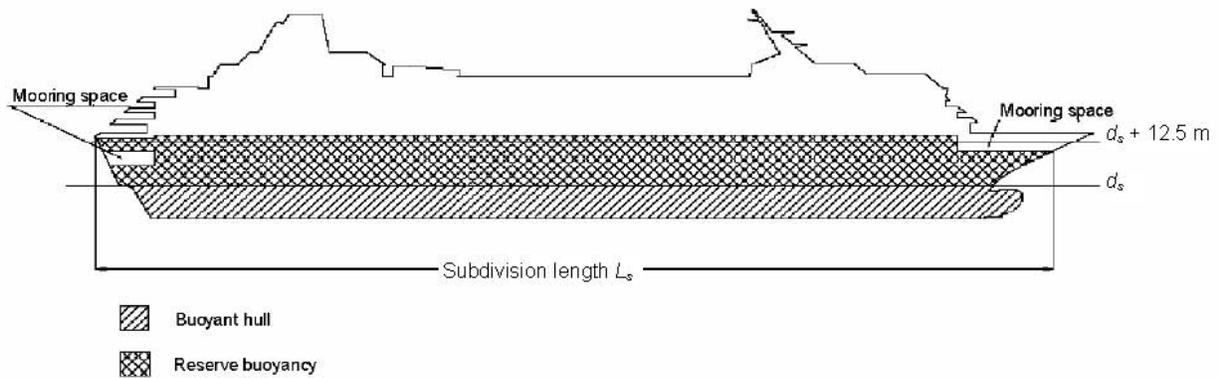
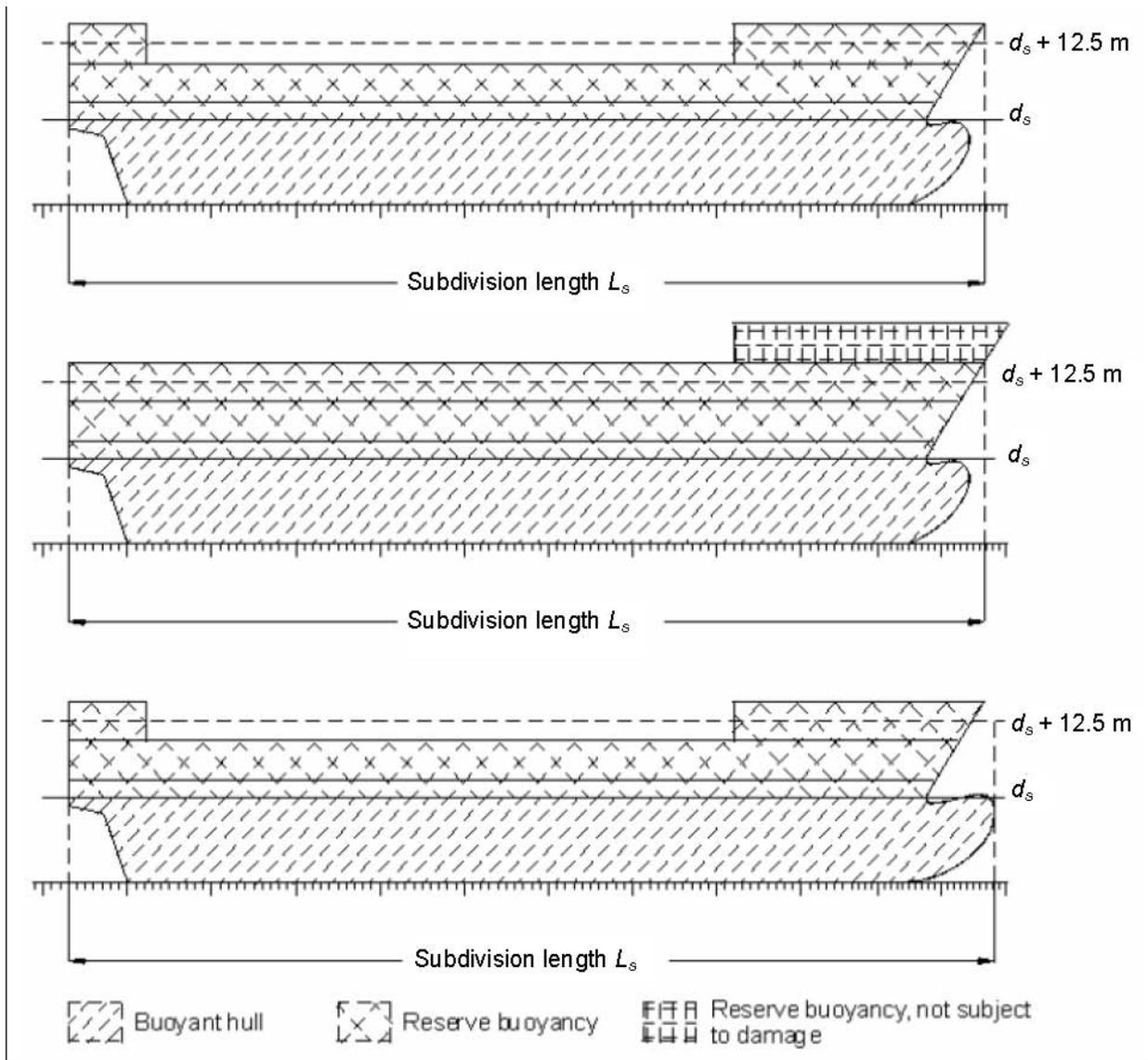
For the purpose of this chapter, unless expressly provided otherwise:

1 *Subdivision length ( $L_s$ )* of the ship is the greatest projected moulded length of that part of the ship at or below deck or decks limiting the vertical extent of flooding with the ship at the deepest subdivision draught.

#### **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*



- 2 Amidships is at the middle of the length ( $L$ ).
- 3 *Aft terminal* is the aft limit of the subdivision length.
- 4 *Forward terminal* is the forward limit of the subdivision length.
- 5 *Length ( $L$ )* is the length as defined in the International Convention on Load Lines in force.
- 6 *Freeboard deck* is the deck as defined in the International Convention on Load Lines in force.

### **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.*

- 7 *Forward perpendicular* is the forward perpendicular as defined in the International Convention on Load Lines in force.
- 8 *Breadth ( $B$ )* is the greatest moulded breadth of the ship at or below the deepest subdivision draught.

9 *Draught ( $d$ )* is the vertical distance from the keel line at:

- .1 amidships, for ships subject to the provisions of regulation II-1/1.1.1.1; and
  - .2 the mid-point of the subdivision length ( $L_s$ ), for ships not subject to the provisions of regulation II-1/1.1.1.1 but constructed on or after 1 January 2009;
- to the waterline in question.

10 *Deepest subdivision draught ( $d_s$ )* is the summer load line draught of the ship.

11 *Light service draught ( $d_l$ )* is the service draught corresponding to the lightest anticipated loading and associated tankage, including, however, such ballast as may be necessary for stability and/or immersion. Passenger ships should include the full complement of passengers and crew on board.

### **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  $d_i$ .*

12 *Partial subdivision draught ( $d_p$ )* is the light service draught plus 60% of the difference between the light service draught and the deepest subdivision draught.

13 Trim is the difference between the draught forward and the draught aft, where the draughts are measured at the forward and aft:

.1 perpendiculars respectively, as defined in the International Convention on Load Lines in force, for ships subject to the provisions of regulation II-1/1.1.1.1; and

.2 terminals respectively, for ships not subject to the provisions of regulation II-1/1.1.1.1 but constructed on or after 1 January 2009;

disregarding any rake of keel.

14 *Permeability ( $\mu$ )* of a space is the proportion of the immersed volume of that space which can be occupied by water.

15 *Machinery spaces* are spaces between the watertight boundaries of a space containing the main and auxiliary propulsion machinery, including boilers, generators and electric motors primarily intended for propulsion. In the case of unusual arrangements, the Administration may define the limits of the machinery spaces.

16 *Weathertight* means that in any sea conditions water will not penetrate into the ship.

17 *Watertight* means having scantlings and arrangements capable of preventing the passage of water in any direction under the head of water likely to occur in intact and damaged conditions. In the damaged condition, the head of water is to be considered in the worst situation at equilibrium, including intermediate stages of flooding.

18 *Design pressure* means the hydrostatic pressure for which each structure or appliance assumed watertight in the intact and damage stability calculations is designed to withstand.

19 *Bulkhead deck* in a passenger ship means the uppermost deck:

.1 to which the main bulkheads and the ship's shell are carried watertight, for ships subject to the provisions of regulation II-1/1.1.1.1; and

- .2 at any point in the subdivision length ( $L_s$ ) to which the main bulkheads and the ship's shell are carried watertight and the lowermost deck from which passenger and crew evacuation will not be impeded by water in any stage of flooding for damage cases defined in regulation 8 and in part B-2 of this chapter, for ships not subject to the provisions of regulation II-1/1.1.1.1 but constructed on or after 1 January 2009.

The bulkhead deck may be a stepped deck. In a cargo ship not subject to the provisions of regulation II-1/1.1.1.1 but constructed on or after 1 January 2009, the freeboard deck may be taken as the bulkhead deck.

### **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.*

20 *Deadweight* is the difference in tonnes between the displacement of a ship in water of a specific gravity of 1.025 at the draught corresponding to the assigned summer freeboard and the lightweight of the ship.

21 *Lightweight* is the displacement of a ship in tonnes without cargo, fuel, lubricating oil, ballast water, fresh water and feedwater in tanks, consumable stores, and passengers and crew and their effects.

22 *Oil tanker* is the oil tanker defined in regulation 1 of Annex I of the Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, 1973.

23 *Ro-ro passenger ship* means a passenger ship with ro-ro spaces or special category spaces as defined in regulation II-2/3.

24 *Bulk carrier* means a bulk carrier as defined in regulation XII/1.1.

25 *Keel line* is a line parallel to the slope of the keel passing amidships through:

- .1 the top of the keel at centreline or line of intersection of the inside of shell plating with the keel if a bar keel extends below that line, on a ship with a metal shell; or
- .2 in wood and composite ships, the distance is measured from the lower edge of the keel rabbet. When the form at the lower part of the midship section is of a hollow character, or where thick garboards are fitted, the distance is measured from the point where the line of the flat of the bottom continued inward intersects the centreline amidships.

**26** *2008 IS Code* means the International Code on Intact Stability, 2008, consisting of an introduction, part A (the provisions of which shall be treated as mandatory) and part B (the provisions of which shall be treated as recommendatory), as adopted by Resolution MSC.267(85), provided that:

- .1 amendments to the introduction and part A of the Code are adopted, brought into force and take effect in accordance with article VIII of the present Convention concerning the amendment procedures applicable to the Annex other than Chapter I: and
- .2 amendments to part B of the Code are adopted by the Maritime Safety Committee in accordance with its Rules of Procedure.

**27** *Goal-based Ship Construction Standards for Bulk Carriers and Oil Tankers* means the Goal-Based Ship Construction Standards for Bulk Carriers and Oil Tankers, adopted by the Maritime Safety Committee by resolution MSC.287(87), as may be amended by the Organization, provided that such amendments are adopted, brought into force and take effect in accordance with the provisions of article VIII of the present Convention concerning the amendment procedures applicable to the annex other than chapter 1 thereof.

**28** *IGF Code* means the International Code of safety for ships using gases or other low-flashpoint fuels as adopted by the Maritime Safety Committee of the Organization by resolution MSC.391(95), as may be amended by the Organization, provided that such amendments are adopted, brought into force and take effect in accordance with the provisions of article VIII of the present Convention concerning the amendment procedures applicable to the annex other than chapter I.

**29** *Low-flashpoint fuel* means gaseous or liquid fuel having a flashpoint lower than otherwise permitted under regulation II-2/4.2.1.1.

### **Regulation 3**

**Definitions relating to parts C, D and E are omitted (not stability related)**

**PART B**  
**SUBDIVISION AND STABILITY**

**Regulation 4**

**General**

1 Unless expressly provided otherwise, the requirements in parts B-1 to B-4 shall apply to passenger ships.

2 For cargo ships, the requirements in parts B-1 to B-4 shall apply as follows:

2.1 In part B-1:

2.1.1 Unless expressly provided otherwise, regulation 5 shall apply to cargo ships and regulation 5-1 shall apply to cargo ships other than tankers, as defined in regulation 1/2(h);

2.1.2 Regulation 6 to regulation 7-3 shall apply to cargo ships having a length (*L*) of 80 m and upwards, but may exclude those ships subject to the following instruments and shown to comply with the subdivision and damage stability requirements of that instrument:

- .1 Annex I to MARPOL, except that combination carriers (as defined in SOLAS regulation II-2/3.14) with type B freeboards shall be in compliance with regulation 6 to regulation 7-3\*; or
- .2 the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code)\*; or
- .3 the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code)\*; or
- .4 the damage stability requirements of regulation 27 of the 1966 Load Lines Convention as applied in compliance with resolutions A.320(IX) and A.514(13), provided that in the case of cargo ships to which regulation 27(9) applies, main transverse watertight bulkheads, to be considered effective, are spaced according to paragraph (12)(f) of resolution A.320(IX), except that ships intended for the carriage of deck cargo shall be in compliance with regulation 6 to regulation 7-3; or

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\* Refer to *Guidelines for verification of damage stability requirements for tankers* (MSC.1/Circ.1461).

- .5 the damage stability requirements of regulation 27 of the 1988 Load Lines Protocol, except that ships intended for the carriage of deck cargo shall be in compliance with regulation 6 to regulation 7-3; or
- .6 the subdivision and damage stability standards in other instruments\*\* developed by the Organization.

2.2 Unless expressly provided otherwise, the requirements in parts B-2 and B-4 shall apply to cargo ships.

3 The Administration may, for a particular ship or group of ships, accept alternative methodologies if it is satisfied that at least the same degree of safety as represented by these regulations is achieved. Any Administration which allows such alternative methodologies shall communicate to the Organization particulars thereof.

4 Ships shall be as efficiently subdivided as is possible having regard to the nature of the service for which they are intended. The degree of subdivision shall vary with the subdivision length ( $L_s$ ) of the ship and with the service, in such manner that the highest degree of subdivision corresponds with the ships of greatest subdivision length ( $L_s$ ), primarily engaged in the carriage of passengers.

5 Where it is proposed to fit decks, inner skins or longitudinal bulkheads of sufficient tightness to seriously restrict the flow of water, the Administration shall be satisfied that proper consideration is given to beneficial or adverse effects of such structures in the calculations.

#### **Regulation 4.45**

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

\*\* .1 For offshore supply vessels of not more than 100 m in length ( $L$ ), the *Guidelines for the design and construction of offshore supply vessels, 2006* (resolution MSC.235(82), as amended by resolution MSC.335(90)); or

.2 For special purpose ships, the *Code of safety for special purpose ships, 2008* (resolution MSC.266(84)), as amended.

**PART B-1****STABILITY****Regulation 5  
Intact stability**

1 Every passenger ship regardless of size and every cargo ship having a length ( $L$ ) of 24 m and upwards, shall be inclined upon its completion. The lightship displacement and the longitudinal, transverse and vertical position of its centre of gravity shall be determined. In addition to any other applicable requirements of the present regulations, ships having a length of 24 m and upwards shall as a minimum comply with the requirements of part A of the 2008 IS Code.

2 The Administration may allow the inclining test of an individual cargo ship to be dispensed with provided basic stability data are available from the inclining test of a sister ship and it is shown to the satisfaction of the Administration that reliable stability information for the exempted ship can be obtained from such basic data, as required by regulation 5-1. A lightweight survey shall be carried out upon completion and the ship shall be inclined whenever, in comparison with the data derived from the sister ship, a deviation from the lightship displacement exceeding 1% for ships of 160 m or more in length and 2% for ships of 50 m or less in length and as determined by linear interpolation for intermediate lengths or a deviation from the lightship longitudinal centre of gravity exceeding 0.5% of  $L$  is found.

**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.

3 The Administration may also allow the inclining test of an individual ship or class of ships especially designed for the carriage of liquids or ore in bulk to be dispensed with when reference to existing data for similar ships clearly indicates that due to the ship's proportions and arrangements more than sufficient metacentric height will be available in all probable loading conditions.

4 Where any alterations are made to a ship so as to materially affect the stability information supplied to the master, amended stability information shall be provided. If necessary, the ship shall be re-inclined. The ship shall be re-inclined if anticipated deviations exceed one of the values specified in paragraph 5.

#### **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 alteration 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.*

5 At periodical intervals not exceeding five years, a lightweight survey shall be carried out on all passenger ships to verify any changes in lightship displacement and longitudinal centre of gravity. The ship shall be re-inclined whenever, in comparison with the approved stability information, a deviation from the lightship displacement exceeding

2% or a deviation of the longitudinal centre of gravity exceeding 1% of  $L$  is found or anticipated.

### **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.*

6 Every ship shall have scales of draughts marked clearly at the bow and stern. In the case where the draught marks are not located where they are easily readable, or operational constraints for a particular trade make it difficult to read the draught marks, then the ship shall also be fitted with a reliable draught indicating system by which the bow and stern draughts can be determined.

### **Regulation 5-1**

#### **Stability information to be supplied to the master \***

1 The master shall be supplied with such information to the satisfaction of the Administration as is necessary to enable him by rapid and simple processes to obtain accurate guidance as to the stability of the ship under varying conditions of service. A copy of the stability information shall be furnished to the Administration.

2 The information should include:

- .1 curves or tables of minimum operational metacentric height ( $GM$ ) and maximum permissible trim versus draught which assures compliance with the intact and damage stability requirements where applicable, alternatively corresponding curves or tables of the maximum allowable vertical centre of gravity ( $KG$ ) and maximum permissible trim versus draught, or with the equivalents of either of these curves or tables;
- .2 instructions concerning the operation of cross-flooding arrangements; and
- .3 all other data and aids which might be necessary to maintain the required intact stability according to the requirements of part A of the 2008 IS Code and stability after damage.

\* Refer also to the *Guidelines for the preparation of intact stability information* (MSC/Circ.456) ~~Guidance on the intact stability of existing tankers during transfer operations~~ (MSC/Circ.706); and the *Revised guidance to the master for avoiding dangerous situations in adverse weather and sea conditions* (MSC.1/Circ.1228).

3 The intact and damage stability information required by regulation 5-1.2 shall be presented as consolidated data and encompass the full operating range of draught and trim. Applied trim values shall coincide in all stability information intended for use on board. Information not required for determination of stability and trim limits should be excluded from this information.

### **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.*

4 If the damage stability is calculated in accordance with regulation 6 to regulation 7-3 and, if applicable, with regulations 8 and 9.8, a stability limit curve is to be determined using linear interpolation between the minimum required  $GM$  assumed for each of the three draughts  $d_s$ ,  $d_p$  and  $d_l$ . When additional subdivision indices are calculated for different trims, a single envelope curve based on the minimum values from these calculations shall be presented. When it is intended to develop curves of maximum permissible  $KG$  it shall be ensured that the resulting maximum  $KG$  curves correspond with a linear variation of  $GM$ .

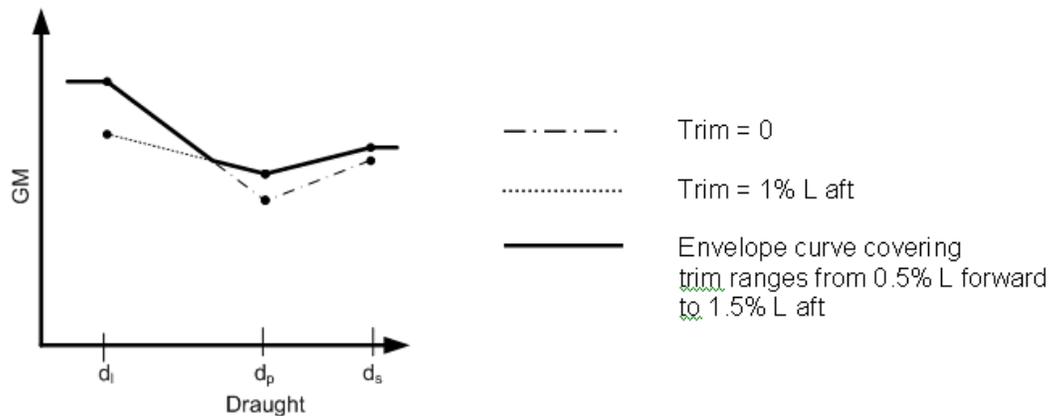
### **Regulation ~~5-1.3~~ and 5-1.4 (see also regulation 7.2)**

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  $\pm 0.5\%$  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 ~~actual~~ ~~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 ~~of partial subdivision draught and deepest subdivision draught~~ 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 ~~one~~ 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 at 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.



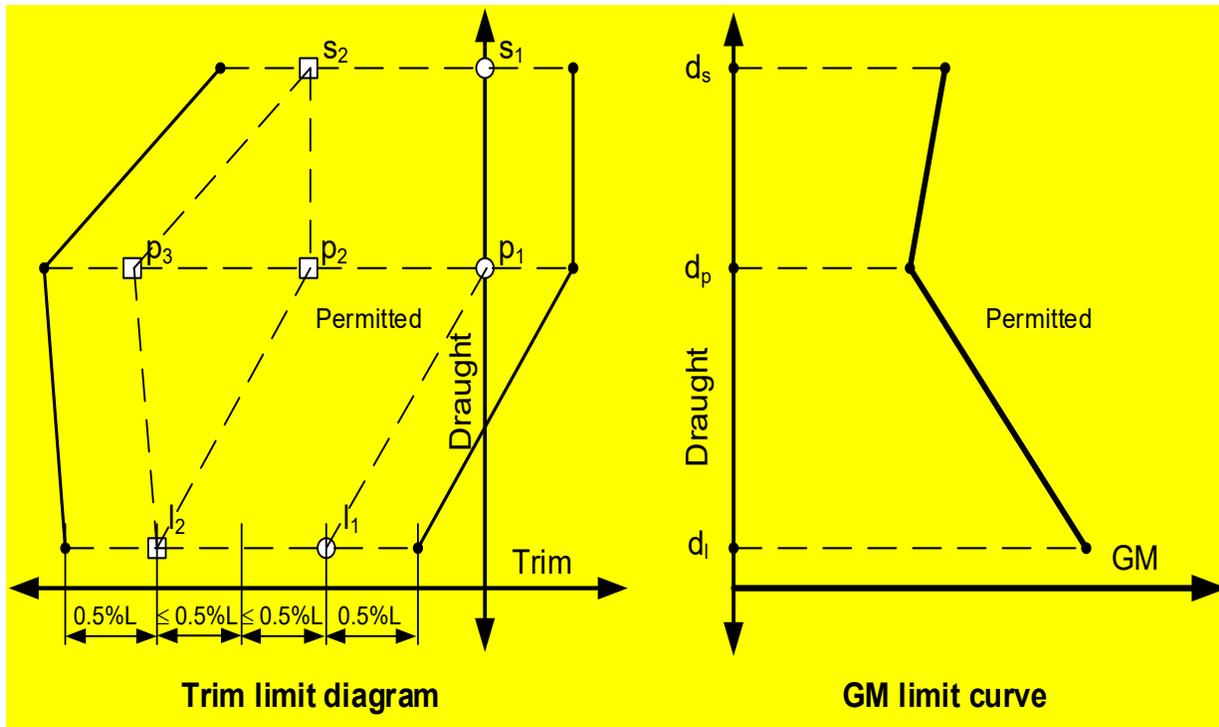
4. Temporary loading conditions may occur with a draught less than the light service draught  $d_l$  due to ballast water exchange requirements, etc. In these cases, for draughts below  $d_l$ , the GM limit value at  $d_l$  is to be used.

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.

5. As an alternative to a single envelope curve, the calculations for additional trims may be carried out with one common GM for all of the trims assumed at each subdivision draught. The lowest values of each partial index  $A_s$ ,  $A_p$  and  $A_l$  across these trims shall then be used in the summation of the attained subdivision index A according to regulation 7.1. This will result in one GM limit curve based on the GM used at each draught. A trim limit diagram showing the assumed trim range shall be developed.

### 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  $s_3, p_3, l_2$ . 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



6 When curves or tables of minimum operational metacentric height ( $GM$ ) or maximum allowable  $KG$  versus draught are not provided, the master shall ensure that the operating condition does not deviate from approved loading conditions or verify by calculation that the stability requirements are satisfied for this loading condition.

**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  $R$**

1 The subdivision of a ship is considered sufficient if the attained subdivision index  $A$ , determined in accordance with regulation 7, is not less than the required subdivision index  $R$  calculated in accordance with this regulation and if, in addition, the partial indices  $A_s$ ,  $A_p$  and  $A_l$  are not less than  $0.9R$  for passenger ships and  $0.5R$  for cargo ships.

**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.*

2 For ships to which the damage stability requirements of this part apply, the degree of subdivision to be provided shall be determined by the required subdivision index  $R$ , as follows:

.1 In the case of cargo ships greater than 100 m in length ( $L_s$ ):

$$R = 1 - \frac{128}{L_s + 152}$$

.2 In the case of cargo ships not less than 80 m in length ( $L$ ) and not greater than 100 m in length ( $L_s$ ):

$$R = 1 - \left[ 1 / \left( 1 + \frac{L_s \times R_o}{100 \times (1 - R_o)} \right) \right]$$

where  $R_o$  is the value  $R$  as calculated in accordance with the formula in subparagraph .1.

.3 In the case of passenger ships:

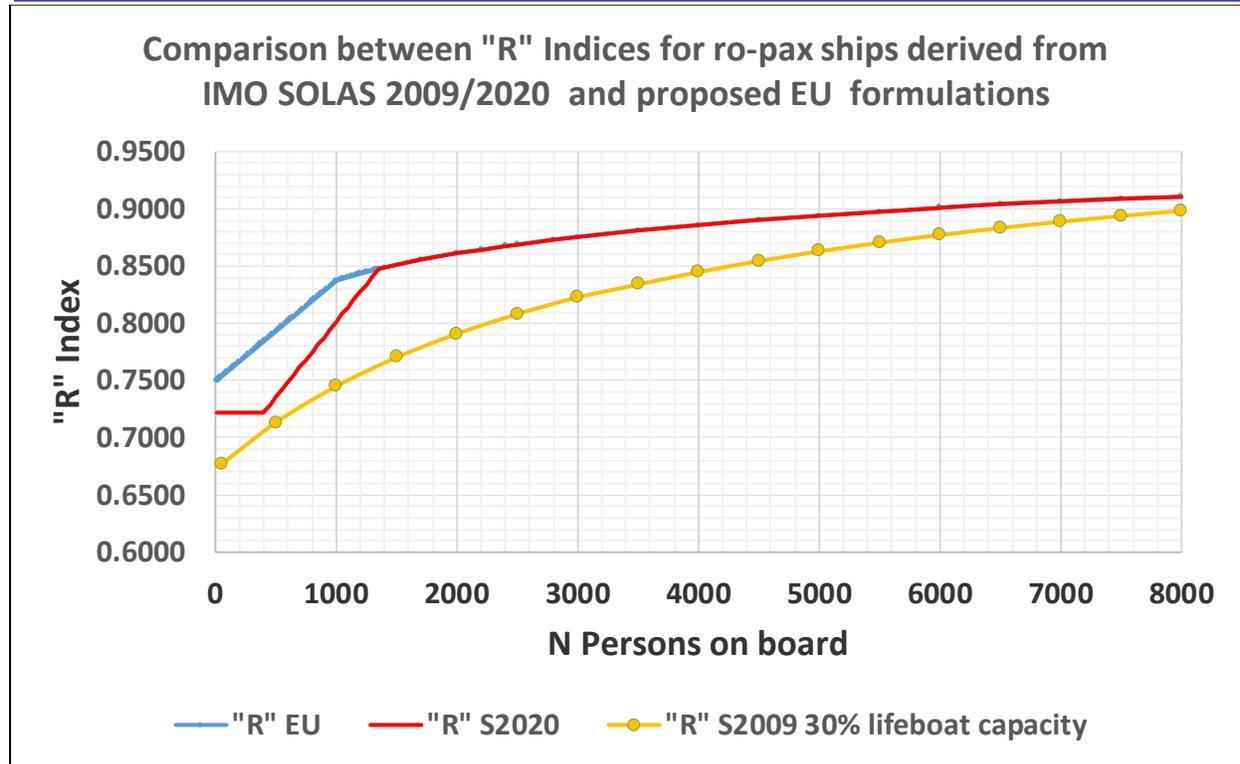
<b>Persons on Board</b>	<b>R</b>
$N < 400$	$R = 0.722$
$400 \leq N \leq 1,350$	$R = N / 7,580 + 0.66923$
$1,350 < N \leq 6,000$	$R = 0.0369 \times \ln(N + 89.048) + 0.579$
$N > 6,000$	$R = 1 - (852.5 + 0.03875 \times N) / (N + 5,000)$

Where:

$N$  = total number of persons on board

.4 Deleted

**MCA Guidance - Ro-Ro Passenger Ships with  $N \leq 1350$  operating in EU waters**



<i>Persons on Board N</i>	<i>R (EU)</i>
$N < 1000$	$R = 0.000088 * N + 0.7488$
$1000 < N \leq 6,000$	$R = 0.0369 \times \ln(N + 89.048) + 0.579$
$N > 6,000$	$R = 1 - (C1 * 6200) / (4 * N + 20000)$ with $C1 = 0.8 - (0.25 / 10000) * (10000 - N)$

A decision on the future of the Stockholm Agreement was agreed on March 14 2023 in the European Parliament (ref. [P9\\_TA\(2023\)0064 Ro-ro passenger ships: stability requirements](#)). The MCA is in the process of producing a new Merchant Shipping Notice (MSN) to explain these changes as they involve a deviation from SOLAS Chapter II-1 for EU flag ro-ro passenger ships carrying 1350 or fewer persons on board. “New” UK flag ro-ro passenger ships to which this applies and constructed after the date of entry into force of these EU amendments will have to comply with them in order to trade in EU waters. The date of entry into force of these amendments to the EU Directive 2003/25/EC is not known at the time of writing (April 2023).

## Regulation 7

### Attained subdivision index A

1 An attained subdivision index A is obtained by the summation of the partial indices  $A_s$ ,  $A_p$  and  $A_l$ , weighted as shown and calculated for the draughts  $d_s$ ,  $d_p$  and  $d_l$  defined in regulation 2 in accordance with the following formula:

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

Each partial index is a summation of contributions from all damage cases taken in consideration, using the following formula:

$$A = \sum p_i s_i$$

where:

- $i$  represents each compartment or group of compartments under consideration,
- $p_i$  accounts for the probability that only the compartment or group of compartments under consideration may be flooded, disregarding any horizontal subdivision, as defined in regulation 7-1,
- $s_i$  accounts for the probability of survival after flooding the compartment or group of compartments under consideration, and includes the effect of any horizontal subdivision, as defined in regulation 7-2.

### **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; 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.

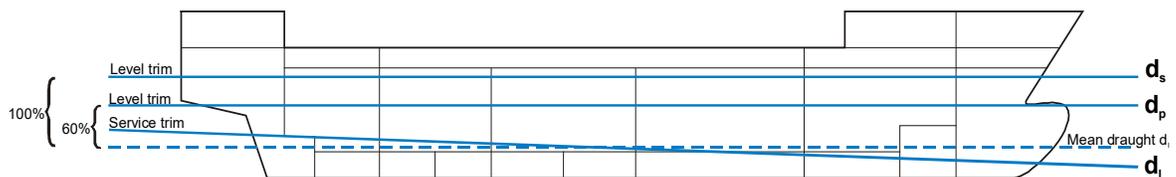
4. The index  $A$  is divided into partial factors as follows:

$p_i$  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 the 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 GMs.

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  $d_i$  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  $d_i$  (and the subsequent change in the draught  $d_p$ ) are acceptable if they are due to small differences in the lightship characteristics that 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.

2 As a minimum, the calculation of A shall be carried out at the level trim for the deepest subdivision draught  $d_s$  and the partial subdivision draught  $d_p$ . The estimated service trim may be used for the light service draught  $d_l$ . If, in any service condition within the draught range from  $d_s$  to  $d_l$ , the trim variation in comparison with the calculated trims is greater than 0.5% of L, one or more additional calculations of A are to be performed for the same draughts but including sufficient trims to ensure that, for all intended service conditions, the difference in trim in comparison with the reference trim used for one calculation will be not more than 0.5% of L. Each additional calculation of A shall comply with regulation 6.1.

### **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.

3 When determining the positive righting lever (GZ) of the residual stability curve in the intermediate and final equilibrium stages of flooding, the displacement used should be that of the intact loading condition. All calculations should be done with the ship freely trimming.

4 The summation indicated by the above formula shall be taken over the ship's subdivision length ( $L_s$ ) for all cases of flooding in which a single compartment or two or more adjacent compartments are involved. In the case of unsymmetrical arrangements, the calculated  $A$  value should be the mean value obtained from calculations involving both sides. Alternatively, it should be taken as that corresponding to the side which evidently gives the least favourable result.

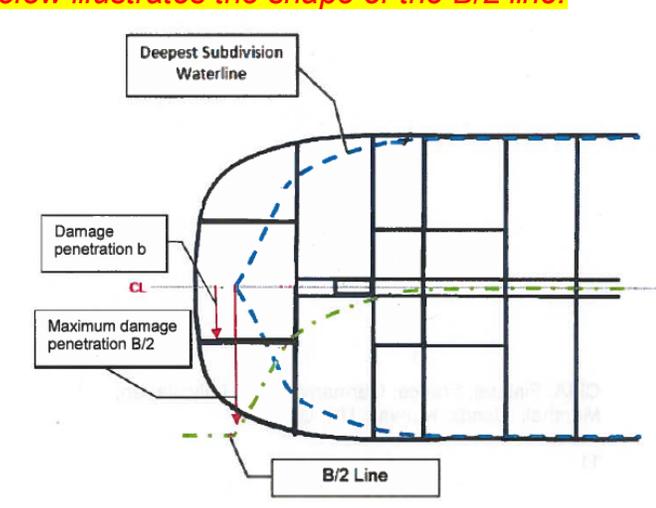
5 Wherever wing compartments are fitted, contribution to the summation indicated by the formula shall be taken for all cases of flooding in which wing compartments are involved. Additionally, cases of simultaneous flooding of a wing compartment or group of compartments and the adjacent inboard compartment or group of compartments but excluding damage of transverse extent greater than one half of the ship breadth  $B$ , may be added. For the purpose of this regulation, transverse extent is measured inboard from ship's side, at right angles to the centreline at the level of the deepest subdivision draught.

### 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 ~~to the centreline~~ 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 the centreline. 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.*

6 In the flooding calculations carried out according to the regulations, only one breach of the hull and only one free surface need to be assumed. The assumed vertical extent of damage is to extend from the baseline upwards to any watertight horizontal subdivision above the waterline or higher. However, if a lesser extent of damage will give a more severe result, such extent is to be assumed.

#### **Regulation 7.6**

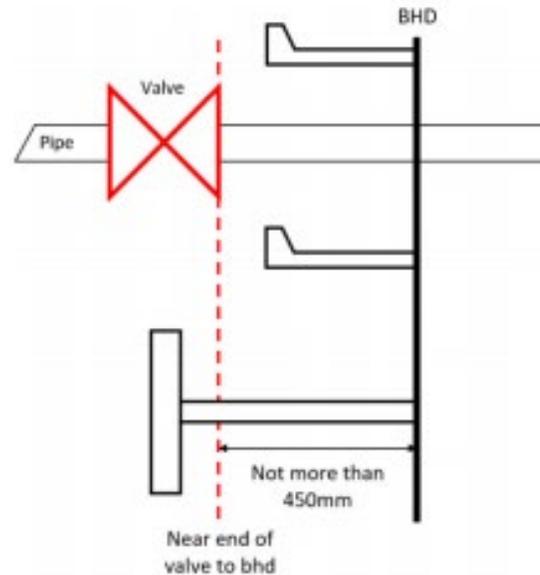
*Refer to the Explanatory Notes for Regulation 7-2.2 for the treatment of free surfaces during all stages of flooding.*

7 If pipes, ducts or tunnels are situated within the assumed extent of damage, arrangements are to be made to ensure that progressive flooding cannot thereby extend to compartments other than those assumed flooded. However, the Administration may permit minor progressive flooding if it is demonstrated that its effects can be easily controlled and the safety of the ship is not impaired.

#### **Regulation 7.7**

1. *This explanatory note only applies to ships for which the building contract is placed on or after 1 January 2020 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 (see figure below).*



**23.** 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  $710 \text{ mm}^2$  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

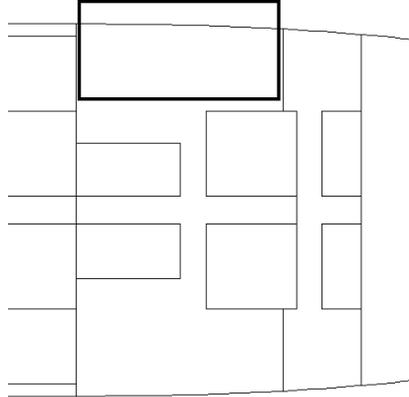
#### Calculation of the factor $p_i$

##### General

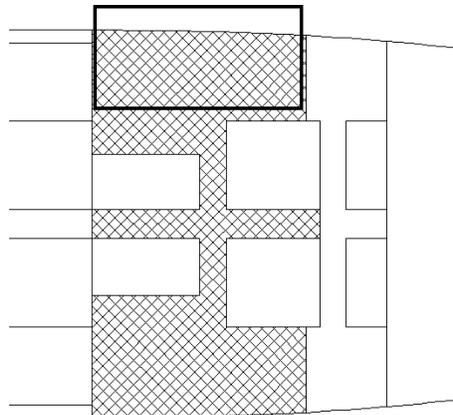
1. The definitions below are intended to be used for the application of part B-1 only.
2. In regulation 7-1, the words “compartment” and “group of compartments” should be understood to mean “zone” and “adjacent zones”.
3. Zone – a longitudinal interval of the ship within the subdivision length.
4. Room – 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:



1 The factor  $p_i$  for a compartment or group of compartments shall be calculated in accordance with paragraphs 1.1 and 1.2 using the following notations:

- $j$  = the aftmost damage zone number involved in the damage starting with No. 1 at the stern;
- $n$  = the number of adjacent damage zones involved in the damage;
- $k$  = the number of a particular longitudinal bulkhead as barrier for transverse penetration in a damage zone counted from shell towards the centre line. The shell has  $k = 0$ ;
- $x_1$  = the distance from the aft terminal of  $L_s$  to the aft end of the zone in question;

$x_2$  = the distance from the aft terminal of  $L_s$  to the forward end of the zone in question;

$b$  = the mean transverse distance in metres measured at right angles to the centreline at the deepest subdivision draught between the shell and an assumed vertical plane extended between the longitudinal limits used in calculating the factor  $p_i$  and which is a tangent to, or common with, all or part of the outermost portion of the longitudinal bulkhead under consideration. This vertical plane shall be so orientated that the mean transverse distance to the shell is a maximum, but not more than twice the least distance between the plane and the shell. If the upper part of a longitudinal bulkhead is below the deepest subdivision draught the vertical plane used for determination of  $b$  is assumed to extend upwards to the deepest subdivision waterline. In any case,  $b$  is not to be taken greater than  $B/2$ .

If the damage involves a single zone only:

$$p_i = p(x_{1j}, x_{2j}) \cdot [r(x_{1j}, x_{2j}, b_k) - r(x_{1j}, x_{2j}, b_{k-1})]$$

If the damage involves two adjacent zones:

$$\begin{aligned} p_i = & p(x_{1j}, x_{2_{j+1}}) \cdot [r(x_{1j}, x_{2_{j+1}}, b_k) - r(x_{1j}, x_{2_{j+1}}, b_{k-1})] \\ & - p(x_{1j}, x_{2j}) \cdot [r(x_{1j}, x_{2j}, b_k) - r(x_{1j}, x_{2j}, b_{k-1})] \\ & - p(x_{1_{j+1}}, x_{2_{j+1}}) \cdot [r(x_{1_{j+1}}, x_{2_{j+1}}, b_k) - r(x_{1_{j+1}}, x_{2_{j+1}}, b_{k-1})] \end{aligned}$$

If the damage involves three or more adjacent zones:

$$\begin{aligned} p_i = & p(x_{1j}, x_{2_{j+n-1}}) \cdot [r(x_{1j}, x_{2_{j+n-1}}, b_k) - r(x_{1j}, x_{2_{j+n-1}}, b_{k-1})] \\ & - p(x_{1j}, x_{2_{j+n-2}}) \cdot [r(x_{1j}, x_{2_{j+n-2}}, b_k) - r(x_{1j}, x_{2_{j+n-2}}, b_{k-1})] \\ & - p(x_{1_{j+1}}, x_{2_{j+n-1}}) \cdot [r(x_{1_{j+1}}, x_{2_{j+n-1}}, b_k) - r(x_{1_{j+1}}, x_{2_{j+n-1}}, b_{k-1})] \\ & + p(x_{1_{j+1}}, x_{2_{j+n-2}}) \cdot [r(x_{1_{j+1}}, x_{2_{j+n-2}}, b_k) - r(x_{1_{j+1}}, x_{2_{j+n-2}}, b_{k-1})] \end{aligned}$$

and where  $r(x_1, x_2, b_0) = 0$

1.1 The factor  $p(x1, x2)$  is to be calculated according to the following formulae:

Overall normalized max damage length:	$J_{\max}$	=	10/33
Knuckle point in the distribution:	$J_{kn}$	=	5/33
Cumulative probability at $J_{kn}$ :	$p_k$	=	11/12
Maximum absolute damage length:	$l_{\max}$	=	60 m
Length where normalized distribution ends:	$L^*$	=	260 m

Probability density at  $J = 0$ :

$$b_0 = 2 \left( \frac{p_k}{J_{kn}} - \frac{1 - p_k}{J_{\max} - J_{kn}} \right)$$

When  $L_s \leq L^*$ :

$$J_m = \min \left\{ J_{\max}, \frac{l_{\max}}{L_s} \right\}$$

$$J_k = \frac{J_m}{2} + \frac{1 - \sqrt{1 + (1 - 2p_k)b_0 J_m + \frac{1}{4}b_0^2 J_m^2}}{b_0}$$

$$b_{12} = b_0$$

When  $L_s > L^*$ :

$$J_m^* = \min \left\{ J_{\max}, \frac{l_{\max}}{L^*} \right\}$$

$$J_k^* = \frac{J_m^*}{2} + \frac{1 - \sqrt{1 + (1 - 2p_k)b_0 J_m^* + \frac{1}{4}b_0^2 J_m^{*2}}}{b_0}$$

$$J_m = \frac{J_m^* \cdot L_s^*}{L_s}$$

$$J_k = \frac{J_k^* \cdot L_s^*}{L_s}$$

$$b_{12} = 2 \left( \frac{p_k}{J_k} - \frac{1 - p_k}{J_m - J_k} \right)$$

$$b_{11} = 4 \frac{1 - p_k}{(J_m - J_k)J_k} - 2 \frac{p_k}{J_k^2}$$

$$b_{21} = -2 \frac{1 - p_k}{(J_m - J_k)^2}$$

$$b_{22} = -b_{21}J_m$$

The non-dimensional damage length:

$$J = \frac{(x2 - x1)}{L_s}$$

The normalized length of a compartment or group of compartments:

$J_n$  is to be taken as the lesser of  $J$  and  $J_m$

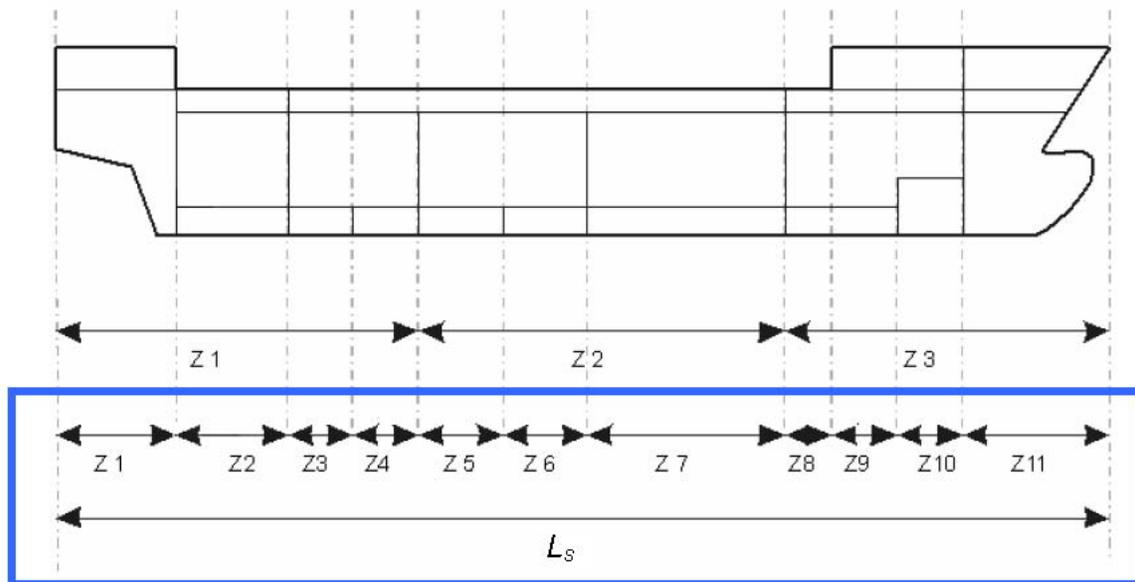
### **Regulation 7-1.1.1**

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  $L_s^*$  (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 extremes for the actual hull 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 must be balanced against extra computing time. The figure below shows different longitudinal zone divisions of the length  $L_s$ .



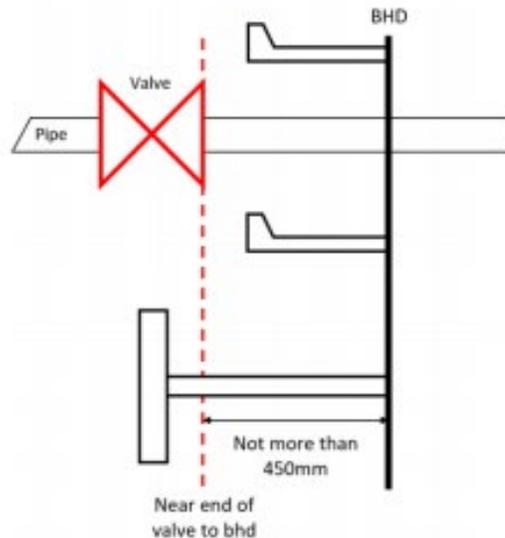
4. The first example is a very rough division into three zones of approximately the same size with limits where longitudinal subdivision is established. The probability that the ship will survive a damage in one of the three zones is expected to be low (i.e. the s-factor is low or zero) and, therefore,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

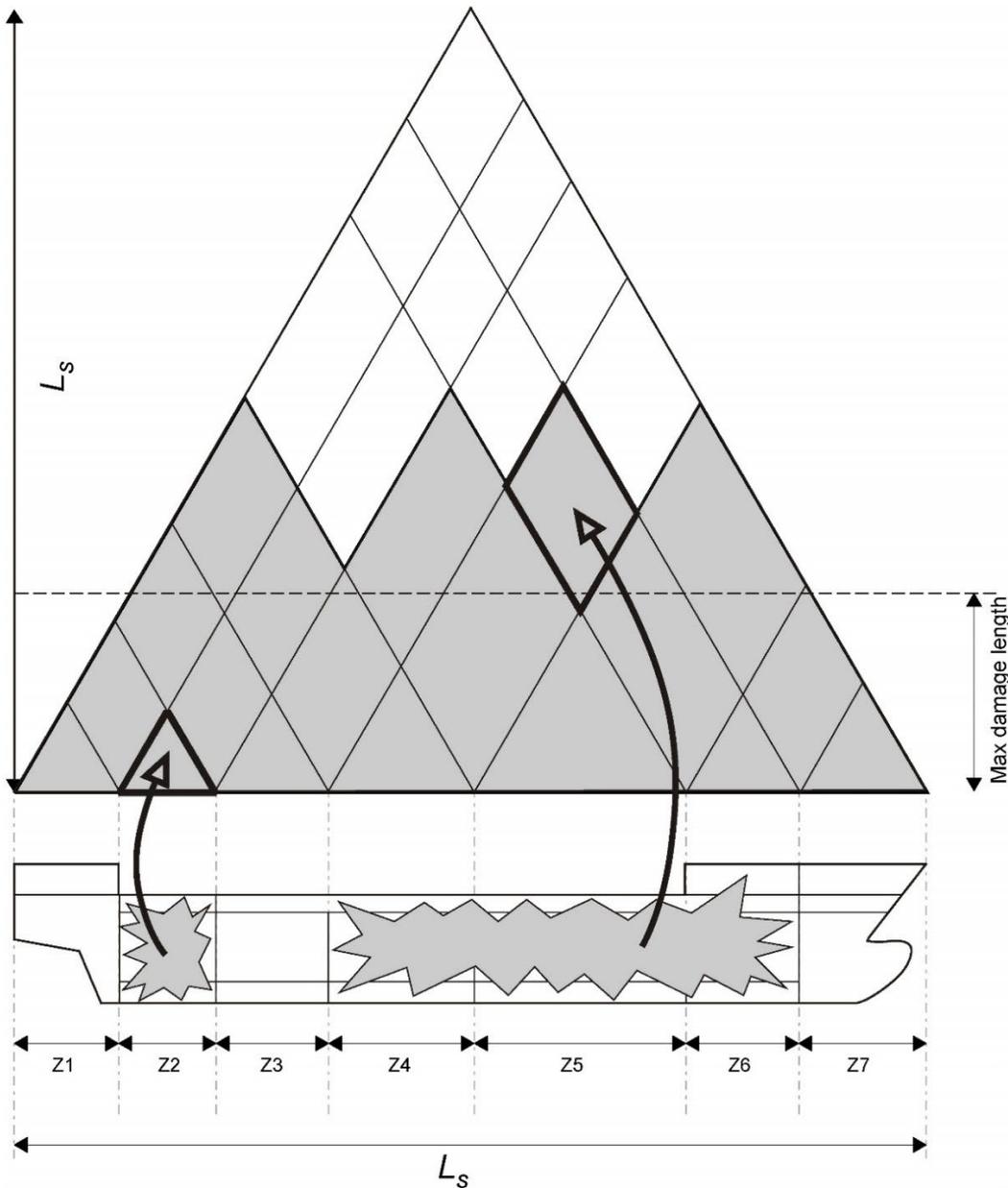
7. This explanatory note only applies to ships for which the building contract is placed on or after 1 January 2020 which are constructed before 1 January 2024. Pipes and valves directly adjacent or situated as close as practicable to a transverse bulkhead can be considered to be part of the bulkhead, 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] (see figure below).



**8-9.** For cases where the pipes and valves are outside the transverse bulkhead stiffening structure 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.

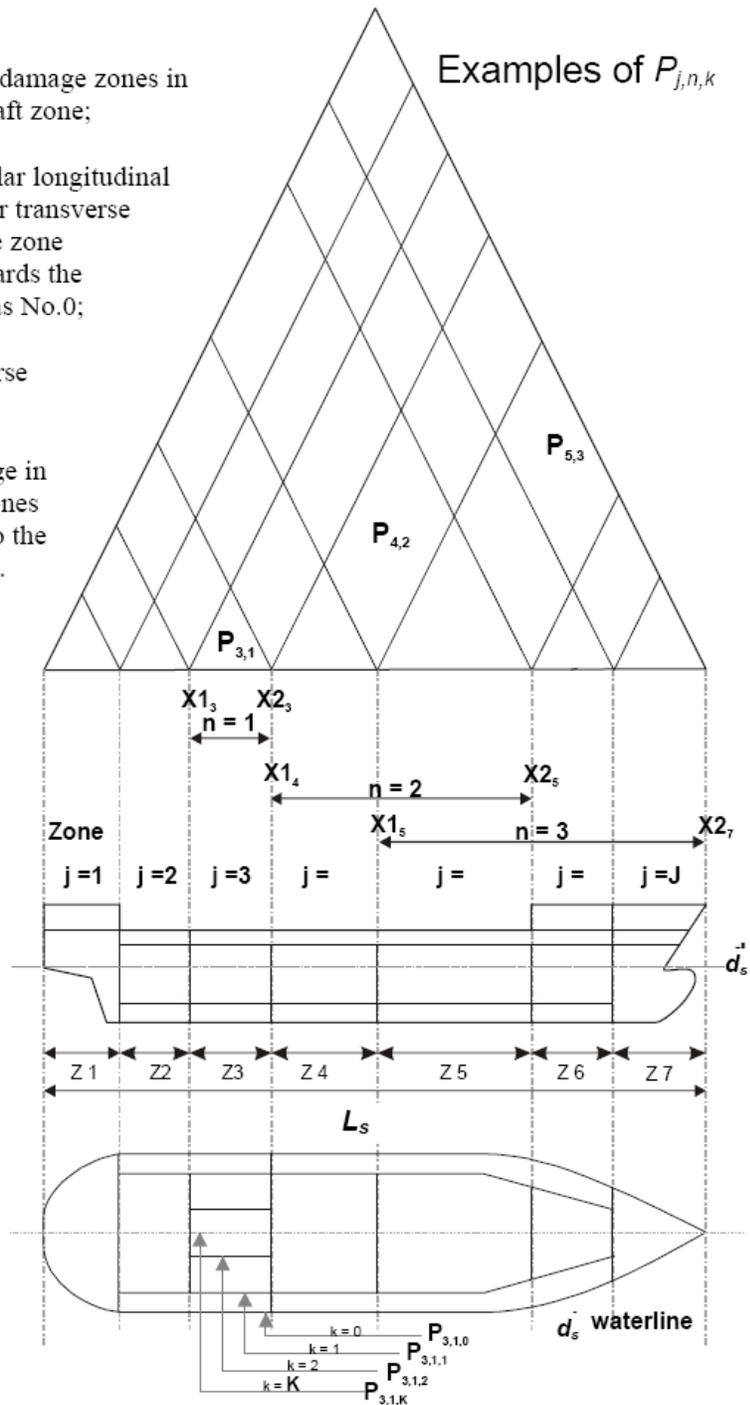


**40 11.** As an example, the triangle illustrates a damage opening the rooms in zone 2 to the sea and the parallelogram illustrates a damage where rooms in the zones 4, 5 and 6 are flooded simultaneously.

**41 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. 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:

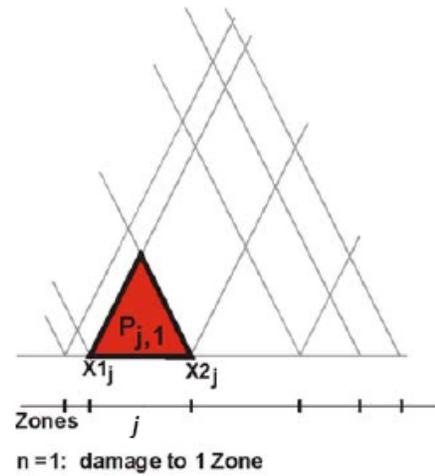
- $j$ : the damage zone number starting with No.1 at the stern;
- $n$ : the number of adjacent damage zones in question where  $j$  is the aft zone;
- $k$ : the number of a particular longitudinal bulkhead as a barrier for transverse penetration in a damage zone counted from shell towards the centreline. 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*

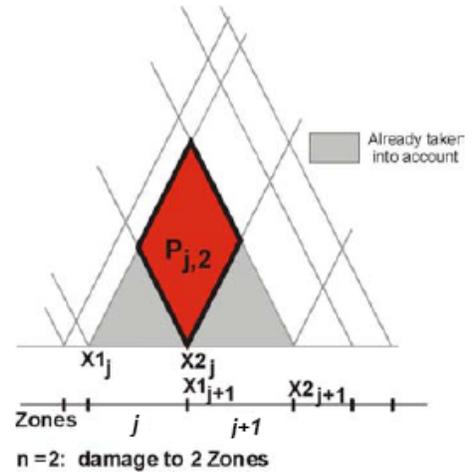
Single damage zone, pure longitudinal subdivision:

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



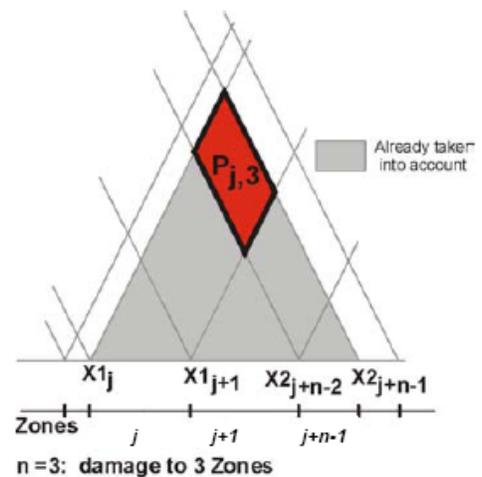
Two adjacent zones, pure longitudinal subdivision:

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



Three or more adjacent zones, pure longitudinal subdivision:

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



1.1.1 Where neither limits of the compartment or group of compartments under consideration coincides with the aft or forward terminals:

$$J = J_k:$$

$$p(x1, x2) = p_1 = \frac{1}{6} J^2 (b_{11} J + 3b_{12})$$

$$J > J_k:$$

$$p(x1, x2) = p_2 = -\frac{1}{3} b_{11} J_k^3 + \frac{1}{2} (b_{11} J - b_{12}) J_k^2 + b_{12} J J_k - \frac{1}{3} b_{21} (J_n^3 - J_k^3) + \frac{1}{2} (b_{21} J - b_{22}) (J_n^2 - J_k^2) + b_{22} J (J_n - J_k)$$

1.1.2 Where the aft limit of the compartment or group of compartments under consideration coincides with the aft terminal or the forward limit of the compartment or group of compartments under consideration coincides with the forward terminal:

$$J = J_k:$$

$$p(x1, x2) = \frac{1}{2} (p_1 + J)$$

$$J > J_k:$$

$$p(x1, x2) = \frac{1}{2} (p_2 + J)$$

1.1.3 Where the compartment or groups of compartments considered extends over the entire subdivision length ( $L_s$ ):

$$p(x1, x2) = 1$$

1.2 The factor  $r(x1, x2, b)$  shall be determined by the following formulae:

$$r(x1, x2, b) = 1 - (1 - C) \cdot \left[ 1 - \frac{G}{p(x1, x2)} \right]$$

where:

$$C = 12 \cdot J_b \cdot (-45 \cdot J_b + 4), \text{ where}$$

$$J_b = \frac{b}{15 \cdot B}$$

### **Regulation 7-1.1.2**

#### **Transverse subdivision in a damage zone**

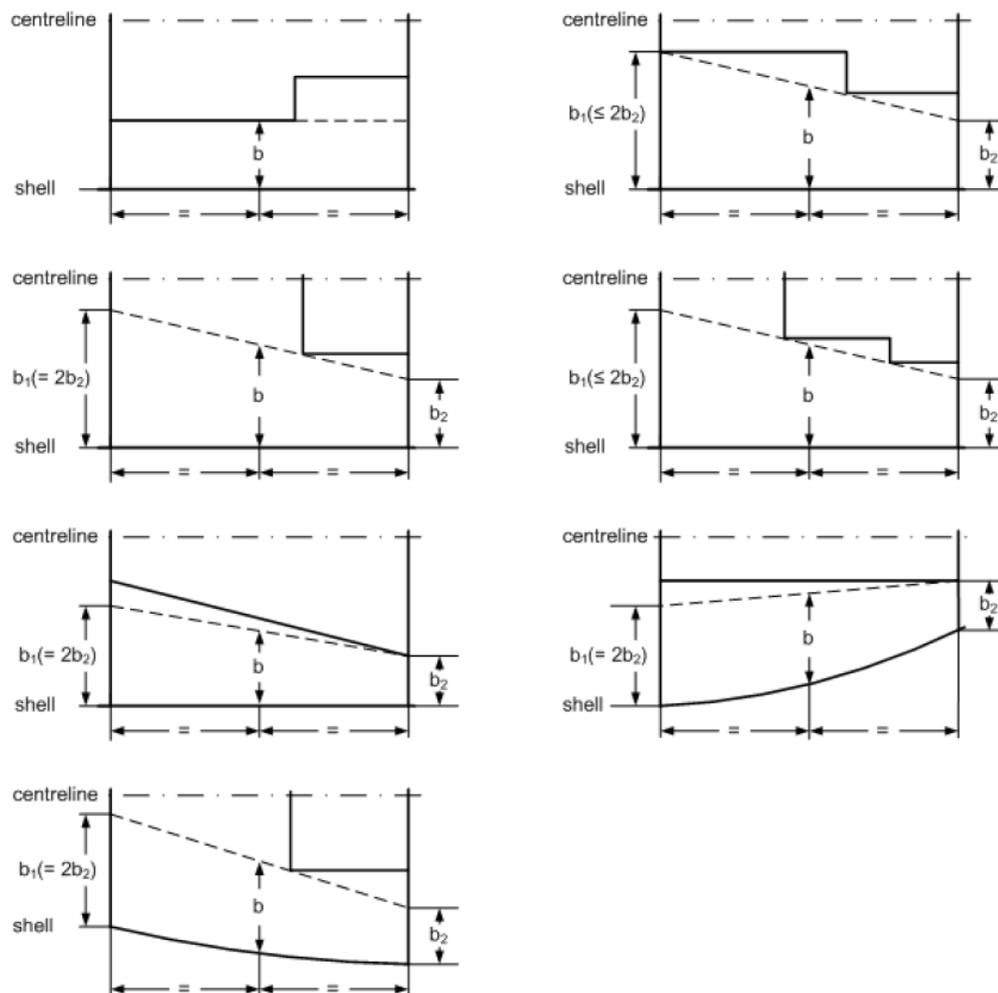
1. **Damage to the hull in a specific damage zone may just penetrate the ship's**

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  $1/2 \leq b_1 / b_2 \leq 2$ .

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.



**Regulation 7-1.1.2 (continued)**

**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.

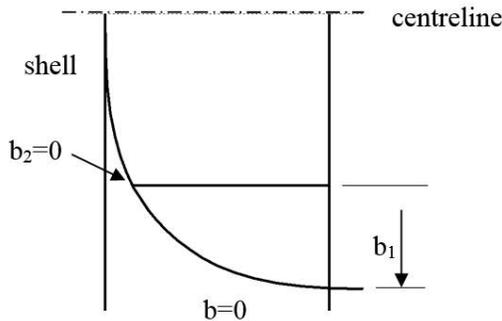


Figure 1

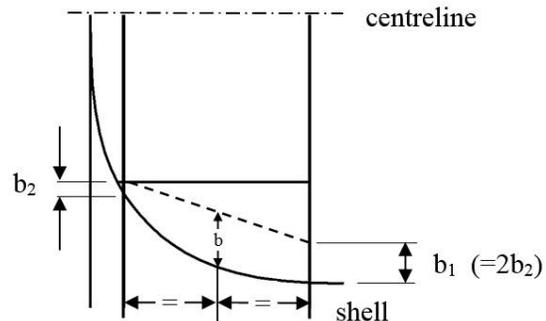


Figure 2

**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.

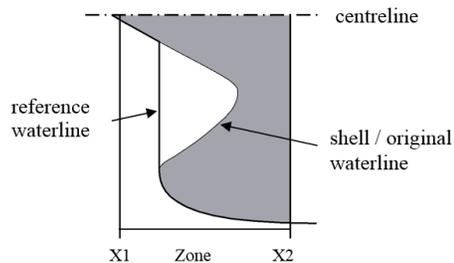


Figure 1

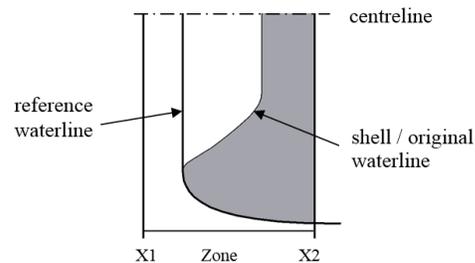


Figure 2

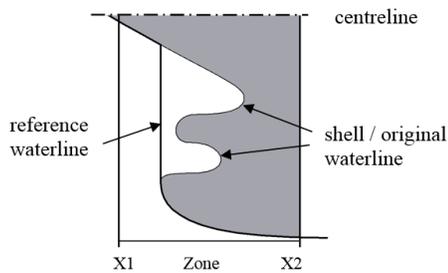


Figure 3

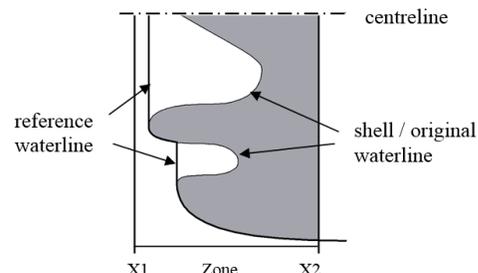


Figure 4

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:

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

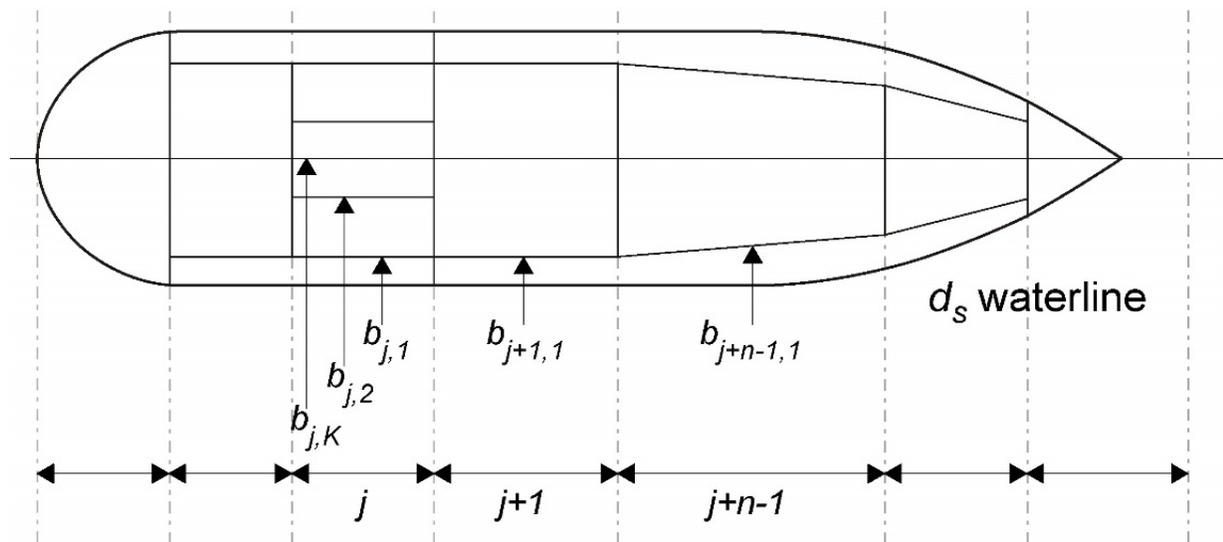
where:  $n =$  number of wing compartments in that group;  
 $b_1, b_2, \dots, b_n =$  mean values of b for individual wing compartments contained in the group.

Accumulating p

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

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

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:

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

8 Because of the expression for  $r(x_1, x_2, b)$  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.

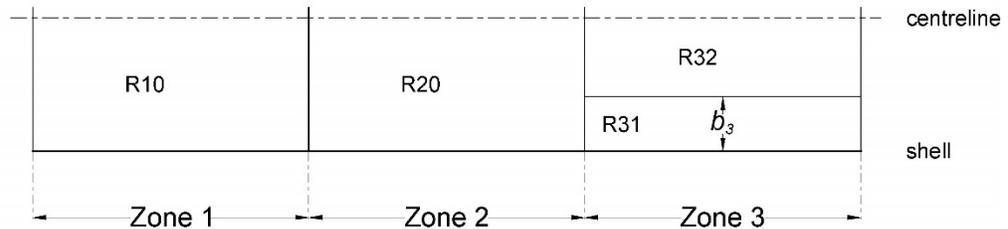


Figure: Combined damage of zones 1 + 2 + 3 includes a limited penetration to  $b_3$ , taken into account generating two damages:

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

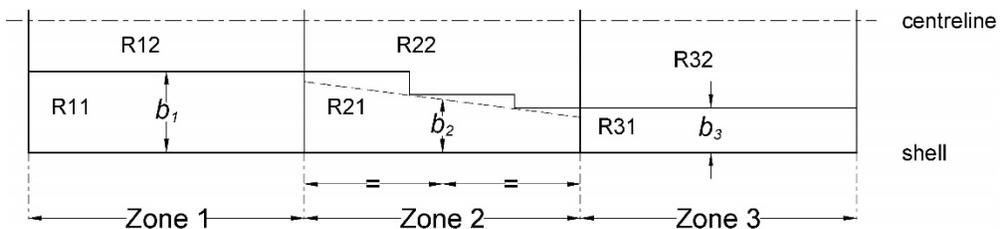


Figure: Combined damage of zones 1 + 2 + 3 includes 3 different limited damage penetrations generating four damages:

- 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.

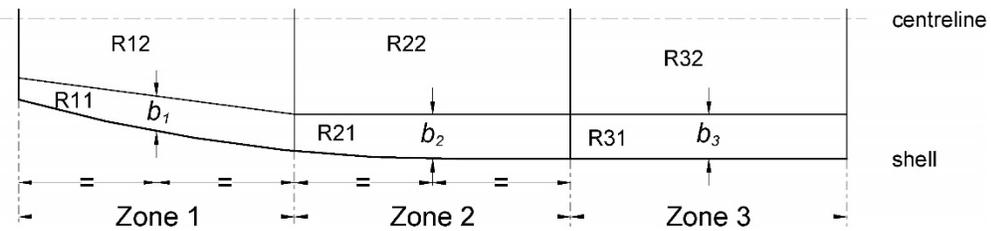
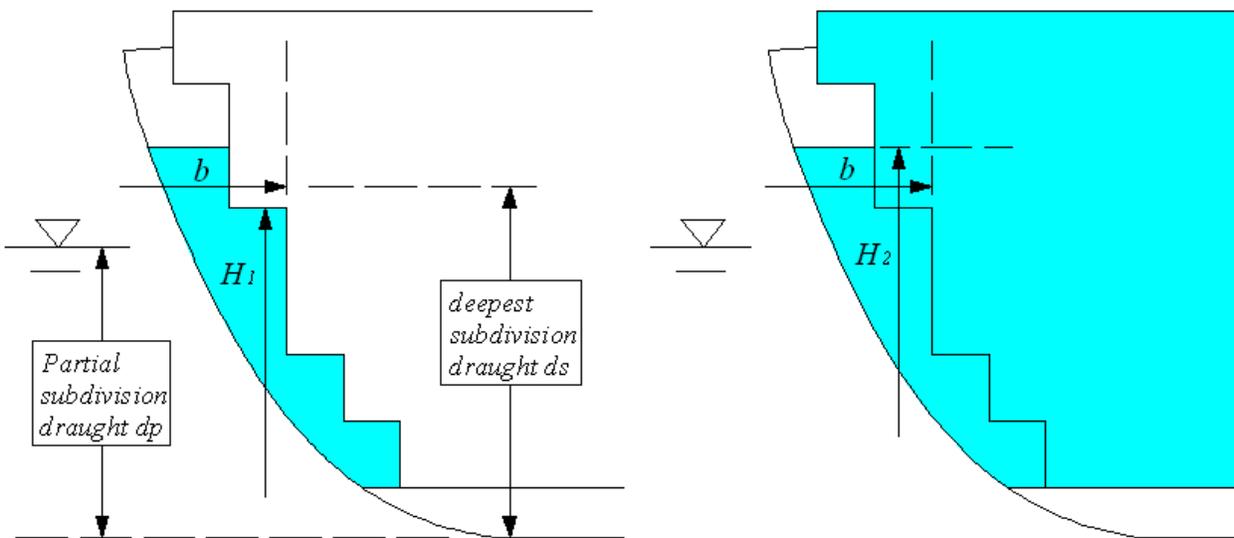


Figure: Combined damage of zone 1 + 2 + 3 including 2 different limited damage penetrations ( $b_1 < b_2 = b_3$ ) generating three damages:

- 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.

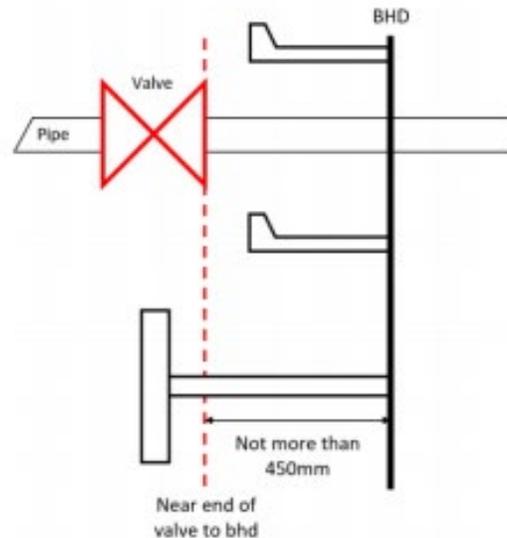
10 A damage having a transverse extent  $b$  and a vertical extent  $H_2$  leads to the flooding of both wing compartment and hold; for  $b$  and  $H_1$  only the wing compartment is flooded. The figure below illustrates a partial subdivision draught  $d_p$  damage.



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 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 be more than 450 mm measured from the valve's near end to the bulkhead (see figure below).



1.2.1 Where the compartment or groups of compartments considered extends over the entire subdivision length ( $L_s$ ):

$$G = G_1 = 1/2 b_{11}J_b^2 + b_{12}J_b$$

1.2.2 Where neither limit of the compartment or group of compartments under consideration coincides with the aft or forward terminals:

$$G = G_2 = 1/3 b_{11}J_0^3 + 1/2 (b_{11}J - b_{12}) J_0^2 + b_{12}JJ_0, \text{ where}$$

$$J_0 = \min (J, J_b)$$

1.2.3 Where the aft limit of the compartment or group of compartments under consideration coincides with the aft terminal or the forward limit of the compartment or group of compartments under consideration coincides with the forward terminal:

$$G = 1/2 (G_2 + G_1 \cdot J)$$

## 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.*

1 The factor  $s_i$  shall be determined for each case of assumed flooding, involving a compartment or group of compartments, in accordance with the following notations and the provisions in this regulation.

$\theta_e$  is the equilibrium heel angle in any stage of flooding, in degrees;

$\theta_v$  is the angle, in any stage of flooding, where the righting lever becomes negative, or the angle at which an opening incapable of being closed weathertight becomes submerged;

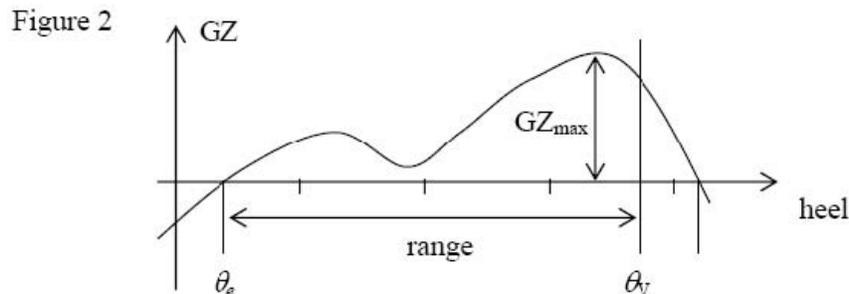
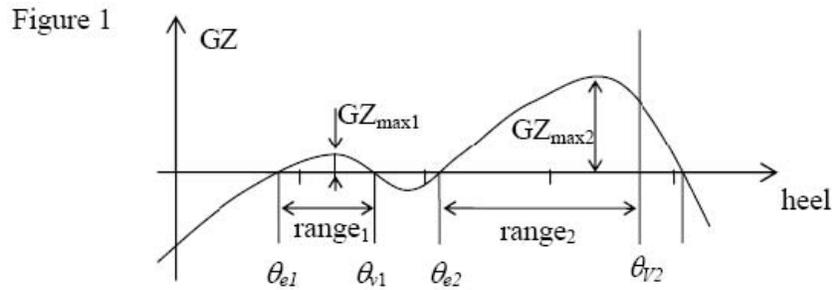
$GZ_{max}$  is the maximum positive righting lever, in metres, up to the angle  $\theta_v$ ;

*Range* is the range of positive righting levers, in degrees, measured from the angle  $\theta_e$ . The positive range is to be taken up to the angle  $\theta_v$ ;

*Flooding stage* is any discrete step during the flooding process, including the stage before equalization (if any) until final equilibrium has been reached.

**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.



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.

1.1 The factor  $s_i$ , for any damage case at any initial loading condition,  $d_i$ , shall be obtained from the formula:

$$s_i = \text{minimum} \{ s_{\text{intermediate},i} \text{ OR } s_{\text{final},i} \times s_{\text{mom},i} \}$$

where:

$s_{\text{intermediate},i}$  is the probability to survive all intermediate flooding stages until the final equilibrium stage, and is calculated in accordance with paragraph 2;

$s_{\text{final},i}$  is the probability to survive in the final equilibrium stage of flooding. It is calculated in accordance with paragraph 3;

$s_{\text{mom},i}$  is the probability to survive heeling moments, and is calculated in accordance with paragraph 4.

2 For passenger ships, and cargo ships fitted with cross-flooding devices, the factor  $S_{intermediate,i}$  is taken as the least of the s-factors obtained from all flooding stages including the stage before equalization, if any, and is to be calculated as follows:

$$S_{intermediate,i} = \left[ \frac{GZ_{max}}{0.05} \cdot \frac{Range}{7} \right]^{\frac{1}{4}}$$

where  $GZ_{max}$  is not to be taken as more than 0.05 m and  $Range$  as not more than 7°.  $S_{intermediate,i} = 0$ , if the intermediate heel angle exceeds 15° for passenger ships and 30° for cargo ships.

For cargo ships not fitted with cross-flooding devices the factor  $S_{intermediate,i}$  is taken as unity, except if the Administration considers that the stability in intermediate stages of flooding may be insufficient, it should require further investigation thereof.

For passenger and cargo ships, where cross-flooding devices are fitted, the time for equalization shall not exceed 10 min.

### 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.

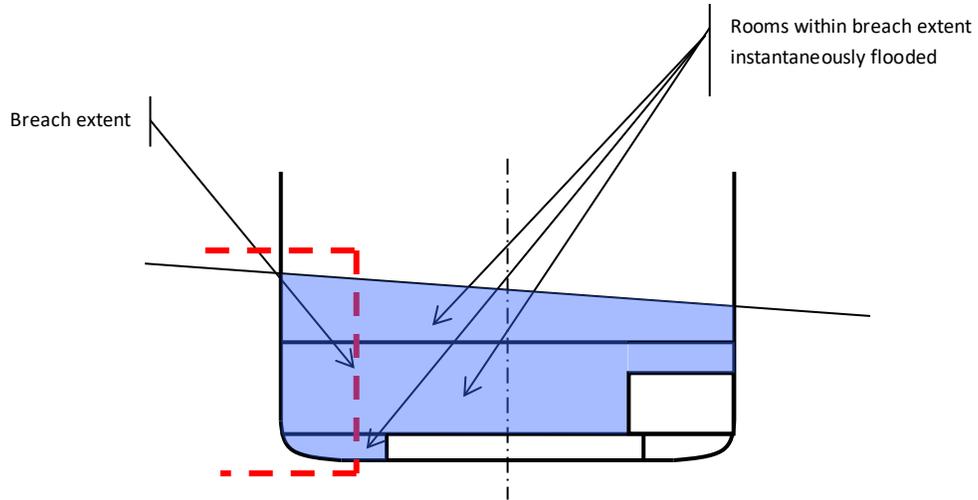
3.1 For each phase of a flooding stage (except the final full phase), the instantaneous transverse moment of this floodwater is calculated by assuming a constant volume of water at each heeling angle. The GZ curve is calculated with a constant intact displacement at all stages of flooding. Only one free 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.

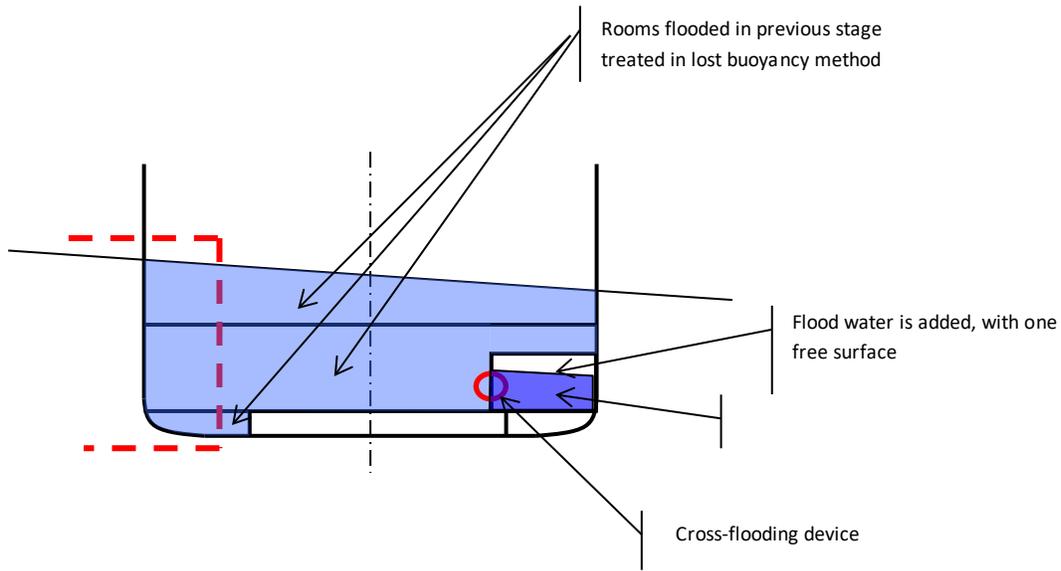
The examples below present a simplified, sequential approach to intermediate stage down-flooding and cross-flooding. Because simultaneous down-flooding and cross-flooding is not accounted for, any time-to-flood calculated with this sequential approach should be conservative. Alternative approaches, such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

**Example 1: Major damage with cross-flooding device**

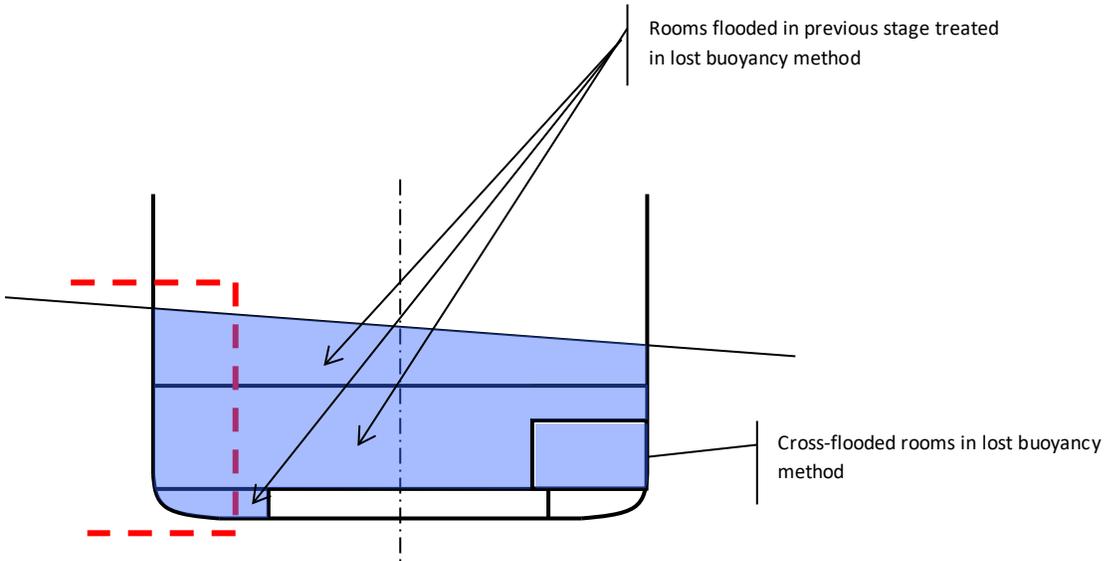
Stage 0: Unrestricted spaces in way of damage should be considered as flooded immediately (intermediate phases are not considered). The lost buoyancy method is applied as this is a full (final) phase. Provided the ship does not capsize and remains at a floating position from which cross-flooding can proceed, stage 0 need not be taken into account for the  $s_{\text{factor}}$  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**



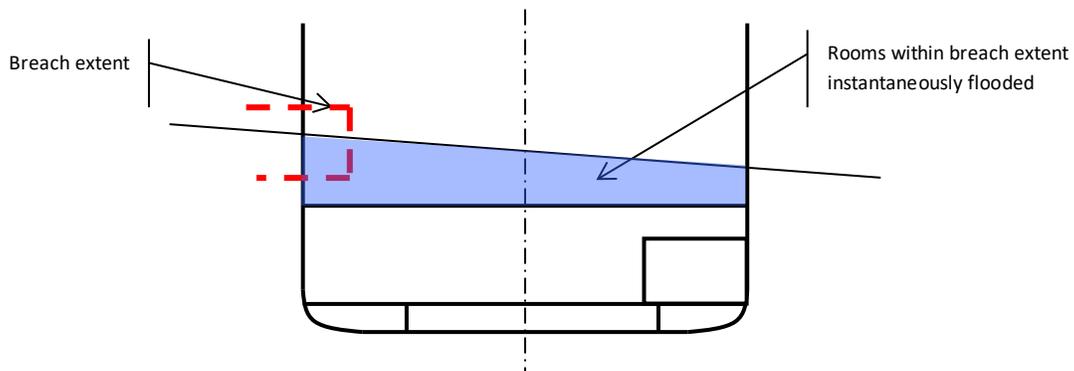
**An intermediate phase**



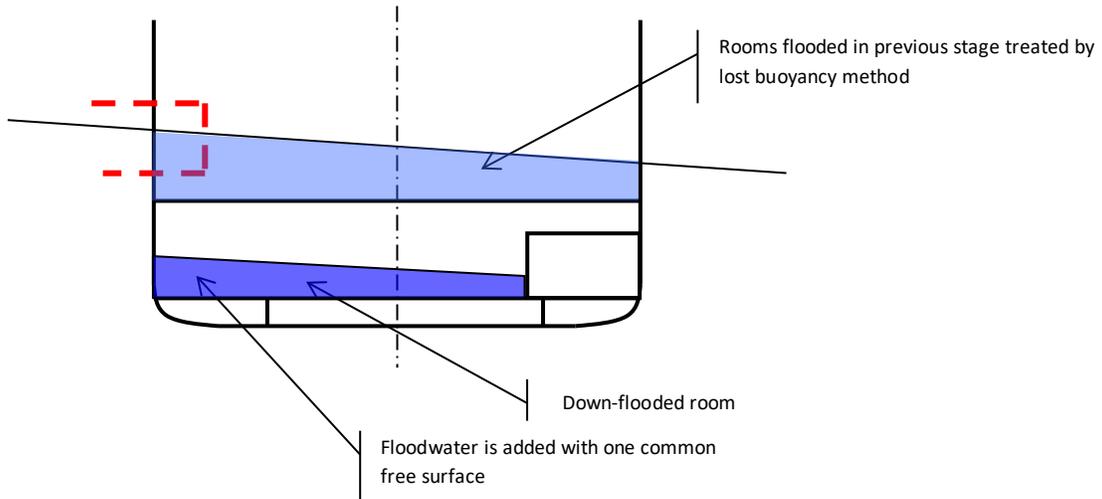
**Full (final) phase of flooding stage 1**

**Example 2: Minor damage with down-flooding and cross-flooding**

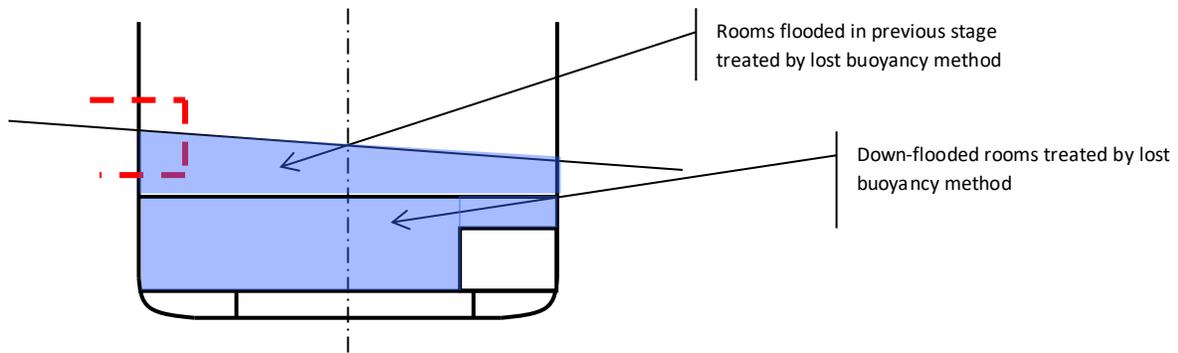
*Stage 0: Unrestricted spaces in way of damage should be considered as flooded immediately (intermediate phases are not considered). The lost buoyancy method is applied as this is a full (final) phase. Provided the ship does not capsize and remains at a floating position from which cross-flooding can 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.*



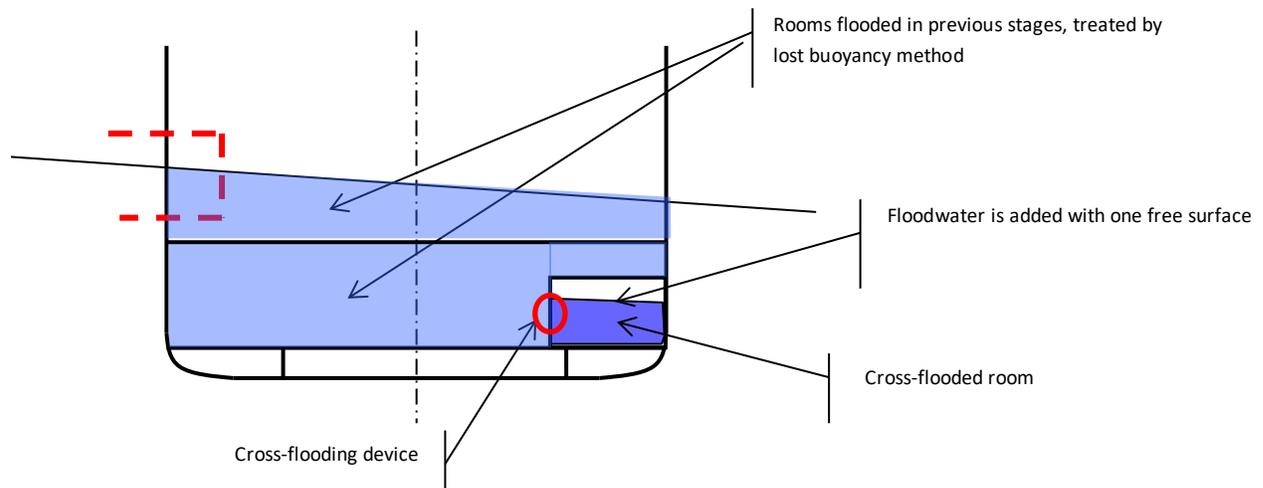
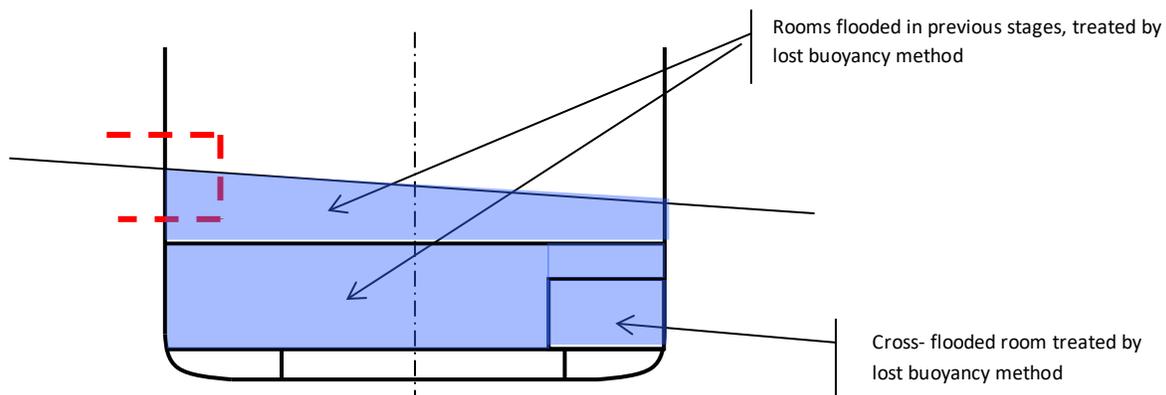
**Stage 1: Down-flooding through non-watertight deck**



**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 meant as a flooding of an undamaged space on the other side of the ship to reduce the heel in the final equilibrium condition.

5. The cross-flooding time should be calculated in accordance with the Recommendation on a standard method for evaluating cross-flooding arrangements (resolution MSC.245(83)) 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  $S_{\text{final}}$  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 **passive 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  $S_{\text{factor}}$  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 **can be carried out for passenger ships as is carried out using the formula in regulation 7-2.1.1 (i.e. as the smallest value of  $S_{\text{intermediate}}$  or  $S_{\text{final}}$ ,  $S_{\text{mom}}$ )**.

9. In case the equalization time is longer than 10 min,  $S_{\text{final}}$  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.245(83) 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  $S_{\text{final}}$  used in the formula in **paragraph 1.1 regulation 7-2.1.1** should be the minimum of  $S_{\text{final}}$  at 10 min or at final equalization.

11. The factor  $S_{\text{intermediate},i}$  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

3 The factor  $s_{\text{final},i}$  shall be obtained from the formula:

$$S_{\text{final},i} = K \times \left[ \frac{GZ_{\text{max}}}{TGZ_{\text{max}}} \times \frac{\text{Range}}{TRange} \right]^{\frac{1}{4}}$$

where:

$GZ_{\text{max}}$  is not to be taken as more than  $TGZ_{\text{max}}$ ;

$\text{Range}$  is not to be taken as more than  $TRange$ ;

$TGZ_{\text{max}} = 0.20 \text{ m}$ , for ro-ro passenger ships each damage case that involves a ro-ro space,

$TGZ_{\text{max}} = 0.12 \text{ m}$ , otherwise;

$TRange = 20^\circ$ , for ro-ro passenger ships each damage case that involves a ro-ro space,

$TRange = 16^\circ$ , otherwise;

$K = 1$  if  $\theta_e \leq \theta_{\text{min}}$

$K = 0$  if  $\theta_e \geq \theta_{\text{max}}$

$$K = \sqrt{\frac{\theta_{\text{max}} - \theta_e}{\theta_{\text{max}} - \theta_{\text{min}}}} \quad \text{otherwise,}$$

where:

$\theta_{\text{min}}$  is  $7^\circ$  for passenger ships and  $25^\circ$  for cargo ships; and

$\theta_{\text{max}}$  is  $15^\circ$  for passenger ships and  $30^\circ$  for cargo ships

### **Regulation 7-2.3**

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

4 The factor  $s_{mom,i}$  is applicable only to passenger ships (for cargo ships  $s_{mom,i}$  shall be taken as unity) and shall be calculated at the final equilibrium from the formula:

$$s_{mom,i} = \frac{(GZ_{max} - 0.04) \cdot Displacement}{M_{heel}}$$

where:

*Displacement* is the intact displacement at the respective draught ( $d_s$ ,  $d_p$  or  $d_i$ ).

$M_{heel}$  is the maximum assumed heeling moment as calculated in accordance with subparagraph 4.1; and

$$s_{mom,i} \leq 1$$

4.1 The heeling moment  $M_{heel}$  is to be calculated as follows:

$$M_{heel} = \text{maximum} \{M_{passenger} \text{ or } M_{wind} \text{ or } M_{Survivalcraft}\}$$

4.1.1  $M_{passenger}$  is the maximum assumed heeling moment resulting from movement of passengers, and is to be obtained as follows:

$$M_{passenger} = (0.075 \times Np) \times (0.45 \times B) \text{ (tm)}$$

where:

$Np$  is the maximum number of passengers permitted to be on board in the service condition corresponding to the deepest subdivision draught under consideration; and

$B$  is the breadth of the ship as defined in Regulation 2.8.

Alternatively, the heeling moment may be calculated assuming the passengers are distributed with 4 persons per square metre on available deck areas towards one side of the ship on the decks where muster stations are located and in such a way that they produce the most adverse heeling moment. In doing so, a weight of 75 kg per passenger is to be assumed.

4.1.2  $M_{wind}$  is the maximum assumed wind moment acting in a damage situation:

$$M_{wind} = (P \times A \times Z) / 9,806 \text{ (tm)}$$

where:

$$P = 120 \text{ N/m}^2;$$

$A$  = projected lateral area above waterline;

$Z$  = distance from centre of lateral projected area above waterline to  $T/2$ ; and

$T$  = respective draught,  $d_s$ ,  $d_p$  or  $d_i$ .

**Regulation 7-2.4.1.2**

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

4.1.3  $M_{\text{Survivalcraft}}$  is the maximum assumed heeling moment due to the launching of all fully loaded davit-launched survival craft on one side of the ship. It shall be calculated using the following assumptions:

- .1 all lifeboats and rescue boats fitted on the side to which the ship has heeled after having sustained damage shall be assumed to be swung out fully loaded and ready for lowering;
- .2 for lifeboats which are arranged to be launched fully loaded from the stowed position, the maximum heeling moment during launching shall be taken;
- .3 a fully loaded davit-launched liferaft attached to each davit on the side to which the ship has heeled after having sustained damage shall be assumed to be swung out ready for lowering;
- .4 persons not in the life-saving appliances which are swung out shall not provide either additional heeling or righting moment; and
- .5 life-saving appliances on the side of the ship opposite to the side to which the ship has heeled shall be assumed to be in a stowed position.

5 Unsymmetrical flooding is to be kept to a minimum consistent with the efficient arrangements. Where it is necessary to correct large angles of heel, the means adopted shall, where practicable, be self-acting, but in any case where controls to equalization devices are provided they shall be operable from above the bulkhead deck **of passenger ships and the freeboard deck of cargo ships**. These fittings together with their controls shall be acceptable to the Administration. Suitable information concerning the use of equalization devices shall be supplied to the master of the ship.

\* Reference is made to the "**Recommendation on a standard method for establishing compliance with the requirements for cross-flooding arrangements in passenger ships**", adopted by the Organization through resolution MSC.245(83), on 12<sup>th</sup> October, 2007 to replace resolution A.266(VIII).

\* Reference is made to the **Revised recommendation on a standard method for evaluating cross-flooding arrangements**, adopted by the Organization by resolution MSC.362(92), as may be amended.

5.1 Tanks and compartments taking part in such equalization shall be fitted with air pipes or equivalent means of sufficient cross-section to ensure that the flow of water into the equalization compartments is not delayed.

5.2 The factor  $s_i$  is to be taken as zero in those cases where the final waterline, taking into account sinkage, heel and trim, immerses:

- .1 **for cargo ships**, the lower edge of openings through which progressive flooding may take place and such flooding is not accounted for in the calculation of factor  $s_i$ . Such openings shall include air-pipes, ventilators and openings which are closed by means of weathertight doors or hatch covers; **and**

### **Regulations 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.*

- .2 any part of the bulkhead deck in passenger ships considered a horizontal evacuation route for compliance with chapter II-2; and
- .3 for passenger ships subject to the provisions of regulation 1.1.1.1 and constructed before 1 January 2024, the lower edge of openings through which progressive flooding may take place and such flooding is not accounted for in the calculation of factor  $s_i$ . Such openings shall include air-pipes, ventilators and openings which are closed by means of weathertight doors or hatch covers.

### **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 ~~the damaged space~~ 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.

~~4. Horizontal escapes situated in way of the damage extent may remain effective, therefore  $s_i$  need not be taken as zero. Contributions to the attained index  $A$  may still be gained.~~

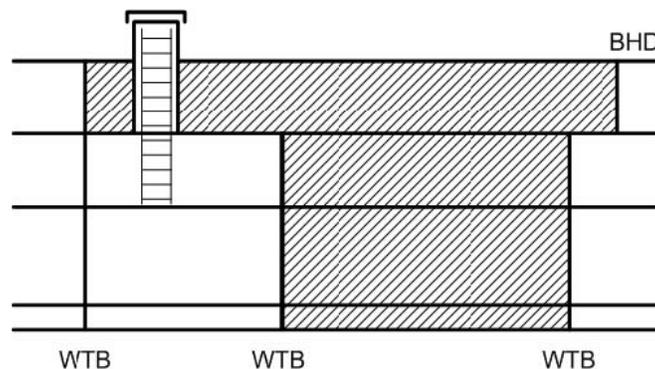
5.3 The factor  $s_i$  is to be taken as zero if, taking into account sinkage, heel and trim, any of the following occur in any intermediate stage or in the final stage of flooding:

- .1 immersion of any vertical escape hatch in the bulkhead deck ~~of passenger ships and the freeboard deck of cargo ships~~ intended for compliance with chapter II-2;

**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.



- .2 any controls intended for the operation of watertight doors, equalization devices, valves on piping or on ventilation ducts intended to maintain the integrity of watertight bulkheads from above the bulkhead deck of passenger ships and the freeboard deck of cargo ships become inaccessible or inoperable;
- .3 immersion of any part of piping or ventilation ducts located within the assumed extent of damage and carried through a watertight boundary if this can lead to the progressive flooding of compartments not assumed as flooded; and
- .4 for passenger ships constructed on or after 1 January 2024, immersion of the lower edge of openings through which progressive flooding may take place and such flooding is not accounted for in the calculation of factor  $s_i$ . Such openings shall include air-pipes, ventilators and openings which are closed by means of weathertight doors or hatch covers.

5.4 However, where compartments assumed flooded due to progressive flooding are taken into account in the damage stability calculations multiple values of  $S_{\text{intermediate},i}$  may be calculated assuming equalization in additional flooding phases.

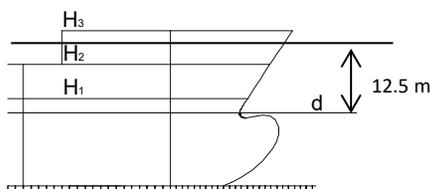
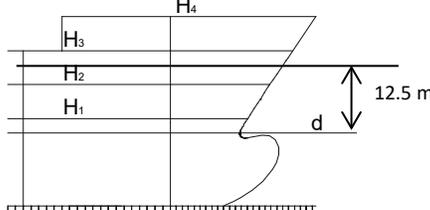
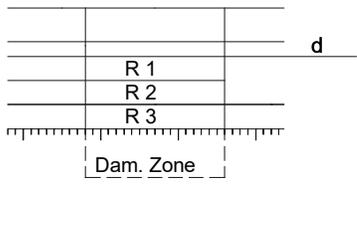
5.5 Except as provided in paragraph 5.3.1, openings closed by means of watertight manhole covers and flush scuttles, remotely operated sliding watertight doors, side scuttles of the non-opening type as well as watertight access doors and watertight hatch covers required to be kept closed at sea during navigation in accordance with regulations 22 to 24 need not be considered.

6 Where horizontal watertight boundaries are fitted above the waterline under consideration the s-value calculated for the lower compartment or group of compartments shall be obtained by multiplying the value as determined in paragraph 1.1 by the reduction factor  $v_m$  according to paragraph 6.1, which represents the probability that the spaces above the horizontal subdivision will not be flooded.

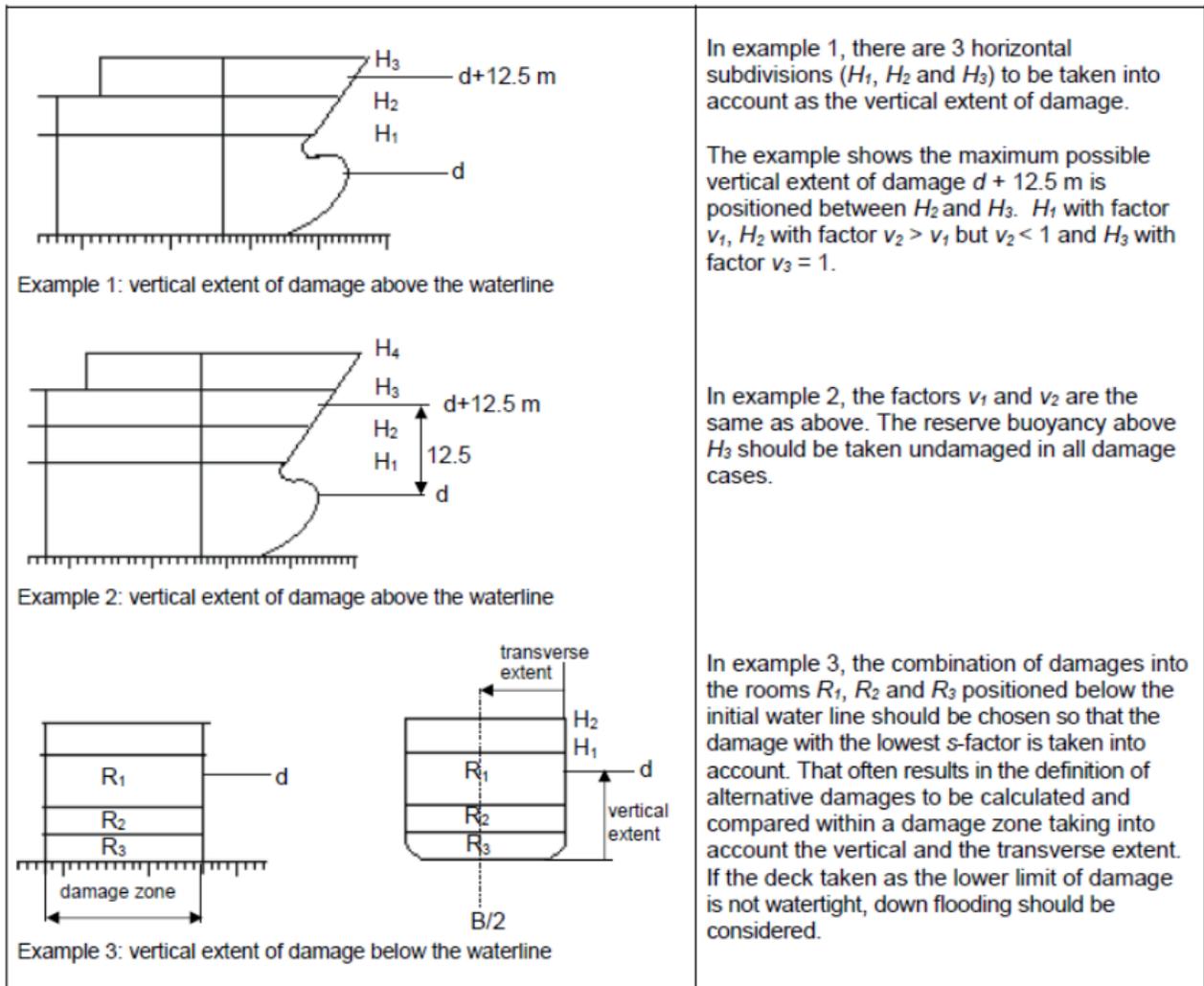
**Regulation 7-2.6**

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.

Delete the existing figure below

<p>Above the waterline</p> 	<p>In this example, there are 3 horizontal subdivisions to be taken into account as the vertical extent of damage.</p> <p>The example shows the maximum possible vertical extent of damage <math>d + 12.5\text{ m}</math> is positioned between <math>H_2</math> and <math>H_3</math> - <math>H_1</math> with factor <math>v_1</math>, <math>H_2</math> with factor <math>v_2 &gt; v_1</math> but <math>v_2 &lt; 1</math> and <math>H_3</math> with factor <math>v_3 = 1</math>.</p>
	<p>The factors <math>v_1</math> and <math>v_2</math> are the same as above. The reserve buoyancy above <math>H_3</math> should be taken undamaged in all damage cases.</p>
<p>Below the waterline</p> 	<p>The combination of damages into the rooms R1, R2 and R3 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. If the deck taken as lower limit of damage is not watertight, down flooding should be considered.</p>

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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  $v_3 = 1$ .

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.

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.

6.1 The factor  $v_m$  shall be obtained from the formula:

$$v_m = v(H_{j, n, m}, d) - v(H_{j, n, m-1}, d)$$

where:

$H_{j, n, m}$  is the least height above the baseline, in metres, within the longitudinal range of  $x_{1(j)} \dots x_{2(j+n-1)}$  of the  $m^{\text{th}}$  horizontal boundary which is assumed to limit the vertical extent of flooding for the damaged compartments under consideration;

$H_{j, n, m-1}$  is the least height above the baseline, in metres, within the longitudinal range of  $x_{1(j)} \dots x_{2(j+n-1)}$  of the  $(m-1)^{\text{th}}$  horizontal boundary which is assumed to limit the vertical extent of flooding for the damaged compartments under consideration;

$j$  signifies the aft terminal of the damaged compartments under consideration;

$m$  represents each horizontal boundary counted upwards from the waterline under consideration;

$d$  is the draught in question as defined in regulation 2; and

$x_1$  and  $x_2$  represent the terminals of the compartment or group of compartments considered in regulation 7-1.

### **Regulation 7-2.6.1**

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

6.1.1 The factors  $v(H_{j, n, m}, d)$  and  $v(H_{j, n, m-1}, d)$  shall be obtained from the formulas:

$$v(H, d) = 0.8 \frac{(H - d)}{7.8}, \text{ if } (H_m - d) \text{ is less than, or equal to, } 7.8 \text{ m;}$$

$$v(H, d) = 0.8 + 0.2 \left[ \frac{(H - d) - 7.8}{4.7} \right] \text{ in all other cases,}$$

where:

$v(H_{j, n, m}, d)$  is to be taken as 1, if  $H_m$  coincides with the uppermost watertight boundary of the ship within the range  $(x_{1(j)} \dots x_{2(j+n-1)})$ , and

$v(H_{j, n, 0}, d)$  is to be taken as 0.

In no case is  $v_m$  to be taken as less than zero or more than 1.

6.2 In general, each contribution  $dA$  to the index  $A$  in the case of horizontal subdivisions is obtained from the formula:

$$dA = p_i \cdot [v_1 \cdot s_{\min 1} + (v_2 - v_1) \cdot s_{\min 2} + \dots + (1 - v_{m-1}) \cdot s_{\min m}]$$

where:

$v_m$  = the  $v$ -value calculated in accordance with paragraph 6.1;

$s_{\min}$  = the least  $s$ -factor for all combinations of damages obtained when the assumed damage extends from the assumed damage height  $H_m$  downwards.

## Regulation 7-3

### Permeability

1 For the purpose of the subdivision and damage stability calculations of the regulations, the permeability of each general compartment or part of a compartment shall be as follows:

Spaces	Permeability
Appropriated to stores	0.60
Occupied by accommodation	0.95
Occupied by machinery	0.85
Void spaces	0.95
Intended for liquids	0 or 0.95 <sup>1</sup>

<sup>1</sup> Whichever result in the more severe requirement

2 For the purpose of the subdivision and damage stability calculations of the regulations, the permeability of each cargo compartment or part of a compartment shall be as follows:

Spaces	Permeability at draught $d_s$	Permeability at draught $d_p$	Permeability at draught $d_l$
Dry cargo spaces	0.70	0.80	0.95
Container spaces	0.70	0.80	0.95
Ro-ro spaces	0.90	0.90	0.95
Cargo liquids	0.70	0.80	0.95

### Regulation 7-3.2

1. *The following additional cargo permeabilities may be used:*

<b>Spaces</b>	<b>Permeability at draught <math>d_s</math></b>	<b>Permeability at draught <math>d_p</math></b>	<b>Permeability at draught <math>d_l</math></b>
<i>Timber cargo in holds</i>	<i>0.35</i>	<i>0.7</i>	<i>0.95</i>
<i>Wood chip cargo</i>	<i>0.6</i>	<i>0.7</i>	<i>0.95</i>

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.*

3 Other figures for permeability may be used if substantiated by calculations.

**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**

1 A passenger ship intended to carry 400 or more persons shall have watertight subdivision abaft the collision bulkhead so that  $s_i = 1$  for a damage involving all the compartments within  $0.08L$  measured from the forward perpendicular for the three loading conditions used to calculate the attained subdivision index  $A$ . If the attained subdivision index  $A$  is calculated for different trims, this requirement must also be satisfied for those loading conditions.

**Regulation 8.1**

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

2 A passenger ship intended to carry 36 or more persons is to be capable of withstanding damage along the side shell to an extent specified in paragraph 3. Compliance with this regulation is to be achieved by demonstrating that  $s_i$ , as defined in regulation 7-2, is not less than 0.9 for the three loading conditions used to calculate the attained subdivision index  $A$ . If the attained subdivision index  $A$  is calculated for different trims, this requirement must also be satisfied for those loading conditions.

3 The damage extent to be assumed when demonstrating compliance with paragraph 2, is to be dependent on the total number of persons carried and  $L$ , such that:

.1 the vertical extent of damage is to extend from the ship’s moulded baseline to a position up to 12.5 m above the position of the deepest subdivision draught as defined in regulation 2, unless a lesser vertical extent of damage were to give a lower value of  $s_i$ , in which case this reduced extent is to be used;

.2 where 400 or more persons are to be carried, a damage length of  $0.03L$ ,

but not less than 3 m is to be assumed at any position along the side shell, in conjunction with a penetration inboard of  $0.1B$  but not less than 0.75 m measured inboard from the ship side, at right angles to the centreline at the level of the deepest subdivision draught;

.3 where less than 400 persons are carried, damage length is to be assumed at any position along the side shell between transverse watertight bulkheads provided that the distance between two adjacent transverse watertight bulkheads is not less than the assumed damage length. If the distance between adjacent transverse watertight bulkheads is less than the assumed damage length, only one of these bulkheads shall be considered effective for the purpose of demonstrating compliance with paragraph 2;

.4 where 36 persons are carried, a damage length of  $0.015L$  but not less than 3 m is to be assumed, in conjunction with a penetration inboard of  $0.05B$  but not less than 0.75 m; and

.5 where more than 36, but fewer than 400 persons are carried the values of damage length and penetration inboard, used in the determination of the assumed extent of damage, are to be obtained by linear interpolation between the values of damage length and penetration which apply for ship carrying 36 persons and 400 persons as specified in subparagraphs .4 and .2.

### Regulation 8-1

#### System capabilities and operational information after a flooding casualty on passenger ships

##### 1 Application

Passenger ships having length, as defined in regulation II-1/2.5, of 120 m or more or having three or more main vertical zones shall comply with the provisions of this regulation.

##### 2 Availability of essential systems in case of flooding damage \*

A passenger ship shall be designed so that the systems specified in regulation II-2/21.4 remain operational when the ship is subject to flooding of any single watertight compartment.

#### 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 onboard space within watertight boundaries).

\* Refer to the *Interim Explanatory Notes for the assessment of passenger ship systems’ capabilities after a fire or flooding casualty* (MSC.1/Circ.1369).

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.*

### 3 Operational information after a flooding casualty

3.1 For the purpose of providing operational information to the Master for safe return to port after a flooding casualty, passenger ships, as specified in paragraph 1, shall have:

- .1 an onboard stability computer; or
- .2 shore-based support,

based on guidelines developed by the Organization\*\*

3.2 Passenger ships constructed before 1 January 2014 shall comply with the provisions of paragraph 3.1 not later than the first renewal survey after 1 January 2025.

\*\* Refer to the *Guidelines on operational information for Masters of passenger ships for safe return to port by own power or under tow* (MSC.1/Circ.1400) for ships constructed on or after 1 January 2014 but before 13 May 2016 or the *Revised Guidelines on operational information for masters of passenger ships for safe return to port* (MSC.1/Circ.1532/Rev.1) for ships constructed on or after 13 May 2016, or the *Guidelines on operational information for masters in case of flooding for passenger ships constructed before 1 January 2014* (MSC.1/Circ.1589)

**PART B-2****SUBDIVISION, WATERTIGHT AND WEATHERTIGHT INTEGRITY****Regulation 9****Double bottoms in passenger ships and cargo ships other than tankers**

1 A double bottom shall be fitted extending from the collision bulkhead to the afterpeak bulkhead, as far as this is practicable and compatible with the design and proper working of the ship.

**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.*

**MCA Guidance - Regulation 9; Double Bottoms (general)****(1) Inner bottom**

The inner bottom may be pierced by the minimum number of access manholes compatible with the design and safe working of the ship, providing such manholes are fitted with efficient covers and provided the joint between the cover and the inner bottom is watertight.

**(2) Air and sounding pipes**

All air and sounding pipes to double bottom compartments are to be effectively protected against the risk of damage and located so far as practical to avoid damage.

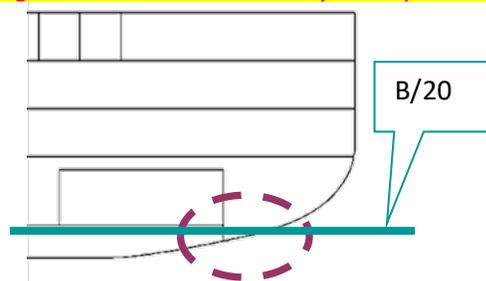
2 Where a double bottom is required to be fitted the inner bottom shall be continued out to the ship's sides in such a manner as to protect the bottom to the turn of the bilge. Such protection will be deemed satisfactory if the inner bottom is not lower at any part than a plane parallel with the keel line and which is located not less than a vertical distance  $h$  measured from the keel line, as calculated by the formula:

$$h = B/20$$

However, in no case is the value of  $h$  to be less than 760 mm, and need not be taken as more than 2,000 mm.

### 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.

3.1 Small wells constructed in the double bottom in connection with drainage arrangements shall not extend downward more than necessary. The vertical distance from the bottom of such a well to a plane coinciding with the keel line shall not be less than  $h/2$  or 500 mm, whichever is greater, or compliance with paragraph 8 of this regulation shall be shown for that part of the ship.

3.2 Other wells (e.g. for lubricating oil under main engines) may be permitted by the Administration if satisfied that the arrangements give protection equivalent to that afforded by a double bottom complying with this regulation.

3.2.1 For a cargo ship of 80 m in length and upwards or for a passenger ship, proof of equivalent protection is to be shown by demonstrating that the ship is capable of withstanding bottom damages as specified in paragraph 8. Alternatively, wells for lubricating oil below main engines may protrude into the double bottom below the boundary line defined by the distance  $h$  provided that the vertical distance between the well bottom and a plane coinciding with the keel line is not less than  $h/2$  or 500 mm, whichever is greater.

3.2.2 For cargo ships of less than 80 m in length the arrangements shall provide a level of safety satisfactory to the Administration.

**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.*

**MCA Guidance - Regulation 9.3; Wells**

**If wells are to be fitted for purposes other than drainage and the surveyor considers they are essential, they should be kept as small as possible. If in doubt, full particulars of the arrangements adopted for maintaining the protection given by the double bottom should be discussed with Headquarters.**

4 A double bottom need not be fitted in way of watertight tanks, including dry tanks of moderate size, provided the safety of the ship is not impaired in the event of bottom or side damage.

5 In the case of passenger ships to which the provisions of regulation 1.5 apply and which are engaged on regular service within the limits of a short international voyage as defined in regulation III/3.22, the Administration may permit a double bottom to be dispensed with if satisfied that the fitting of a double bottom in that part would not be compatible with the design and proper working of the ship.

6 Any part of a cargo ship of 80 m in length and upwards or of a passenger ship that is not fitted with a double bottom in accordance with paragraphs 1, 4 or 5, as specified in paragraph 2, shall be capable of withstanding bottom damages, as specified in paragraph 8, in that part of the ship. For cargo ships of less than 80 m in length the alternative arrangements shall provide a level of safety to the satisfaction of the Administration.

**Regulation 9.6**

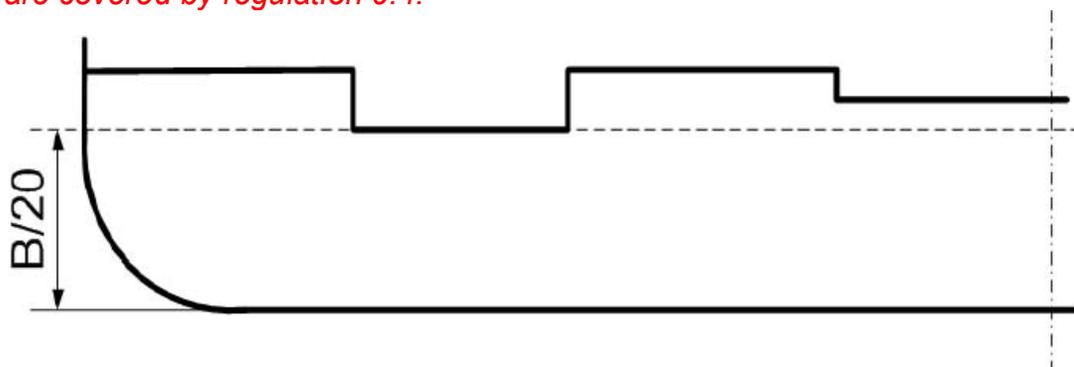
*1. Any part of a passenger ship or a cargo ship of 80 m in length (L) and upwards where a double bottom is omitted in accordance with regulation 9.1, 9.4 or 9.5 shall be capable of withstanding bottom damages, as specified in regulation 9.8. The intent of this provision is to specify the circumstances 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.*

7 In the case of unusual bottom arrangements in a cargo ship of 80 m in length and upwards or a passenger ship, it shall be demonstrated that the ship is capable of withstanding bottom damages as specified in paragraph 8. For cargo ships of less than 80 m in length the alternative arrangements shall provide a level of safety to the satisfaction of the Administration.

**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.*



8 Compliance with paragraphs 3.1, 3.2.1, 6 or 7 is to be achieved by demonstrating that  $s_r$ , when calculated in accordance with regulation 7-2, is not less than 1 for all service conditions when subject to bottom damage with an extent specified in subparagraph .2 below for any position in the affected part of the ship:

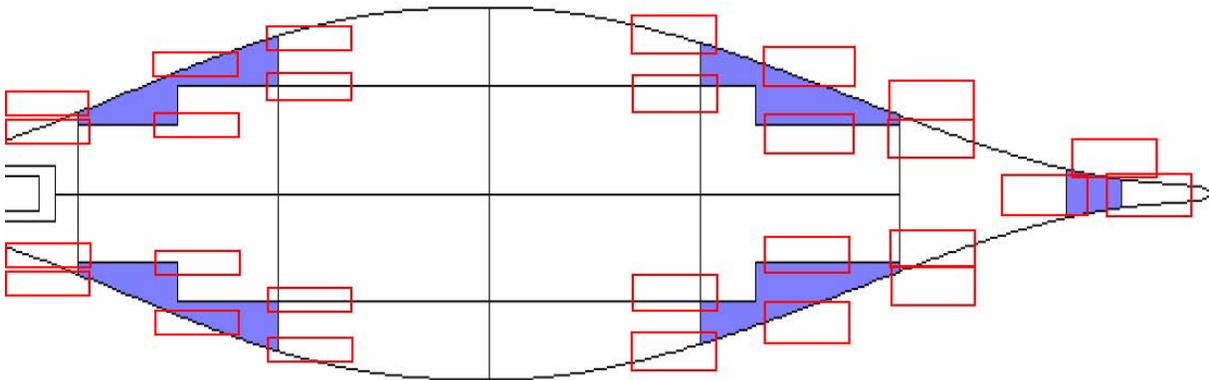
- .1 Flooding of such spaces shall not render emergency power and lighting, internal communication, signals or other emergency devices inoperable in other parts of the ship.
- .2 Assumed extent of damage shall be as follows:

	For 0.3 L from the forward perpendicular of the ship	Any other part of the ship
Longitudinal Extent	$1/3 L^{2/3}$ or 14.5 m, whichever is less	$1/3 L^{2/3}$ or 14.5 m, whichever is less
Transverse Extent	$B/6$ or 10 m, whichever is less	$B/6$ or 5 m, whichever is less
Vertical Extent, measured from the keel line	$B/20$ , to be taken not less than 0.76 m and not more than 2 m	$B/20$ , to be taken not less than 0.76 m and not more than 2 m

### 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).

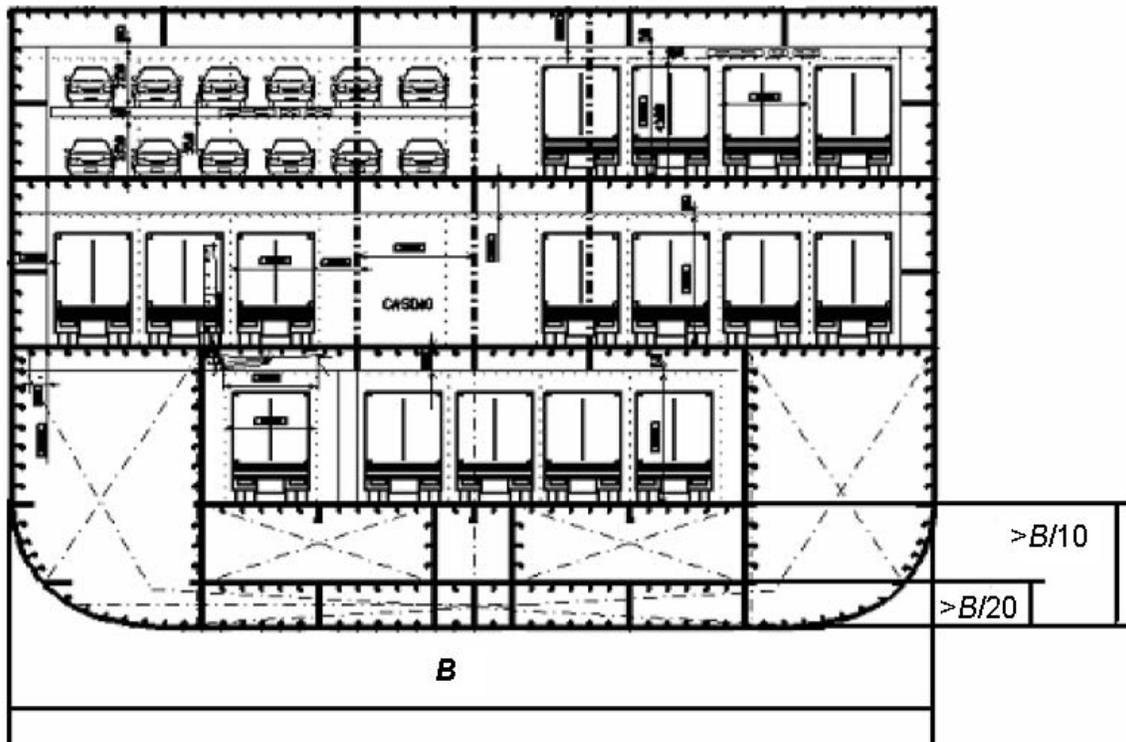


9 In case of large lower holds in passenger ships, the Administration may require an increased double bottom height of not more than  $B/10$  or 3 m, whichever is less, measured from the keel line. Alternatively, bottom damages may be calculated for these areas, in accordance with paragraph 8, but assuming an increased vertical extent.

### 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.



#### MCA Guidance - Regulation 9.9; Large Lower Holds in ro-ro passenger ships

SUBJECT TO REVIEW PENDING DEVELOPMENTS AT THE EU DURING 2020

(1) UK flag ro-ro passenger ships with large lower holds (LLH) constructed before 1 January 2009 have hitherto been subject to the provisions laid out in "Instructions for the Guidance of Surveyors – Passenger Ship Construction – Classes I, II and II(A)" which outlines in Section 2.5 a method using equivalent damage stability calculations to account for the problem of the compliance of this class of vessel with the floodable length regulations 4-7 in SOLAS 90 Chapter II-1 Part B (ref. IMO SLS.14/Circ. 321).

(2) Although compliance with floodable length calculations is no longer required in the SOLAS 2009 regulations, which are deemed to be fully equivalent to SOLAS 90 in terms of the level of safety they provide, nonetheless the MCA still

has some concerns about the safety of vessels constructed with this design feature.

(3) A research study jointly funded by the UK and Netherlands and completed early in 2009 (Ref. RP 592) indicated that LLH ships could now be constructed with a lower level of protection from side damage due to the removal of the B/5 limit in SOLAS 2009, making penetration of the LLH more probable in the event of collision and leaving vessels of this type even more prone to either sinkage or rapid capsizing.

(4) It is permissible for owners of ro-ro passenger ships with LLH constructed prior to 1 January 2009 under the provisions of SOLAS Chapter 1 Part A Regulation 5 to request that their ships be approved under SOLAS 2009 on the basis that these regulations are deemed to be fully equivalent to SOLAS 90.

(5) As new vessels constructed after 1 January 2009 will be required to comply with the same SOLAS 2009 regulations, the MCA cannot object to the use of these regulations in principle but for owners of ro-ro passenger ships fitted with LLH the following points are to be considered: -

- All the provisions of SOLAS 2009 must be complied with. For LLH ships, particular attention will be paid to Regulation 9.9 with the accompanying explanatory notes relating to bottom damage and also Regulation 17-1 relating to the watertight integrity of the vehicle deck.
- New and existing ro-ro passenger ships must continue to comply with the Stockholm Agreement (Directive 2003/25/EC), as agreed by the EU at COSS on 3 February, 2009, until such time as it is confirmed that the SOLAS 2009 regulations make sufficient provision for the water on deck phenomenon. The EU has made a decision on this in 2023 following completion of a 3-year research project (see MCA Guidance under Regulation 6.2, above, for more details). A new MSN is being produced at the time of writing (April 2023).
- The MCA strongly recommends, in the interests of passenger and crew safety, that specific and detailed checks of the damage stability characteristics of each ro-ro passenger ship (new and existing ships joining the UK fleet) be carried out following side damage penetration to the centreline in way of the LLH.
- Such calculations should be submitted to the Stability Unit for consideration and advice will be given on a case-by-case basis until such time as it is confirmed that SOLAS 2009 ro-ro passenger ships with LLH have at least an equivalent safety level to that provided by SOLAS 90 in conjunction with Instructions to Surveyors Section 2.5.

## Regulation 10

### Construction of watertight bulkheads

1 Each watertight subdivision bulkhead, whether transverse or longitudinal, shall be constructed having scantlings as specified in regulation 2.17. In all cases, watertight subdivision bulkheads shall be capable of supporting at least the pressure due to a head of water up to the bulkhead deck **of passenger ships and the freeboard deck of cargo ships.**

#### **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.*

#### **MCA Guidance - Regulation 10.1; Construction of Watertight Bulkheads**

(1) The strength and construction of every watertight subdivision bulkhead, or other portion of the internal structure forming part of the watertight subdivision of the ship, shall be of sufficient strength to be capable of supporting, with an adequate margin of resistance, the pressure due to the maximum head of water which it might have to sustain in the event of damage to the ship. The pressure head is not to be less than the pressure due to a head of water up to the bulkhead deck, including any additional head estimated to result from flooding or heeling, when calculating stability in the damaged condition.

(2) Every watertight bulkhead and its parts should be constructed of steel.

(3) In the case of a ship which is classed with a Certifying Authority and built to its survey requirements it shall be sufficient for compliance with paragraph (1) if that Authority certifies that the watertight bulkheads and parts thereof are constructed in accordance with the requirements of its Rules.

(4) In the case of a ship which is not classed with a Certifying Authority and built to the survey requirements of the Maritime and Coastguard Agency, compliance with paragraph (1) will be met if the bulkhead scantlings comply with the appropriate rules of a Certifying Authority.

2 Steps and recesses in watertight bulkheads shall be as strong as the bulkhead at the place where each occurs.

**MCA Guidance - Regulation 10.2; Construction of Watertight Recesses, Trunkways and Tunnels**

- (1) Every recess and trunkway required to be watertight shall be so constructed as to provide strength and stiffness at all parts not less than that required for watertight bulkheads at a corresponding level.
- (2) Every tunnel required to be watertight shall be constructed with plating of thickness not less than that required for bulkheads, other than the collision bulkhead.

**Regulation 11****Initial testing of watertight bulkheads, etc.**

1 Testing watertight spaces not intended to hold liquids and cargo holds intended to hold ballast by filling them with water is not compulsory. When testing by filling with water is not carried out, a hose test shall be carried out where practicable. This test shall be carried out in the most advanced stage of the fitting out of the ship. Where a hose test is not practicable because of possible damage to machinery, electrical equipment insulation or outfitting items, it may be replaced by a careful visual examination of welded connections, supported where deemed necessary by means such as a dye penetrant test or an ultrasonic leak test or an equivalent test. In any case a thorough inspection of the watertight bulkheads shall be carried out.

**MCA Guidance - Regulation 11.1; Initial testing of watertight bulkheads**

- (1) Any hose and pressure tests should be carried out in the presence and to the satisfaction of the surveyor, who should record the results of the test on the appropriate file.
- (2) The pressure of the water in the hose should not be less than 207 kN/m<sup>2</sup>.
- (3) When testing arrangements considered equivalent to the above are proposed, full details should be submitted to Headquarters.

2 The forepeak, double bottom (including duct keels) and inner skins shall be tested with water to a head corresponding to the requirements of regulation 10.1.

3 Tanks which are intended to hold liquids, and which form part of the watertight subdivision of the ship, shall be tested for tightness and structural strength with water to a head corresponding to its design pressure. The water head is in no case to be less than the top of the air pipes or to a level of 2.4 m above the top of the tank, whichever is the greater.

4 The tests referred to in paragraphs 2 and 3 are for the purpose of ensuring that the subdivision structural arrangements are watertight and are not to be regarded as a test of the fitness of any compartment for the storage of oil fuel or for other special purposes for which a test of a superior character may be required depending on the height to which the liquid has access in the tank or its connections.

## Regulation 12

### Peak and machinery space bulkheads, shaft tunnels, etc.

1 A collision bulkhead shall be fitted which shall be watertight up to the bulkhead deck of passenger ships and the freeboard deck of cargo ships. This bulkhead shall be located at a distance from the forward perpendicular of not less than  $0.05L$  or 10 m, whichever is the less, and, except as may be permitted by the Administration, not more than  $0.08L$  or  $0.05L + 3$  m, whichever is the greater.

2 The ship shall be so designed that  $s_i$  calculated in accordance with regulation 7-2 will not be less than 1 at the deepest subdivision draught loading condition, level trim or any forward trim loading conditions, if any part of the ship forward of the collision bulkhead is flooded without vertical limits.

3 Where any part of the ship below the waterline extends forward of the forward perpendicular, e.g., a bulbous bow, the distances stipulated in paragraph 1 shall be measured from a point either:

- .1 at the mid-length of such extension;
- .2 at a distance  $0.015L$  forward of the forward perpendicular; or
- .3 at a distance 3 m forward of the forward perpendicular,

whichever gives the smallest measurement.

4 The bulkhead may have steps or recesses provided they are within the limits prescribed in paragraph 1 or 3.

5 No doors, manholes, access openings, ventilation ducts or any other openings shall be fitted in the collision bulkhead below the bulkhead deck of passenger ships and the freeboard deck of cargo ships.

6.1 For ships subject to the provisions of regulation 1.1.1.1 and constructed before 1 January 2024, except as provided in paragraph 6.23, the collision bulkhead may be pierced below the bulkhead deck of passenger ships and the freeboard deck of cargo ships by not more than one pipe for dealing with fluid in the forepeak tank, provided that the pipe is fitted with a screw-down valve capable of being operated from above the bulkhead deck of passenger ships and the freeboard deck of cargo ships, the valve being

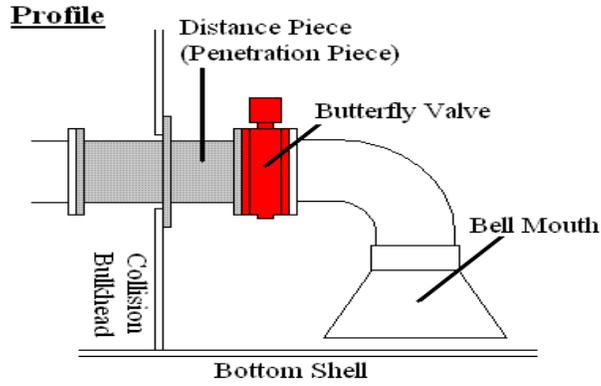
located inside the forepeak at the collision bulkhead. The Administration may, however, authorize the fitting of this valve on the after side of the collision bulkhead provided that the valve is readily accessible under all service conditions and the space in which it is located is not a cargo space. Alternatively, for cargo ships, the pipe may be fitted with a butterfly valve suitably supported by a seat or flanges and capable of being operated from above the freeboard deck. All valves shall be of steel, bronze or other approved ductile material. Valves of ordinary cast iron or similar material are not acceptable.

6.42 For ships constructed on or after 1 January 2024, eExcept as provided in paragraph 6.23, the collision bulkhead may be pierced below the bulkhead deck of passenger ships and the freeboard deck of cargo ships by not more than one pipe for dealing with fluid in the forepeak tank, provided that the pipe is fitted with a screw-down valve remotely controlled valve capable of being operated from above the bulkhead deck of passenger ships and the freeboard deck of cargo ships., the valve being located inside the forepeak at the collision bulkhead. The Administration may, however, authorize the fitting of this valve on the after side of the collision bulkhead provided that the valve is readily accessible under all service conditions and the space in which it is located is not a cargo space. Alternatively, for cargo ships, the pipe may be fitted with a butterfly valve suitably supported by a seat or flanges and capable of being operated from above the freeboard deck. The valve shall be normally closed. If the remote-control system should fail during operation of the valve, the valve shall close automatically or be capable of being closed manually from a position above the bulkhead deck of passenger ships and the freeboard deck of cargo ships. The valve shall be located at the collision bulkhead on either the forward or aft side, provided the space on the aft side is not a cargo space. All The valves shall be of steel, bronze or other approved ductile material. Valves of ordinary cast iron or similar material are not acceptable.

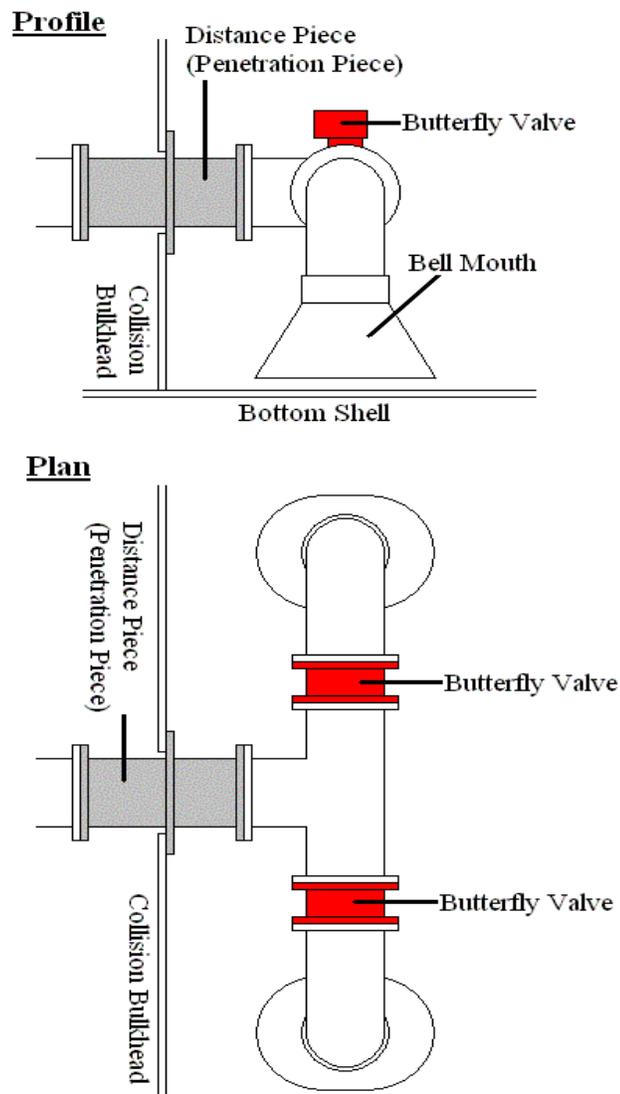
6.23 If the forepeak is divided to hold two different kinds of liquids the Administration may allow the collision bulkhead to be pierced below the bulkhead deck of passenger ships and the freeboard deck of cargo ships by two pipes, each of which is fitted as required by paragraph 6.1 or 6.2, provided the Administration is satisfied that there is no practical alternative to the fitting of such a second pipe and that, having regard to the additional subdivision provided in the forepeak, the safety of the ship is maintained.

**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.*

**7** Where a long forward superstructure is fitted, the collision bulkhead shall be extended weathertight to the deck next above the bulkhead deck **of passenger ships and the freeboard deck of cargo ships**. The extension need not be fitted directly above the bulkhead below provided that all parts of the extension, including any part of the ramp attached to it are located within the limits prescribed in paragraph 1 or **3**, with the exception permitted by paragraph **8** and that the part of the deck which forms the step is made effectively weathertight. The extension shall be so arranged as to preclude the possibility of the bow door **or ramp, where fitted**, causing damage to it in the case of damage to, or detachment of, a bow door **or any part of the ramp**.

**8** Where bow doors are fitted and a sloping loading ramp forms part of the extension of the collision bulkhead above the bulkhead deck **of passenger ships and the freeboard deck of cargo ships** the ramp shall be weathertight over its complete length. In cargo ships the part of the ramp which is more than 2.3 m above the **freeboard** deck may extend forward of the limit specified in paragraph 1 or **3**. Ramps not meeting the above requirements shall be disregarded as an extension of the collision bulkhead

*Note that former EN for Reg. 12 is now deleted and incorporated into regs 12.7 & 12.8.*

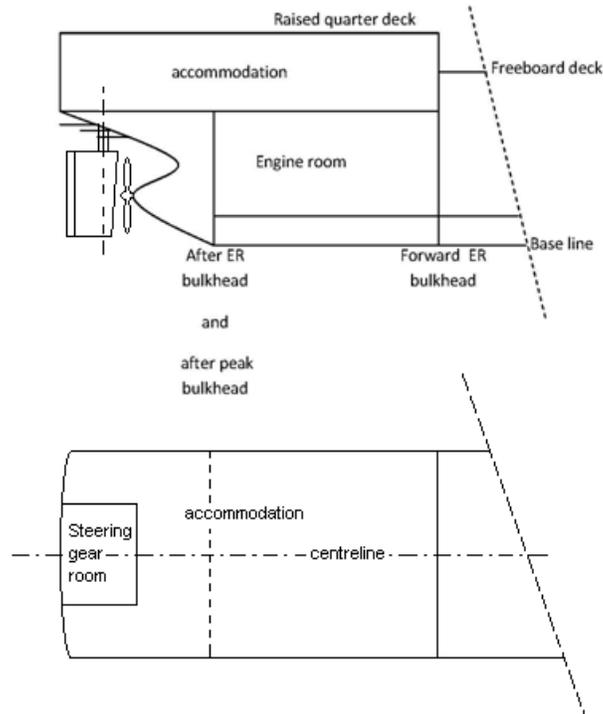
**9** The number of openings in the extension of the collision bulkhead above the freeboard deck shall be restricted to the minimum compatible with the design and normal operation of the ship. All such openings shall be capable of being closed weathertight.

**10** Bulkheads shall be fitted separating the machinery space from cargo and accommodation spaces forward and aft and made watertight up to the bulkhead deck **of passenger ships and the freeboard deck of cargo ships**. An afterpeak bulkhead shall also be fitted and made watertight up to the bulkhead deck **or the freeboard deck**. The afterpeak bulkhead may, however, be stepped below the bulkhead deck **or the freeboard deck**, provided the degree of safety of the ship as regards subdivision is not thereby diminished.

### **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.



**11** In all cases stern tubes shall be enclosed in watertight spaces of moderate volume. In passenger ships the stern gland shall be situated in a watertight shaft tunnel or other watertight space separate from the stern tube compartment and of such volume that, if flooded by leakage through the stern gland, the bulkhead deck will not be immersed. In cargo ships other measures to minimize the danger of water penetrating into the ship in case of damage to stern tube arrangements may be taken at the discretion of 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.

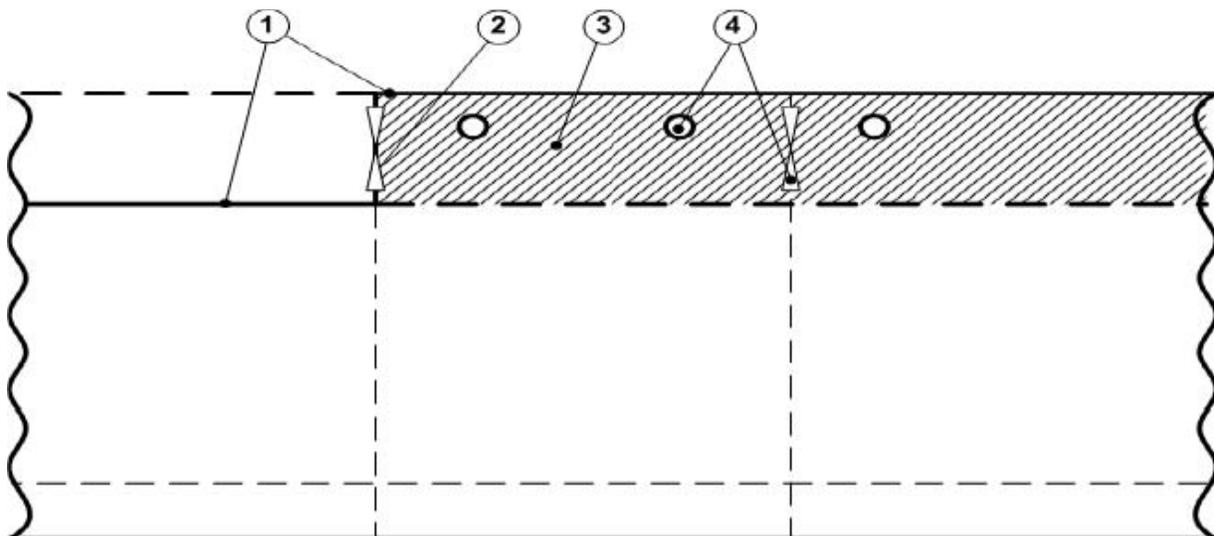
**MCA Guidance - Regulation 12.11; Stern Gland and Stern Tube**

The watertight shaft tunnel, or other watertight space in which, the stern gland is to be situated, should be of sufficient height and width to allow proper attention to be given to shaft couplings, bearings etc. within the space.

**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

1 The number of openings in watertight bulkheads boundaries shall be reduced to the minimum compatible with the design and proper working of the ship, satisfactory means shall be provided for closing these openings.

**MCA Guidance - Regulation 13.1; Position of Watertight Doors**

(1) It has always been accepted that some access openings, closed by means of watertight doors, will be required in some watertight bulkheads for essential purposes, for example, to inspect vital items of machinery, provide emergency or alternative means of escape. Acceptance of the location of any watertight door will be dependent upon the Certifying Authority being satisfied that its presence is essential for the proper working of the ship.

(2) Every effort should be made to reduce, as far as practicable, the number of watertight doors fitted in any passenger ship. In any new design reducing the number of openings in watertight bulkheads might be achieved in a number of ways. For example, in the accommodation spaces, efforts should be made to arrange access and escape routes in a manner which would minimise the need for people to pass through watertight bulkheads below the level of the bulkhead deck. In the case of service spaces and other working compartments normal access should where possible be available without the need for continual passage through main bulkheads.

(3) The possible effects of progressive flooding through an unclosed opening should always be taken into account when deciding upon the position and size of any watertight door. An unclosed door, lying wholly below the level of the waterline, obviously presents a great potential hazard. To lessen such dangers, watertight doors should be kept as small as possible and be positioned, whenever practicable, close to the centreline with their sills as high as is possible and consistent with safe access and preferably above the level of the waterline.

(4) The effectiveness of subdivision arrangements is dependent on any watertight door being closed when breaching occurs, or almost immediately afterwards. It is also essential to limit the number of access openings placed in the divisional bulkheads and also to exercise the strictest control over the operation of the watertight doors provided to close such openings.

(5) Watertight doors should be fitted inboard of the B/5 line and with their sills as high as possible above the keel. A door positioned outboard of the B/5 may be permitted if the surveyor, and Headquarters, is satisfied that it is necessary for the proper working of the ship and cannot be located elsewhere.

(6) Where watertight doors are permitted to be fitted in bulkheads dividing two between deck cargo spaces they must be located inboard of the B/5 line.

2.1 Where pipes, scuppers, electric cables, etc., are carried through watertight bulkheads boundaries, arrangements shall be made to ensure the watertight integrity of the bulkheads boundaries.

2.2 Valves not forming part of a piping system shall not be permitted in watertight bulkheads boundaries.

2.3 Lead or other heat sensitive materials shall not be used in systems which penetrate watertight bulkheads boundaries, where deterioration of such systems in the event of fire would impair the watertight integrity of the bulkheads boundaries.

### **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 to be considered as being 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<sup>1</sup>.

The fire tested pipe penetration should 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. (See also SDC 9/10/1 below).

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.

3 No doors, manholes, or access openings are permitted in watertight transverse bulkheads dividing a cargo space from an adjoining cargo space, except as provided in paragraph 9.8.1 and in regulation 14.

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

**IACS Interpretation of II-1/13**

**(ref. SDC 9/10/1 was discussed at SDC 9 in January 2023 and is awaiting MSC approval at the time of writing (April 2023))**

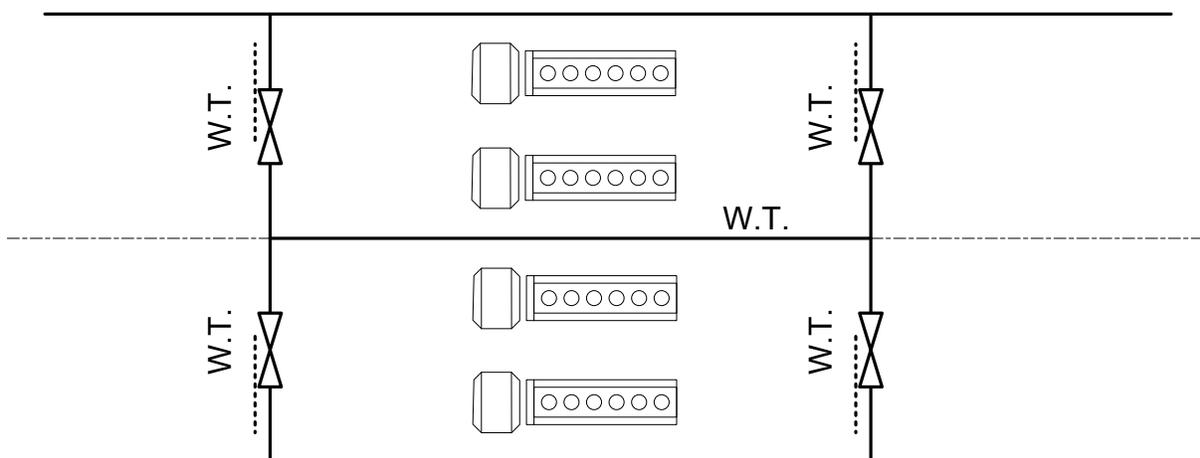
1 Any penetration used for the passage of heat sensitive piping systems through a watertight bulkhead or deck on a passenger ship under SOLAS regulation II-1/13 should be tested with the heat sensitive piping and should be type approved for watertight integrity as per the explanatory notes to regulation 13.2.3.4 contained in annex of resolution MSC.429(98)/Rev.1 and Rev.2 (as applicable) after the fire test.

2 SOLAS regulation II-1/13 should be applicable to heat sensitive piping systems and should not be applied to cable penetrations in watertight bulkheads and decks.

4 Subject to paragraph 10.9, not more than one door, apart from the doors to shaft tunnels, may be fitted in each watertight bulkhead within spaces containing the main and auxiliary propulsion machinery including boilers serving the needs of propulsion. Where two or more shafts are fitted, the tunnels shall be connected by an intercommunicating passage. There shall be only one door between the machinery space and the tunnel spaces where two shafts are fitted and only two doors where there are more than two shafts. All these doors shall be of the sliding type and shall be so located as to have their sills as high as practicable. The hand gear for operating these doors from above the bulkhead deck shall be situated outside the spaces containing the machinery.

**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.*



5.1 Watertight doors, except as provided in paragraph 9 8.1 or regulation 14, shall be power-operated sliding doors complying with the requirements of paragraph 7 6 capable of being closed simultaneously from the central operating console at the navigation bridge in not more than 60 s with the ship in the upright position.

5.2 The means of operation whether by power or by hand of any power-operated sliding watertight door shall be capable of closing the door with the ship listed to 15° either way. Consideration shall also be given to the forces which may act on either side of the door as may be experienced when water is flowing through the opening applying a static head equivalent to a water height of at least 1 m above the sill on the centreline of the door.

5.3 Watertight door controls, including hydraulic piping and electric cables, shall be kept as close as practicable to the bulkhead in which the doors are fitted, in order to minimize the likelihood of them being involved in any damage which the ship may sustain. The positioning of watertight doors and their controls shall be such that if the ship sustains damage within one fifth of the breadth of the ship, as defined in regulation 2, such distance being measured at right angles to the centreline at the level of the deepest subdivision draught, the operation of the watertight doors clear of the damaged portion of the ship is not impaired.

~~6 All power operated sliding watertight doors shall be provided with means of indication which will show at all remote operating positions whether the doors are open or closed. Remote operating positions shall only be at the navigation bridge as required by paragraph 7.1.5 and at the location where hand operation above the bulkhead deck is required by paragraph 7.1.4.~~

~~7-6.1~~ Each power-operated sliding watertight door:

- .1 shall have a vertical or horizontal motion;
- .2 shall, subject to paragraph 10 9, be normally limited to a maximum clear opening width of 1.2 m. The Administration may permit larger doors only to the extent considered necessary for the effective operation of the ship provided that other safety measures, including the following, are taken into consideration:
  - .1 special consideration shall be given to the strength of the door and its closing appliances in order to prevent leakages; and
  - .2 the door shall be located inboard the damage zone  $B/5$ ;
- .3 shall be fitted with the necessary equipment to open and close the door using electric power, hydraulic power, or any other form of power that is acceptable to the Administration;
- .4 shall be provided with an individual hand-operated mechanism. It shall be possible to open and close the door by hand at the door itself from either side, and in addition, close the door from an accessible position above the

bulkhead deck with an all-round crank motion or some other movement providing the same degree of safety acceptable to the Administration. Direction of rotation or other movement is to be clearly indicated at all operating positions. The time necessary for the complete closure of the door, when operating by hand gear, shall not exceed 90 s with the ship in the upright position. Visual indicators to show whether the door is open or closed shall be provided at the accessible position above the bulkhead deck.

- .5 shall be provided with controls for opening and closing the door by power from both sides of the door and also for closing the door by power from the central operating console(s) at the navigation bridge required by paragraph 7.1;
- .6 shall be provided with an audible alarm, distinct from any other alarm in the area, which will sound whenever the door is closed remotely by power and which shall sound for at least 5 s but no more than 10 s before the door begins to move and shall continue sounding until the door is completely closed. In the case of remote hand operation it is sufficient for the audible alarm to sound only when the door is moving. Additionally, in passenger areas and areas of high ambient noise the Administration may require the audible alarm to be supplemented by an intermittent visual signal at the door; and
- .7 shall have an approximately uniform rate of closure under power. The closure time, from the time the door begins to move to the time it reaches the completely closed position shall in no case be less than 20 s or more than 40 s with the ship in the upright position.

7.6.2 The electrical power required for power-operated sliding watertight doors shall be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck. The associated control, indication and alarm circuits shall be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically supplied by the transitional source of emergency electrical power required by regulation 42.3.1.3 in the event of failure of either the main or emergency source of electrical power.

7.6.3 Power-operated sliding watertight doors shall have either:

- .1 a centralized hydraulic system with two independent power sources each consisting of a motor and pump capable of simultaneously closing all doors. In addition, there shall be for the whole installation hydraulic accumulators of sufficient capacity to operate all the doors at least three times, i.e. closed-open-closed, against an adverse list of 15°. This operating cycle shall be capable of being carried out when the accumulator is at the pump cut-in pressure. The fluid used shall be chosen considering the temperatures liable to be encountered by the installation during its service. The power operating system shall be designed to minimize the possibility of having a

- single failure in the hydraulic piping adversely affect the operation of more than one door. The hydraulic system shall be provided with a low-level alarm for hydraulic fluid reservoirs serving the power-operated system and a low gas pressure alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators. These alarms are to be audible and visual and shall be situated on the central operating console(s) at the navigation bridge required by paragraph 7.1; or
- .2 an independent hydraulic system for each door with each power source consisting of a motor and pump capable of opening and closing the door. In addition, there shall be a hydraulic accumulator of sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°. This operating cycle shall be capable of being carried out when the accumulator is at the pump cut-in pressure. The fluid used shall be chosen considering the temperatures liable to be encountered by the installation during its service. A low gas pressure group alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators shall be provided at the central operating console(s) at the navigation bridge required by paragraph 7.1. Loss of stored energy indication at each local operating position shall also be provided; or
  - .3 an independent electrical system and motor for each door with each power source consisting of a motor capable of opening and closing the door. The power source shall be capable of being automatically supplied by the transitional source of emergency electrical power as required by regulation 42.4.2 – in the event of failure of either the main or emergency source of electrical power and with sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°.

For the systems specified in paragraphs 76.3.1, 76.3.2 and 76.3.3, provision should be made as follows: Power systems for power-operated watertight sliding doors shall be separate from any other power system. A single failure in the electric or hydraulic power-operated systems excluding the hydraulic actuator shall not prevent the hand operation of any door.

**76.4** Control handles shall be provided at each side of the bulkhead at a minimum height of 1.6 m above the floor and shall be so arranged as to enable persons passing through the doorway to hold both handles in the open position without being able to set the power closing mechanism in operation accidentally. The direction of movement of the handles in opening and closing the door shall be in the direction of door movement and shall be clearly indicated.

**76.5** As far as practicable, electrical equipment and components for watertight doors shall be situated above the bulkhead deck and outside hazardous areas and spaces.

**7.6.6** The enclosures of electrical components necessarily situated below the bulkhead deck shall provide suitable protection against the ingress of water. \*

\* Refer to the following publication IEC 60529:2003:

- .1 electrical motors, associated circuits and control components; protected to IPX 7 standard;
- .2 door position indicators and associated circuit components; protected to IPX 8 standard; and
- .3 door movement warning signals; protected to IPX 6 standard.

Other arrangements for the enclosures of electrical components may be fitted provided the Administration is satisfied that an equivalent protection is achieved. The water pressure IPX 8 shall be based on the pressure that may occur at the location of the component during flooding for a period of 36 h.

**7.6.7** Electric power, control, indication and alarm circuits shall be protected against fault in such a way that a failure in one door circuit will not cause a failure in any other door circuit. Short circuits or other faults in the alarm or indicator circuits of a door shall not result in a loss of power operation of that door. Arrangements shall be such that leakage of water into the electrical equipment located below the bulkhead deck will not cause the door to open.

**7.6.8** A single electrical failure in the power operating or control system of a power-operated sliding watertight door shall not result in a closed door opening. Availability of the power supply should be continuously monitored at a point in the electrical circuit as near as practicable to each of the motors required by paragraph **7.6.3**. Loss of any such power supply should activate an audible and visual alarm at the central operating console ~~(s) at the navigation bridge~~ required by paragraph **7.1**;

**8.7.1** A central operating console for all power-operated sliding watertight doors shall be located in the safety centre in accordance with regulation II-2/23. If the safety centre is located in a separate space adjacent to the navigation bridge, a central operating console shall also be located on the navigation bridge. The central operating console ~~(s) at the navigation bridge~~ shall have a “master mode” switch with two modes of control: a “local control” mode which shall allow any door to be locally opened and locally closed after use without automatic closure, and a “doors closed” mode which shall automatically close any door that is open in not more than 60 s with the ship in an upright position. ~~[The “doors closed” mode shall automatically close any door that is open.]~~ The “doors closed” mode shall permit doors to be opened locally and shall automatically re-close the doors upon release of the local control mechanism. The “master mode” switch shall normally be in the “local control” mode. The “doors closed” mode shall only be used in an emergency or for testing purposes. ~~Special consideration shall be given to the reliability of the “master mode” switch.~~

**8.7.2** For ships subject to the provisions of regulation 1.1.1.1 and constructed before 1 January 2024, the central operating console at the navigation bridge shall be provided with a diagram showing the location of each door, with visual indicators to show whether each door is open or closed. A red light shall indicate a door is fully open and a green light shall indicate a door is fully closed. When the door is closed remotely the red light

shall indicate the intermediate position by flashing. The indicating circuit shall be independent of the control circuit for each door.

**8.27.3** For ships constructed on or after 1 January 2024, ~~the~~ the central operating console(s) ~~at the navigation bridge~~ shall be provided with a diagram showing the location of each power-operated sliding watertight door, with visual indicators to show whether each door is open or closed. A red light shall indicate a door is fully open and a green light shall indicate a door is fully closed. When the door is closed remotely the red light shall indicate the intermediate position by flashing. The indicating circuit shall be independent of the control circuit for each door. ~~Indication shall also be provided to the onboard stability computer, if installed in accordance with regulation II-1/8-1.3.1.~~

**87.34** It shall not be possible to remotely open any door from the central operating console.

**98.1** If the Administration is satisfied that such doors are essential, watertight doors of satisfactory construction may be fitted in watertight bulkheads dividing cargo ~~between deck spaces~~ on 'tween decks. Such doors may be hinged, rolling or sliding doors but shall not be remotely controlled. They shall be fitted at the highest level and as far from the shell plating as practicable, but in no case shall the outboard vertical edges be situated at a distance from the shell plating which is less than one fifth of the breadth of the ship, as defined in regulation 2, such distance being measured at right angles to the centreline at the level of the deepest subdivision draught.

**98.2** Should any such doors be accessible during the voyage, they shall be fitted with a device which prevents unauthorized opening. When it is proposed to fit such doors, the number and arrangements shall receive the special consideration of the Administration.

**109** Portable plates on bulkheads shall not be permitted except in machinery spaces. The Administration may permit not more than one power-operated sliding watertight door ~~in each watertight bulkhead~~ larger than those specified in paragraph ~~76.1.2~~ to be substituted for these portable plates ~~in each watertight bulkhead~~, provided these doors are intended to remain closed during navigation except in case of urgent necessity at the discretion of the master. These doors need not meet the requirements of paragraph ~~76.1.4~~ regarding complete closure by hand-operated gear in 90 s.

**110.1** Where trunkways or tunnels for access from crew accommodation to the ~~machinery spaces~~, for piping, or for any other purpose are carried through watertight bulkheads, they shall be watertight and in accordance with the requirements of regulation 16-1. The access to at least one end of each such tunnel or trunkway, if used as a passage at sea, shall be through a trunk extending watertight to a height sufficient to permit access above the bulkhead deck. The access to the other end of the trunkway or tunnel may be through a watertight door ~~of the type required by its location in the ship~~. Such trunkways or tunnels shall not extend through the first subdivision bulkhead abaft the collision bulkhead.

**MCA Guidance - Regulation 13.10.1; Watertight Door at End of Tunnel**

Where a watertight door must be fitted at one end of a tunnel, surveyors should note that an exemption from this requirement can be considered for short tunnels situated near the centre line of the ship, if the safety of the ship in the event of damage is not impaired. In other cases, where the tunnel is used as a passage at sea, access shall also be obtained by means of a trunkway extending watertight to above the margin line.

140.2 Where it is proposed to fit tunnels piercing watertight bulkheads, these shall receive the special consideration of the Administration.

140.3 Where trunkways in connection with refrigerated cargo and ventilation or forced draught trunks are carried through more than one watertight bulkhead, the means of closure at such openings shall be operated by power and be capable of being closed from a central position situated above the bulkhead deck.

**Regulation 13-1****Openings in watertight bulkheads and internal decks in cargo ships**

1 The number of openings in watertight subdivisions is to be kept to a minimum compatible with the design and proper working of the ship. Where penetrations of watertight bulkheads and internal decks are necessary for access, piping, ventilation, electrical cables, etc., arrangements are to be made to maintain the watertight integrity. The Administration may permit relaxation in the watertightness of openings above the freeboard deck, provided that it is demonstrated that any progressive flooding can be easily controlled and that the safety of the ship is not impaired.

**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*

2 Doors provided to ensure the watertight integrity of internal openings which are used while at sea are to be sliding watertight doors capable of being remotely closed from the bridge and are also to be operable locally from each side of the bulkhead. Indicators are to be provided at the control position showing whether the doors are open or closed, and an audible alarm is to be provided at the door closure. The power, control and indicators are to be operable in the event of main power failure. Particular attention is to

be paid to minimizing the effect of control system failure. Each power-operated sliding watertight door shall be provided with an individual hand-operated mechanism. It shall be possible to open and close the door by hand at the door itself from both sides.

3 Access doors and access hatch covers normally closed at sea, intended to ensure the watertight integrity of internal openings, shall be provided with means of indication locally and on the bridge showing whether these doors or hatch covers are open or closed. A notice is to be affixed to each such door or hatch cover to the effect that it is not to be left open.

4 Watertight doors or ramps of satisfactory construction may be fitted to internally subdivide large cargo spaces, provided that the Administration is satisfied that such doors or ramps are essential. These doors or ramps may be hinged, rolling or sliding doors or ramps, but shall not be remotely controlled. Should any of the doors or ramps be accessible during the voyage, they shall be fitted with a device which prevents unauthorized opening.

5 Other closing appliances which are kept permanently closed at sea to ensure the watertight integrity of internal openings shall be provided with a notice which is to be affixed to each such closing appliance to the effect that it is to be kept closed. Manholes fitted with closely bolted covers need not be so marked.

## **Regulation 14**

### **Passenger ships carrying goods vehicles and accompanying personnel**

1 This regulation applies to passenger ships designed or adapted for the carriage of goods vehicles and accompanying personnel.

2 If in such a ship the total number of passengers which include personnel accompanying vehicles does not exceed  $12 + A_d/25$ , where  $A_d$  = total deck area (square metres) of spaces available for the stowage of goods vehicles and where the clear height at the stowage position and at the entrance to such spaces is not less than 4 m, the provisions of regulations 13.9.1 and 13.9.2 in respect of watertight doors apply except that the doors may be fitted at any level in watertight bulkheads dividing cargo spaces. Additionally, indicators are required on the navigation bridge to show automatically when each door is closed and all door fastenings are secured.

3 The ship may not be certified for a higher number of passengers than assumed in paragraph 2, if a watertight door has been fitted in accordance with this regulation.

## Regulation 15

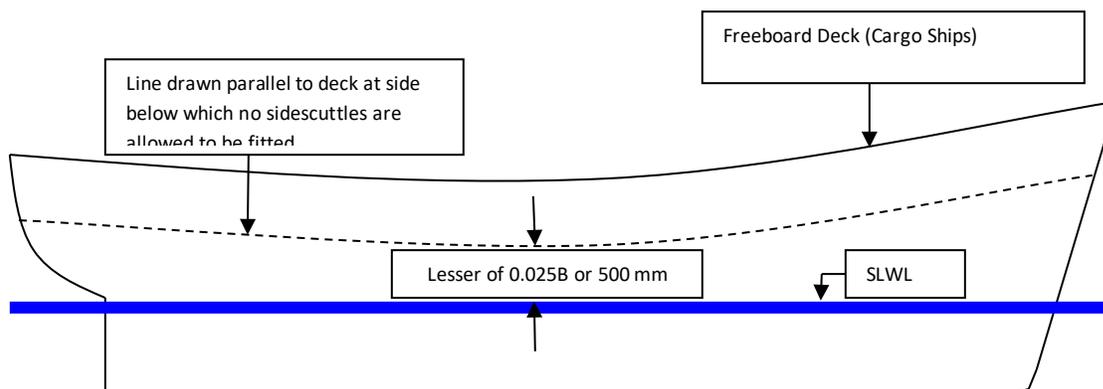
### Openings in the shell plating below the bulkhead deck of passenger ships and the freeboard deck of cargo ships

#### **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.*

- 1 The number of openings in the shell plating shall be reduced to the minimum compatible with the design and proper working of the ship.
- 2 The arrangement and efficiency of the means for closing any opening in the shell plating shall be consistent with its intended purpose and the position in which it is fitted and generally to the satisfaction of the Administration.
- 3.1 Subject to the requirements of the International Convention on Load Lines in force, no sidescuttle shall be fitted in such a position that its sill is below a line drawn parallel to the bulkhead deck at side and having its lowest point 2.5% of the breadth of the ship above the deepest subdivision draught, or 500 mm, whichever is the greater.

#### **MCA Guidance - Regulation 15.3.1; Permitted Location of Side Scuttles**



- (1) The arrangements of side scuttles should be re-examined for compliance when an increase in draught is proposed. Any side scuttle found not to comply must be blanked off.
- (2) Where it is proposed to fit heavy duty side scuttles bolted to the shell, particular attention should be made where the connection is not bolted through the shell plating.

3.2 All sidescuttles the sills of which are below the bulkhead deck of passenger ships and the freeboard deck of cargo ships, as permitted by paragraph 3.1, shall be of such construction as will effectively prevent any person opening them without the consent of the master of the ship.

### **MCA Guidance - Regulation 15.3 in general; Side Scuttles**

The greatest problem in strength of windows, are the very large openings now being glazed, where the weak point can be the frames themselves if they cannot withstand the pressure forces from such large areas. There is no ISO or national standard that I know of which provides for increased frame scantlings for extra large windows. Deadlights for such windows also become unmanageable.

#### **(1) General**

(i) The approach to be taken when considering the acceptance of windows or side scuttles shall depend upon the basis upon which these items have been constructed.

(ii) They may be of a type which has previously been “Type Approved” by the Certifying Authority, they may be constructed to the rules of a recognised Classification Society or they may have been designed and constructed on a “one-off” basis, in which case approval shall be by examination. See below.

#### **(2) Type Approved Side Scuttles and Windows**

(i) Where Side Scuttles and Windows are constructed in accordance with a Type Approved design, then their frames should be marked in accordance with the applicable standard under which such type approval was given. Recognised standards are BSMA24 and BSMA25 and their ISO equivalents, namely ISO 1751 and ISO 3903.

(ii) In addition, glasses used in the construction of Side Scuttles and Windows should also comply with the relevant requirements of BSMA24 and BSMA25 or their ISO equivalents, namely ISO 1095 and ISO 614 or ISO 3254 and ISO 614, relating to size and strength of toughened glass panes. Where glass panes used in the construction of Side Scuttles and Windows meet the requirements of one of the above standards for strength, they should be marked in accordance with the provisions of BSMA24, BSMA25 or ISO 614 as appropriate.

(iii) Additional checks which should be undertaken during plan and as fitted approval, are comparison of the frames and fitting with the requirements of the applicable standard. Where there is any doubt, further

comparison would need to be made with the approved drawings cited in the Approval Certificate (or attached Schedules) before any referral was made to Headquarters for advice regarding non-compliance of the frame with the approved design or of the approved design in relation to the applicable standard.

(iv) Note that type approved frames of BSMA type should be marked with the thickness of the glass which they are designed to accept. For “double glazed” units, this thickness shall include the full depth of both panes and the intermediate air gap.

### (3) Class Approved Side Scuttles and Windows

(i) Where Side Scuttles and Windows are constructed in accordance with the requirements of a recognised Classification Society, then the surveyor should approach the builders to provide supporting documentation in the form of copies of the approved construction drawings stamped and endorsed by the Class Society.

(ii) It is of particular importance in such cases that the surveyor should satisfy himself that approval of both the frame and the glasses is given with respect to construction rules which are fully appropriate for the design the proposed position and the service of the vessel.

### (4) Side Scuttles and Windows of Non-Approved Type

(i) Where Side Scuttles and Windows presented for survey are not of a type previously approved in accordance with the requirements of a recognised standard, then the surveyor should undertake approval of such items on an individual basis for the vessel concerned. See Guidance to SOLAS2009 Explanatory Notes Appendix 2.2, above.

(ii) Such an approach should commence by assessing the frames against a recognised standard appropriate to the proposed application, noting that strength tests may be required on sample panes to confirm compliance where documentary evidence is not available, and that glass thicknesses are appropriate to the position and size of the each side scuttle or window under consideration. See paragraph 4, above.

(iii) Where the design of proposed frames and glasses is shown to comply with the requirements of the applicable standard the frames should be marked during manufacture in accordance with the provisions of the

standard, where such markings are specified, and formal notification of the approval should be given to the builders.

(iv) In cases where non-approved frames presented for survey do not conform to any recognised standard, or are not in full accordance with the provisions of the applicable standard, full details including supporting documentation regarding the chemical composition and mechanical strength of the materials used should be referred to Headquarters for consideration of acceptance as an “equivalent” to the requirements of a relevant standard.

**(5) Side Scuttles and Windows - Glazing Materials other than Glass**

(i) The material used for side scuttles, windows and for enclosing promenades and deck spaces should normally be heat treated toughened safety glass. However, the use of other materials may be considered provided that these fulfil relevant provisions for strength, stiffness, structural fire protection, visibility and location and suitability for use in escapes.

(ii) In general, where it is proposed to use materials other than toughened safety glass panes, their use should be in accordance with the requirements of an acceptable standard appropriate to the proposed Class and service of the vessel. Otherwise, full details of the proposed materials and their use should be submitted to Headquarters for consideration of acceptance as an “equivalent” to the requirements of a relevant standard.

**(6) Internal Glazing of Windows and other Translucent Divisions**

(i) Where it is proposed to fit internal glazed divisions in a vessel, then application of BSMA25, or its equivalent ISO 3903, may not be appropriate.

(ii) Whilst such internal divisions should be glazed using heat treated toughened safety glass, the use of other materials will be accepted provided that these comply with the requirements of an acceptable standard. Such standards may be those of a recognised Classification Society, appropriate for the Class and service of the vessel, or other national or international standards applicable to such divisions, provided that they are appropriate to the application under consideration.

(iii) In such cases the surveyor should satisfy himself that any such division is constructed in a manner which shall afford passengers and crew the maximum protection in the event of breakage.

(iv) An appropriate standard for such consideration would be BS6206:1981 which relates to the “impact” testing of glazed constructions used in land based applications. This standard grades glazing arrangements in three strength bands A to C, where A affords the highest impact resistance. Glazing arrangements (such as a door or window unit) shall pass the test if the pane “breaks safely” or does not break during the test.

(v) It is recommended that only units which meet Class a, and are marked as such, are accepted for marine use, noting that in the case of plastics and laminated glasses, preference should be given to constructions which did not break during impact testing. Copies of test certificates specifying the test result should be available from the manufacturers on request.

(vi) Alternatively, appropriately marked toughened glass panes, strength tested in accordance with BSMA25 or ISO 614, or another applicable standard, may be accepted for use in internal screens/divisions with the recommendation that panes which exceed 0.75 sq.m in area have a minimum thickness of 10 mm and those smaller than 0.75 sq.m have a minimum thickness of 6 mm.

(vii) In cases where the surveyor is unsure as to the acceptability of proposed internal glazing arrangements, they should refer the case to Headquarters for consideration giving as much detail as possible with respect to the position, construction and glazing of each item, along with details of any markings or certification supplied by the manufacturer/shipbuilder in support of the proposed construction.

4 Efficient hinged inside deadlights so arranged that they can be easily and effectively closed and secured watertight, shall be fitted to all sidescuttles except that, abaft one eighth of the ship's length from the forward perpendicular and above a line drawn parallel to the bulkhead deck at side and having its lowest point at a height of 3.7 m plus 2.5% of the breadth of the ship above the deepest subdivision draught, the deadlights may be portable in passenger accommodation ~~other than that for stowage passengers,~~ unless the deadlights are required by the International Convention on Load Lines in force to be permanently attached in their proper positions. Such portable deadlights shall be stowed adjacent to the sidescuttles they serve.

5.1 No sidescuttles shall be fitted in any spaces which are appropriated exclusively to the carriage of cargo ~~or coal.~~

5.2 Sidescuttles may, however, be fitted in spaces appropriated alternatively to the carriage of cargo or passengers, but they shall be of such construction as will effectively prevent any person opening them or their deadlights without the consent of the master.

6 Automatic ventilating sidescuttles shall not be fitted in the shell plating below the bulkhead deck of passenger ships and the freeboard deck of cargo ships without the special sanction of the Administration.

7 The number of scuppers, sanitary discharges and other similar openings in the shell plating shall be reduced to the minimum either by making each discharge serve for as many as possible of the sanitary and other pipes, or in any other satisfactory manner.

#### **MCA Guidance - Regulation 15.7; Water-closets**

**When water-closets of the under-waterline type are to be fitted, plans should be specially submitted for acceptance.**

8.1 All inlets and discharges in the shell plating shall be fitted with efficient and accessible arrangements for preventing the accidental admission of water into the ship.

#### **MCA Guidance - Regulation 15.8.1; Inlets and Discharges**

**(1) Discharge pipes, fitted in accordance with the provisions of the Regulations, should have a sufficient bend to provide for expansion of the pipe and also any movement due to the working of the ship.**

**(2) All discharge pipes led through the shell below the bulkhead deck in passenger ships (freeboard deck in cargo ships) and the valves relating thereto shall be protected from damage.**

**(3) The arrangements of scuppers and discharges should be re-examined when an increase in draught is proposed, and where such an increase warrants a more positive means of preventing water from passing inboard, such means must be fitted to the scuppers and discharges**

8.2.1 Subject to the requirements of the International Convention on Load Lines in force, and except as provided in paragraph 8.3, each separate discharge led through the shell plating from spaces below the bulkhead deck of passenger ships and the freeboard deck of cargo ships shall be provided with either one automatic non-return valve fitted with a positive means of closing it from above the bulkhead deck **of passenger ships and the freeboard deck of cargo ships** or with two automatic non-return valves without positive means of closing, provided that the inboard valve is situated above the deepest subdivision draught and is always accessible for examination under service conditions. Where a valve with positive means of closing is fitted, the operating position above the bulkhead deck **of passenger ships and the freeboard deck of cargo ships** shall always be readily accessible and means shall be provided for indicating whether the valve is open or closed

8.2.2 The requirements of the International Convention on Load Lines in force shall apply to discharges led through the shell plating from spaces above the bulkhead deck of passenger ships and the freeboard deck of cargo ships.

8.3 Machinery space, main and auxiliary sea inlets and discharges in connection with the operation of machinery shall be fitted with readily accessible valves between the pipes and the shell plating or between the pipes and fabricated boxes attached to the shell plating. In manned machinery spaces the valves may be controlled locally and shall be provided with indicators showing whether they are open or closed.

8.4 Moving parts penetrating the shell plating below the deepest subdivision draught shall be fitted with a watertight sealing arrangement acceptable to the Administration. The inboard gland shall be located within a watertight space of such volume that, if flooded, the bulkhead deck **of passenger ships and the freeboard deck of cargo ships** will not be submerged. The Administration may require that if such compartment is flooded, essential or emergency power and lighting, internal communication, signals or other emergency devices must remain available in other parts of the ship.

#### **MCA Guidance - Regulation 15.8.4; Storm Valve**

**The storm valve fitted at the ship's side is to be of a substantial back-balanced type, or of a type in which the valve face is at an angle of not less than 15° to the vertical when closed. Valves mounted on a spigot, instead of being attached directly to the shell, may be accepted provided that the spigot is:**

- (i) not more than 305 mm in length;**
- (ii) efficiently welded and bracketed to the shell; and**
- (iii) its thickness is not less than the thickness of the shell plating in which it is situated.**

8.5 All shell fittings and valves required by this regulation shall be of steel, bronze or other approved ductile material. Valves of ordinary cast iron or similar material are not acceptable. All pipes to which this regulation refers shall be of steel or other equivalent material to the satisfaction of the Administration.

9 **For ships subject to the provisions of regulation 1.1.1.1 and constructed before 1 January 2024,** gangway, cargo and fuelling ports fitted below the bulkhead deck of passenger ships and the freeboard deck of cargo ships shall be watertight and in no case be so fitted as to have their lowest point below the deepest subdivision draught.

**910 For ships constructed on or after 1 January 2024, Gangway, cargo ports and other similar openings (e.g. gangway and fuelling ports) in the side of ships fitted below the bulkhead deck of passenger ships and the freeboard deck of cargo ships shall be fitted with doors so designed as to ensure the same watertightness and structural integrity as the surrounding shell plating. Unless otherwise granted by the Administration, these openings shall open outwards. The number of such openings shall be the minimum compatible with the design and proper working of the ship. watertight and in no case shall**

these openings be so fitted as to have their lowest point below the deepest subdivision draught.

~~10.1 The inboard opening of each ash chute, rubbish chute, etc., shall be fitted with an efficient cover.~~

~~10.2 If the inboard opening is situated below the bulkhead deck of passenger ships and the freeboard deck of cargo ships, the cover shall be watertight and, in addition, an automatic non-return valve shall be fitted in the chute in an easily accessible position above the deepest subdivision draught.~~

## 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.**

1 All external openings leading to compartments assumed intact in the damage analysis, which are below the final damage waterline, are required to be watertight.

#### **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.*

2 External openings required to be watertight in accordance with paragraph 1 shall, except for cargo hatch covers, be fitted with indicators on the bridge.

3 Openings in the shell plating below the deck limiting the vertical extent of damage shall be fitted with a device that prevents unauthorized opening if they are accessible during the voyage.

4 Other closing appliances which are kept permanently closed at sea to ensure the watertight integrity of external openings shall be provided with a notice affixed to each appliance to the effect that it is to be kept closed. Manholes fitted with closely bolted covers need not be so marked.

## Regulation 16

### Construction and initial tests of watertight closures

#### **Regulation 16**

#### **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 of Load Lines.*

~~1 In all ships~~

1.1 The design, materials and construction of all watertight closures such as doors, hatches, sidescuttles, gangway and cargo ports, valves, and pipes, ~~ash chutes and rubbish chutes~~ referred to in these regulations shall be to the satisfaction of the Administration;

1.2 Such valves, doors, hatches, and mechanisms shall be suitably marked to ensure that they may be properly used to provide maximum safety; and

1.3 The frames of vertical watertight doors shall have no groove at the bottom in which dirt might lodge and prevent the door closing properly.

#### **MCA Guidance - Regulation 16.1; Construction of WT doors**

(1) Every watertight door should be of such design, material and construction as will maintain the integrity of the watertight bulkhead in which it is fitted. For this purpose it may be necessary, particularly with large sliding watertight doors, to arrange points of support in way of the leading and trailing edges of the door at the closed position. The design stress in the door should be such that a factor of safety of approximately three, based on the ultimate tensile strength of the material, will be obtained.

(2) Every sliding watertight door should be fitted with rubbing faces of brass or similar material which may be fitted either on the door itself or on the door frame, and which, if they are less than 25 mm in width, should be fitted in recesses. In the case of ships constructed after 1 February 1992, other methods of sealing sliding watertight doors may be acceptable.

(3) If screw gear is used for operating such a door, the screw and nut should be of suitable metals which are resistant to corrosion.

(4) As the Regulations states, the frame of every vertically sliding watertight door should have no groove at the bottom thereof in which dirt may lodge. The bottom of such a frame, if it is of skeleton form, should be so arranged that dirt cannot lodge therein. The bottom edge of every such door should be tapered or bevelled.

(5) Every vertically sliding watertight door which is operated by power should be so designed and fitted that, if the power supply ceases, there should be no danger of the door dropping.

(6) Every horizontally sliding watertight door should be so installed as to prevent its moving if the ship rolls, and if necessary a clip or other suitable device should be provided for that purpose. The device should not interfere with the closing of the door when the door is required to be closed.

(7) In the case of sliding watertight doors, care should be taken to ensure a satisfactory connection where the door frame beds on to the bulkhead plating. In compartments where oil fuel may catch fire, these connections should be metal to metal. Any jointing used should not be adversely affected by heat or the local environment.

2 ~~In passenger ships and cargo ships~~ Watertight doors and hatches shall be tested by water pressure to the maximum head of water they might sustain in a final or intermediate stage of flooding. ~~For cargo ships not covered by damage stability requirements,~~ watertight doors and hatches shall be tested by water pressure to a head of water measured from the lower edge of the opening to one metre above the freeboard deck. Where testing of individual doors and hatches is not carried out because of possible damage to insulation or outfitting items, testing of individual doors and hatches may be replaced by a prototype pressure test of each type and size of door or hatch with a test pressure corresponding at least to the head required for the individual location. The prototype test shall be carried out before the door or hatch is fitted. The installation method and procedure for fitting the door or hatch on board shall correspond to that of the prototype test. When fitted on board, each door or hatch shall be checked for proper seating between the bulkhead, the frame and the door or between deck, the coaming and the hatch.

### **Regulation 16.2**

~~1. Watertight doors should be tested by water pressure to a head of water measured from the lower edge of the door opening to the bulkhead deck or the freeboard deck, or to the most unfavourable final or intermediate waterplane during flooding, whichever is greater.~~

~~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.

**MCA Guidance - Regulation 16.2; Testing of WT doors**

(1) Every watertight door should be tested at the works in the presence of the surveyor by hydraulic pressure equivalent to the head of water measured from the bottom of the door to the margin line in way of the bulkhead to which the door is to be fitted, but in no case should the test pressure be less than 6 m head for sliding doors or less than 3 m head for hinged doors. The framework to which the door frame is secured for the purpose of testing at the works should not give greater reinforcement to the frame than the stiffening of the bulkheads to which it is to be fitted. The purpose of the test is to show whether the door is of sufficient strength and reasonably watertight under pressure. The rate of leakage and deflection of the door at the centre should be reported.

(2) After a satisfactory hydraulic test, each watertight door and its frame should be stamped with the following identification marks: -

CERTIFYING AUTHORITY  
TESTED TO                      METRES HEAD  
DATE  
SURVEYOR'S INITIALS

(3) After being fitted in place on the bulkhead in the ship, the door and the attachment of the door frame to the bulkhead should be included in the hose test required for watertight bulkheads.

(4) All sliding watertight doors should be operated by hand and, if power operated, by power in the presence of the surveyor, who should note and record the times taken to close the doors.

(5) The surveyor should see that the warning signals are efficient and comply with the provisions of paragraph 3.1.2.5 (ii) of these Instructions and that the indicators register properly.

(6) Hinged watertight doors are to be inspected and tried. The surveyor should see that the lever operated clips are in order and that the joints are watertight.

**Regulation 16-1****Construction and initial tests of watertight decks, trunks, etc.**

1 Watertight decks, trunks, tunnels, duct keels and ventilators shall be of the same strength as watertight bulkheads at corresponding levels. The means used for making them watertight, and the arrangements adopted for closing openings in them, shall be to the satisfaction of the Administration. Watertight ventilators and trunks shall be carried at least up to the bulkhead deck in passenger ships and up to the freeboard deck in cargo ships.

2 In passenger ships, where a ventilation trunk passing through a structure

penetrates a watertight area of the bulkhead deck, the trunk shall be capable of withstanding the water pressure that may be present within the trunk, after having taken into account the maximum heel angle during flooding, in accordance with regulation 7-2.

3 In ro-ro passenger ships, where all or part of the penetration of the bulkhead deck is on the main ro-ro deck, the trunk shall be capable of withstanding impact pressure due to internal water motions (sloshing) of water trapped on the ro-ro deck.

4 After completion, a hose or flooding test shall be applied to watertight decks and a hose test to watertight trunks, tunnels and ventilators.

## 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.*

1 For passenger ships subject to the provisions of regulation 1.1.1.1 and constructed before 1 January 2024, the Administration may require that all reasonable and practicable measures shall be taken to limit the entry and spread of water above the bulkhead deck. Such measures may include partial bulkheads or webs. When partial watertight bulkheads and webs are fitted on the bulkhead deck, above or in the immediate vicinity of watertight bulkheads, they shall have watertight shell and bulkhead deck connections so as to restrict the flow of water along the deck when the ship is in a heeled damaged condition. Where the partial watertight bulkhead does not line up with the bulkhead below, the bulkhead deck between shall be made effectively watertight. Where openings, pipes, scuppers, electric cables etc. are carried through the partial watertight bulkheads or decks within the immersed part of the bulkhead deck, arrangements shall be made to ensure the watertight integrity of the structure above the bulkhead deck.\*

\* Refer to the Guidance notes on the integrity of flooding boundaries above the bulkhead deck of passenger ships for proper application of regulations II-1/8 and 20, paragraph 1, of SOLAS 1974, as amended (MSC/Circ.541, as may be amended).

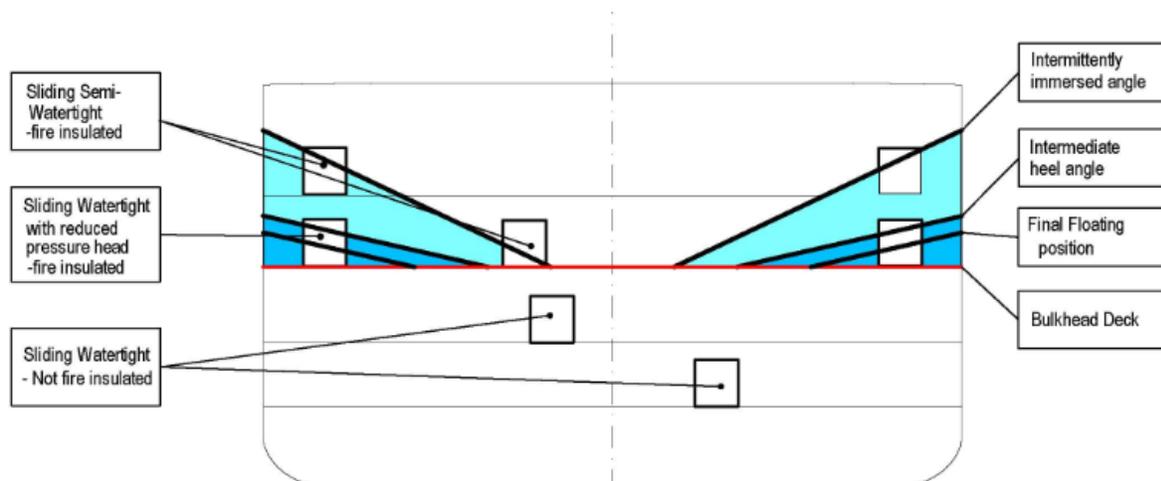
#### **Regulation 17.1**

*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.*

*Watertight sliding doors with reduced pressure head complying with the requirements of MSC/Circ.541 (reproduced below), as may be amended, should be in line with regulation 7-2.5.2.1. These types of tested watertight sliding doors with reduced pressure head could be immersed during intermediate stages of flooding.*

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-2/9.4.1.1.23, 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.*

4.2 For ships constructed on or after 1 January 2024, The Administration may require that all reasonable and practicable measures shall be taken to limit the entry and spread of water above the bulkhead deck. Such measures may include partial bulkheads or webs. the internal watertight subdivision arrangements to limit the entry and spread of water above the bulkhead deck shall be in accordance with the design arrangements necessary for compliance with the stability requirements in parts B-1, and B-2, if applicable. When partial watertight bulkheads and webs are fitted on the bulkhead deck, above or in the immediate vicinity of watertight bulkheads, they shall have watertight shell and bulkhead deck connections so as to restrict the flow of water along the deck when the ship is in a heeled damaged condition. Where the partial watertight bulkhead does not line up with the bulkhead below, the bulkhead deck between shall be made effectively watertight. Where openings, pipes, scuppers, electric cables etc. are carried through the partial internal watertight bulkheads or decks within the immersed part of the bulkhead deck, arrangements boundaries that are immersed at any intermediate or final stage of flooding in damage cases that contribute to the attained subdivision index A, arrangements shall be made to ensure their watertight integrity of the structure above the bulkhead deck.\*

\* Refer to the Guidance notes on the integrity of flooding boundaries above the bulkhead deck of passenger ships for proper application of regulations II-1/8 and 20, paragraph 1, of SOLAS 1974, as amended (MSC/Circ.541, as may be amended).

### **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 or by table 9.3 and regulation II-2/9.2.2.1.1.2 as appropriate (see MSC 102/J/3 para 8 by IACS). 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.

3 For ships constructed on or after 1 January 2024, doors in internal watertight subdivision arrangements above the bulkhead deck, and also above the worst intermediate or final stage of flooding waterlines, shall be capable of preventing the passage of water when immersed in the required range of positive stability for any damage cases contributing to the attained subdivision index A. These doors may remain open provided they can be remotely closed from the navigation bridge. They shall always be ready to be immediately closed.

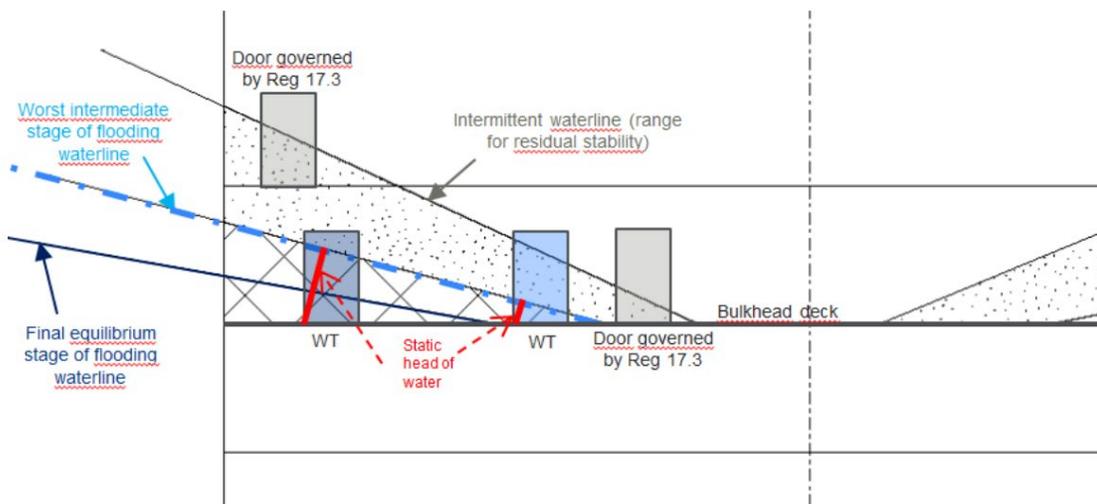
**Regulation 17.3** This explanatory note only applies to passenger ships constructed on or after 1 January 2024.

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. Insert the new figure below



insert the new table below

	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  Note IACS paper MSC 102/J/3 para 9 for changes to	Closed during navigation

<p>Door according to regulation 17.3</p>	<p>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 equilibrium position</p>	<p>Hinged or Sliding</p>	<p>circ. 1572 para 3.5.4 to be approved at MSC 102: - "An independent hydraulic unit" (19/10/20)</p>	<p>Doors that are remotely operated should be closed in case of damage</p>
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**24** All openings in the exposed weather deck shall have coamings of ample height and strength and shall be provided with efficient means for expeditiously closing them weathertight. Freeing ports, open rails and scuppers shall be fitted as necessary for rapidly clearing the weather deck of water under all weather conditions.

**35** Air pipes terminating within a superstructure which are not fitted with watertight means of closure shall be considered as unprotected openings when applying regulation 7-2.6.1.1.

**Regulation 17.35**

~~These provisions regarding the open end of air pipes should be applied only to damages of longitudinal and transverse extent as defined in regulation 8.3 but limited to the bulkhead deck and involving tanks having their open end terminating within the superstructure.~~

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.

**46** Sidescuttles, gangway, cargo and fuelling ports and other means for closing openings in the shell plating above the bulkhead deck shall be of efficient design and construction and of sufficient strength having regard to the spaces in which they are fitted and their positions relative to the deepest subdivision draught\*\*

\*\* Refer to Recommendation on strength and security and locking arrangements of shell doors on ro-ro passenger ships, (resolution A.793(19)).

**MCA Guidance - Regulation 17.6; Sidescuttles and Windows above the Bulkhead Deck****(1) Side scuttles**

The guidance under Regulation 15.3 also applies to side scuttles fitted to openings in the ship's sides above the bulkhead line

**(2) Window sizes**

(i) Where proposed window sizes exceed those defined within a recognised standard, these may be accepted providing they are situated in the fourth and higher tiers of superstructures for category 1 windows, and in the third and higher tiers of superstructures for category 2 windows. The Certifying Authority may require the glass in such windows to be thicker than the maximum standard size.

(ii) Category 1 means windows situated in the ships' sides and in exposed casings or deckhouse sides set inboard not more than 4% of the breadth of the ship or 1.5 m whichever is the greater, and windows facing forward.

(iii) Category 2 means windows situated in the side screens and in exposed casings or deckhouse sides set inboard more than 4% of the breadth of the ship, or 1.5 m whichever is the greater.

**(3) Glass for side scuttles and windows**

(i) Glass for side scuttles and windows fitted in all ships should be in accordance with the guidance to Regulation 15.3.

(ii) The number of spare glasses which are to be provided for the side scuttles and windows fitted in ships of Classes I and II should not be less than 4% of the total number of glasses for each size fitted, with a minimum of 2 glasses for each size.

(iii) For ships of Class II(A) the number of spare glasses should not be less than 2 glasses for each size of side scuttle and window.

**57** Efficient inside deadlights, so arranged that they can be easily and effectively closed and secured watertight, shall be provided for all sidescuttles to spaces below the first deck above the bulkhead deck.

**MCA Guidance - Regulation 17.7; Deadlights above the Bulkhead Deck**

Deadlights should comply with the following: -

- (1) In enclosed spaces below the first deck above the bulkhead deck (passenger ships) or freeboard deck (cargo ships) efficient hinged deadlights which can be effectively closed and secured watertight must be fitted to all side scuttles.
- (2) In other enclosed superstructures, side scuttles and windows should be provided with deadlights or shutters, which may be fixed or portable, except that only fixed deadlights or shutters should be fitted to side scuttles and windows situated in the bridge front of the first tier of superstructures immediately above the weather-deck. Portable deadlights and shutters should be provided to the extent shown in the following table: -

Tier of superstructure above the bulkhead deck or freeboard deck, whichever is the higher	Required number of portable deadlights or shutters, expressed as a percentage of the total number of side scuttles or windows of each type or size, excluding those fitted with fixed deadlights or shutters
2nd tier	50
3rd tier	25
4th and higher tiers	May be required, subject to consideration

- (3) Shutters should be of steel of not less than 3.5 mm in thickness, or of an equivalent material, and provided with means of securing them to the frame sufficient to withstand the pressures likely to be experienced in service.

### Regulation 17-1

#### Integrity of the hull and superstructure, damage prevention and control on ro-ro passenger ships

1.1 Subject to the provisions of paragraphs 1.2 and 1.3, all accesses from the ro-ro deck that lead to spaces below the bulkhead deck shall have a lowest point which is not less than 2.5 m above the bulkhead deck, unless the access is covered by the provisions in paragraphs 1.2 or 1.3.

1.2 Where vehicle ramps are installed to give access to spaces below the bulkhead deck, their openings shall be able to be closed weathertight to prevent ingress of water

below, alarmed and indicated to the navigation bridge and fitted with alarms and open/close indicators on the navigation bridge. The means of closure shall be watertight if the deck is intended as a watertight horizontal boundary under regulation 7-2.6.

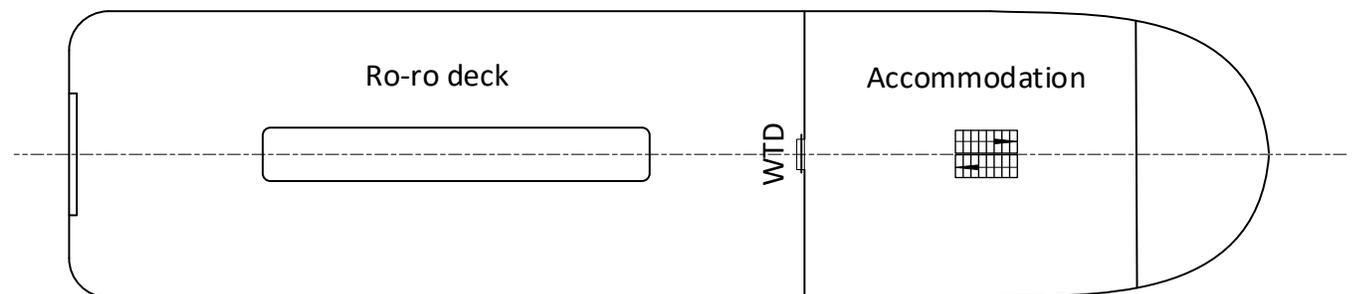
### Regulation 17-1.1.2

*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.*

1.3 Subject to regulations 23.3 and 23.6, the Administration may permit the fitting of particular accesses to spaces below the bulkhead deck provided they are necessary for the essential working of the ship, e.g. the movement of machinery and stores, and subject to such accesses being made watertight, alarmed and indicated on the navigation bridge fitted with alarms and open/close indicators on the navigation bridge.

*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.*

*Insert the figure below*



### MCA Guidance - Regulation 17-1.1; Weathertightness of ro-ro deck.

In ro-ro passenger ships, although the enclosed ro-ro deck is usually protected by a higher weathertight deck, it is recommended that the deck itself should be at least weathertight even though this is no longer required following the introduction of the SOLAS 2009 amendments. The sentence “the bulkhead deck or a deck above it shall be weathertight” in SOLAS 90 chapter II-1 Part B regulation 20.2 was removed in SOLAS 2009 regulation 17.2.

According to the definition of “compartment” in the explanatory notes to Regulation 7-1 and 8-1.2 (i.e. a space within watertight boundaries), if the ro-ro deck is not watertight then not only does it not constitute a watertight horizontal boundary under Regulation 7-2.6 but it means that should any tank or space below

the ro-ro deck be damaged then the ro-ro garage space itself must also be considered as damaged. The implication of this is that  $TGZ_{max}$  and  $TRange$  in regulation 7-2.3 must assume the higher values of 0.20 metres and  $20^\circ$  respectively when calculating the  $s_{final,i}$  factor.

In ro-ro passenger ships with LLH, consideration should be given to making the ro-ro deck watertight should penetration of the LLH following bottom damage result in submergence of the vehicle deck through up-flooding (see also Regulation 9.9 and 17-1.1.2).

2 Indicators shall be provided on the navigation bridge for all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could, in the opinion of the Administration, lead to flooding of a special category space or ro-ro space. The indicator system shall be designed on the fail-safe principle and shall show by visual alarms if the door is not fully closed or if any of the securing arrangements are not in place and fully locked and by audible alarms if such door or closing appliances become open or the securing arrangements become unsecured. The indicator panel on the navigation bridge shall be equipped with a mode selection function “harbour/sea voyage” so arranged that an audible alarm is given on the navigation bridge if the ship leaves harbour with the bow doors, inner doors, stern ramp or any other side shell doors not closed or any closing device not in the correct position. The power supply for the indicator system shall be independent of the power supply for operating and securing the doors.

3 Television surveillance and a water leakage detection system shall be arranged to provide an indication to the navigation bridge and to the engine control station of any leakage through inner and outer bow doors, stern doors or any other shell doors which could lead to flooding of special category spaces or ro-ro spaces.

## PART B-3

### SUBDIVISION LOAD LINE ASSIGNMENT FOR PASSENGER SHIPS

#### Regulation 18

##### Assigning, marking and recording of subdivision load lines for passenger ships

1 In order that the required degree of subdivision shall be maintained, a load line corresponding to the approved subdivision draught shall be assigned and marked on the ship's sides. A ship intended for alternating modes of operation may, if the owners desire, have one or more additional load lines assigned and marked to correspond with the subdivision draughts which the Administration may approve for the alternative service configurations. Each service configuration so approved shall comply with part B-1 of this chapter independently of the results obtained for other modes of operation.

2 The subdivision load lines assigned and marked shall be recorded in the Passenger Ship Safety Certificate and shall be distinguished by the notation P1 for the principal passenger service configuration, and P2, P3, etc., for the alternative configurations. The principal passenger configuration shall be taken as the mode of operation in which the required subdivision index  $R$  will have the highest value.

3 The freeboard corresponding to each of these load lines shall be measured at the same position and from the same deck line as the freeboards determined in accordance with the International Convention on Load Lines in force.

4 The freeboard corresponding to each approved subdivision load line and the service configuration, for which it is approved, shall be clearly indicated on the Passenger Ship Safety Certificate.

5 In no case shall any subdivision load line mark be placed above the deepest load line in salt water as determined by the strength of the ship or the International Convention on Load Lines in force.

6 Whatever may be the position of the subdivision load line marks, a ship shall in no case be loaded so as to submerge the load line mark appropriate to the season and locality as determined in accordance with the International Convention on Load Lines in force.

7 A ship shall in no case be so loaded that when it is in salt water the subdivision load line mark appropriate to the particular voyage and service configuration is submerged.

## PART B-4

### STABILITY MANAGEMENT

#### Regulation 19

##### Damage control information\*

1 There shall be permanently exhibited, or readily available on the navigation bridge, for the guidance of the officer in charge of the ship, plans showing clearly for each deck and hold the boundaries of the watertight compartments, the openings therein with the means of closure and position of any controls thereof, and the arrangements for the correction of any list due to flooding. In addition, booklets containing the aforementioned information shall be made available to the officers of the ship.

~~2 Watertight doors in passenger ships permitted to remain open during navigation shall be clearly indicated in the ship's stability information.~~

2 General precautions to be included shall consist of a listing of equipment, conditions, and operational procedures, considered by the Administration to be necessary to maintain watertight integrity under normal ship operations.

3 Specific precautions to be included shall consist of a listing of elements (i.e. closures, security of cargo, sounding of alarms, etc.) considered by the Administration to be vital to the survival of the ship, passengers and crew.

4 In case of ships to which damage stability requirements of part B-1 apply, damage stability information shall provide the master a simple and easily understandable way of assessing the ship's survivability in all damage cases involving a compartment or group of compartments.~~\*\* delete asterisks~~

5 For passenger ships constructed on or after 1 January 2024, and to which regulation 8-1.3 applies, the damage control information shall include a reference to activation of damage stability support from the onboard stability computer, if installed, and to shore based support when provided..

\* ~~Refer to the Guidelines for damage control plans (MSC.1/Circ.1245).~~

\*\* ~~Refer to the guidelines to be developed by the Organization.~~

\* ~~Refer to the Guidelines for damage control plans and information to the master (MSC.1/Circ.1245) and amendments to section 3 of the Guidelines for damage control plans and information to the master (MSC.1/Circ.1570)~~

\* Refer to Guidelines for damage control plans and information to the master (MSC.1/Circ.1245), as amended by MSC.1/Circ.1570 and to the Guidelines for verification of damage stability requirements for tankers (MSC.1/Circ.1461)''''

**Regulation 19-1****Damage control drills for passenger ships**

- 1 This regulation applies to passenger ships constructed before, on or after 1 January 2020.
- 2 A damage control drill shall take place at least every three months. The entire crew need not participate in every drill, but only those crew members with damage control responsibilities.
- 3 The damage control drill scenarios shall vary each drill so that emergency conditions are simulated for different damage conditions and shall, as far as practicable, be conducted as if there were an actual emergency.
- 4 Each damage control drill shall include:
  - .1 for crew members with damage control responsibilities, reporting to stations and preparing for the duties described in the muster list required by regulation III/8;
  - .2 use of the damage control information and the on-board damage stability computer, if fitted, to conduct stability assessments for the simulated damage conditions;
  - .3 establishment of the communications link between the ship and shore-based support, if provided;
  - .4 operation of watertight doors and other watertight closures;
  - .5 demonstrating proficiency in the use of the flooding detection system, if fitted, in accordance with muster list duties;
  - .6 demonstrating proficiency in the use of cross-flooding and equalization systems, if fitted, in accordance with muster list duties;
  - .7 operation of bilge pumps and checking of bilge alarms and automatic bilge pump starting systems; and
  - .8 instruction in damage survey and use of the ship's damage control systems.
- 5 At least one damage control drill each year shall include activation of the shore-based support, if provided in compliance with regulation II-1/8-1.3, to conduct stability assessments for the simulated damage conditions.

6 Every crew member with assigned damage control responsibilities shall be familiarized with their duties and about the damage control information before the voyage begins.

7 A record of each damage control drill shall be maintained in the same manner as prescribed for the other drills in regulation III/19.5

## Regulation 20

### Loading of passenger ships

1 On completion of loading of the ship and prior to its departure, the master shall determine the ship's trim and stability and also ascertain and record that the ship is upright and in compliance with stability criteria in relevant regulations. The determination of the ship's stability shall always be made by calculation or by ensuring that the ship is loaded according to one of the pre-calculated loading conditions within the approved stability information. The Administration may accept the use of an electronic loading and stability computer or equivalent means for this purpose.

2 Water ballast should not in general be carried in tanks intended for oil fuel. In ships in which it is not practicable to avoid putting water in oil fuel tanks, oily-water separating equipment to the satisfaction of the Administration shall be fitted, or other alternative means, such as discharge to shore facilities, acceptable to the Administration shall be provided for disposing of the oily-water ballast.

3 The provisions of this regulation are without prejudice to the provisions of the International Convention for the Prevention of Pollution from Ships in force.

## Regulation 21

### Periodical operation and inspection of watertight doors, etc., in passenger ships

1 Drills for the operating of Operational tests of watertight doors, sidescuttles, valves and closing mechanisms of scuppers, ~~ash chutes and rubbish chutes~~ shall take place weekly. In ships in which the voyage exceeds one week in duration a complete drill set of operational tests shall be held before leaving port the voyage commences, and others thereafter at least once a week during the voyage.

2 All watertight doors, both hinged and power operated, in watertight bulkheads, in use at sea, shall be operated daily.

3 The watertight doors and all mechanisms and indicators connected therewith, all valves the closing of which is necessary to make a compartment watertight and all valves the operation of which is necessary for damage control cross connections shall be periodically inspected at sea at least once a week.

4 A record of all drills operational tests and inspections required by this regulation shall be entered recorded in the log-book with an explicit record of any defects which may be disclosed.

## 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.*

1 All watertight doors shall be kept closed during navigation except that they may be opened during navigation as specified in paragraph 3. Watertight doors of a width of more than 1.2 m in machinery spaces as permitted by regulation 13.10 may only be opened in the circumstances detailed in that regulation. Any door which is opened in accordance with this paragraph shall be ready to be immediately closed.

2 Watertight doors located below the bulkhead deck of passenger ships and the freeboard deck of cargo ships having a maximum clear opening width of more than 1.2 m shall be kept closed when the ship is at sea during navigation, except for limited periods when absolutely necessary as determined by the Administration.

3 A watertight door may be opened during navigation to permit the passage of passengers or crew, or when work in the immediate vicinity of the door necessitates it being opened. The door must be immediately closed when transit through the door is complete or when the task which necessitated it being open is finished. The Administration shall authorize that such a watertight door 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\*. A watertight door permitted to be opened during navigation shall be clearly indicated in the ship's stability information and shall always be ready to be immediately closed.

### 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 at the discretion of the Administration.*

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\* Refer to the Revised guidance for watertight doors on passenger ships which may be opened during navigation (MSC.1/Circ.1564).

4 Portable plates on bulkheads shall always be in place before the ~~ship leaves port~~ voyage commences and shall not be removed during navigation except in case of urgent necessity at the discretion of the master. The necessary precautions shall be taken in replacing them to ensure that the joints are watertight. Power-operated sliding watertight doors permitted in machinery spaces in accordance with regulation 13.10 shall be closed before the ~~ship leaves port~~ voyage commences and shall remain closed during navigation except in case of urgent necessity at the discretion of the master.

5 Watertight doors fitted in watertight bulkheads dividing cargo ~~between deck~~ spaces on ~~tween decks~~ in accordance with regulation 13.98.1 shall be closed before the voyage commences and shall be kept closed during navigation. The time at which such doors are opened or closed shall be recorded in such log-book as may be prescribed by the Administration.

6 For ships subject to the provisions of regulation 1.1.1.1 and constructed before 1 January 2024, Gangway, cargo and fuelling ports fitted below the bulkhead deck of passenger ships and the freeboard deck of cargo ships shall be effectively closed and secured watertight before the voyage commences and shall be kept closed during navigation.

67 For ships constructed on or after 1 January 2024, Gangway, cargo and fuelling ports fitted below the bulkhead deck of passenger ships and the freeboard deck of cargo ships and all watertight hatches, shall be effectively closed and secured watertight before the voyage commences, and shall be kept closed during navigation. However, the master may permit a watertight hatch to be opened during navigation for a limited period of time sufficient to permit passage or for access. It shall then be closed.

### **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.*

78 The following doors, located above the bulkhead deck ~~freeboard deck of cargo ships~~, shall be closed and locked before the ~~ship proceeds on any~~ voyage commences and shall remain closed and locked until the ship is at its next berth:

- .1 cargo loading doors in the shell or the boundaries of enclosed superstructures;
- .2 bow visors fitted in positions as indicated in paragraph 78.1;
- .3 cargo loading doors in the collision bulkhead; and
- .4 ramps forming an alternative closure to those defined in paragraphs 78.1 to 78.3 inclusive.

8 9 Where a door cannot be opened or closed while the ship is at the berth, such a door may be opened or left open while the ship approaches or draws away from the berth, but only so far as may be necessary to enable the door to be immediately operated. In any case, the inner bow door must be kept closed.

9 10 Notwithstanding the requirements of paragraphs 78.1 and 78.4, the Administration may authorize that particular doors can be opened at the discretion of the master, if necessary for the operation of the ship or the embarking and disembarking of passengers when the ship is at safe anchorage and provided that the safety of the ship is not impaired.

40 11 The master shall ensure that an effective system of supervision and reporting of the closing and opening of the doors referred to in paragraph 78 is implemented.

44 12 The master shall ensure, before ~~the ship proceeds on~~ any voyage commences, that an entry in ~~such log-book as may be prescribed by the Administration~~ is made of the time the doors specified in paragraph 42 13 are closed and the time at which particular doors are opened in accordance with paragraph 43 14.

42 13 Hinged doors, portable plates, sidescuttles, gangway, cargo and bunkering ports and other openings, which are required by these regulations to be kept closed during navigation, shall be closed before the voyage commences. The time at which such doors are opened and closed (if permissible under these regulations) shall be recorded in such log-book as may be prescribed by the Administration.

43 14 Where in a between-deck, the sills of any of the sidescuttles referred to in regulation 15.3.2 are below a line drawn parallel to the bulkhead deck at side of passenger ships and the freeboard deck at sides in cargo ships, and having its lowest point 1.4 m plus 2.5% of the breadth of the ship above the water when the ~~ship departs from any port~~ voyage commences, all the sidescuttles in that between-deck shall be closed watertight and locked before the ~~ship leaves port~~ voyage commences, and they shall not be opened before the ship arrives at the next port. In the application of this paragraph the appropriate allowance for fresh water may be made when applicable.

- .1 The time at which such sidescuttles are opened in port and closed and locked before the voyage commences shall be recorded in such log-book as may be prescribed by the Administration.
- .2 For any ship that has one or more sidescuttles so placed that the requirements of paragraph 14 would apply when it was floating at its deepest subdivision draught, the Administration may indicate the limiting mean draught at which these sidescuttles will have their sills above the line drawn parallel to the bulkhead deck at side of passenger ships and the freeboard deck at sides of cargo ships, and having its lowest point 1.4 m plus 2.5% of the breadth of the ship above the waterline corresponding to the limiting mean draught, and at which it will therefore be permissible ~~to depart from any port~~ for the voyage to commence without them being closed and locked

and to **be opened during navigation** on the responsibility of the master. In tropical zones as defined in the International Convention on Load Lines in force, this limiting draught may be increased by 0.3 m.

**44 15** Sidescuttles and their deadlights which will not be accessible during navigation shall be closed and secured before the **ship leaves port voyage commences**.

**45 16** If cargo is carried in spaces referred to in regulation 15.5.2, the sidescuttles and their deadlights shall be closed watertight and locked before the cargo is shipped and **the time at which such scuttles and deadlights are closed and locked** shall be recorded in such log-book as may be prescribed by the Administration.

~~16 — When a rubbish chute, etc. is not in use, both the cover and the valve required by regulation 15.10.2 shall be kept closed and secured.~~

### **Regulation 22-1**

#### **Flooding detection systems for passenger ships carrying 36 or more persons**

A flooding detection system for watertight spaces below the bulkhead deck shall be provided based on the guidelines developed by the Organization. \*

### **Regulation 23**

#### **Special requirements for ro-ro passenger ships**

1 Special category spaces and ro-ro spaces shall be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorized access by passengers thereto can be detected **whilst the ship is under way during navigation**.

2 Documented operating procedures for closing and securing all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could, in the opinion of the Administration, lead to flooding of a special category space or ro-ro space, shall be kept on board and posted at an appropriate place.

3 All accesses from the ro-ro deck and vehicle ramps that lead to spaces below the bulkhead deck shall be closed before the **ship leaves the berth on any voyage commences** and shall remain closed until the ship is at its next berth.

4 The master shall ensure that an effective system of supervision and reporting of the closing and opening of such accesses referred to in paragraph 3 is implemented.

\* Refer to *Guidelines for flooding detection systems on passenger ships* (MSC.1/Circ.1291).

5 The master shall ensure, before the ~~ship leaves the berth on any~~ voyage commences that an entry in the log-book, as required by regulation 22.12, is made of the time of the last closing of the accesses referred to in paragraph 3.

6 Notwithstanding the requirements of paragraph 3, the Administration may permit some accesses to be opened during the voyage, but only for a period sufficient to permit through passage and, if required, for the essential working of the ship.

### **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".*

7 All transverse or longitudinal bulkheads which are taken into account as effective to confine the seawater accumulated on the ro-ro deck shall be in place and secured before the ~~ship leaves the berth~~ voyage commences and remain in place and secured until the ship is at its next berth.

8 Notwithstanding the requirements of paragraph 7, the Administration may permit some accesses within such bulkheads to be opened during the voyage but only for sufficient time to permit through passage and, if required, for the essential working of the ship.

9 In all ro-ro passenger ships, the master or the designated officer shall ensure that, without the expressed consent of the master or the designated officer, no passengers are allowed access to an enclosed ro-ro deck ~~when the ship is under way~~ during navigation.

## **Regulation 24**

### **Additional Requirements for prevention and control of water ingress, etc. in cargo ships**

1 Openings in the shell plating below the deck limiting the vertical extent of damage shall be kept permanently closed ~~while at sea~~ during navigation.

2 Notwithstanding the requirements of paragraph 3, the Administration may authorize that particular doors may be opened at the discretion of the master, if necessary for the operation of the ship and provided that the safety of the ship is not impaired.

3 Watertight doors or ramps fitted to internally subdivide large cargo spaces shall be closed before the voyage commences and shall be kept closed during navigation. The time at which such doors are opened or closed shall be recorded in such log-book as may be prescribed by the Administration.

4 The use of access doors and hatch covers intended to ensure the watertight integrity of internal openings shall be authorized by the officer of the watch.

## Regulation 25

### Water level detectors on single hold cargo ships other than bulk carriers

1 Single hold cargo ships other than bulk carriers constructed before 1 January 2007 shall comply with the requirements of this regulation not later than 31 December 2009.

2 Ships having a length ( $L$ ) of less than 80 m, or 100 m if constructed before 1 July 1998, and a single cargo hold below the freeboard deck or cargo holds below the freeboard deck which are not separated by at least one bulkhead made watertight up to that deck, shall be fitted in such space or spaces with water level detectors<sup>\*</sup>

3 The water level detectors required by paragraph 2 shall:

- .1 give an audible and visual alarm at the navigation bridge when the water level above the inner bottom in the cargo hold reaches a height of not less than 0.3 m, and another when such level reaches not more than 15% of the mean depth of the cargo hold; and
- .2 be fitted at the aft end of the hold, or above its lowest part where the inner bottom is not parallel to the designed waterline. Where webs or partial watertight bulkheads are fitted above the inner bottom, Administrations may require the fitting of additional detectors.

4 The water level detectors required by paragraph 2 need not be fitted in ships complying with regulation XII/12, or in ships having watertight side compartments each side of the cargo hold length extending vertically at least from inner bottom to freeboard deck.

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<sup>\*</sup> Refer to *Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers* (resolution MSC.188(79)).

## 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<sup>\*</sup> 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 an audible and visual alarm at the navigation bridge, one when the water level above the bottom of the 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 or liquid cargo, an alarm overriding device may be installed. The visual alarms shall clearly discriminate between the two different water levels detected in each hold.

3 As an alternative to the water level detector at a height of not less than 0.3 m, a bilge level alarm sensor may be fitted, located in the cargo hold bilge wells or other suitable location in the aft end of the cargo holds, serving the bilge pumping arrangements required by regulation 35-1 and giving audible and visual alarms at the navigation bridge.

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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*, adopted by the Maritime Safety Committee by resolution MSC.188(79).

Paragraph 3 above was proposed in a paper by Belgium and the US (MSC 102/17/1) and approved at MSC 102 for adoption at MSC 103. However, IACS expressed concerns (see MSC 102/24 para.17.22): -

### **Water level detectors on non-bulk carrier cargo ships with multiple cargo holds**

17.21 The Committee considered new draft SOLAS regulation II-1/25-1, requiring water level detectors on multiple hold cargo ships other than bulk carriers and tankers, as set out in annex 6 to document SDC 7/16, together with document MSC 102/17/1 (Belgium and United States), proposing to add a new provision to permit bilge level alarm sensors to be used as an alternative to a water level detector, as an equivalent arrangement.

17.22 In this regard, the Committee noted a statement by the observer from IACS expressing concerns about the above-mentioned proposal as water level detectors and bilge level alarm sensors located in the cargo hold bilge wells differed; the statement also suggested a need for consequential revision of the Performance Standards in resolution MSC.188(79), which currently did not cover detectors for multiple hold cargo ships. The full text of the statement is set out in annex 30: -.

### **MSC 102/24/Add.1; Annex 30 - Statement by the observer from IACS**

"We note that the draft amendments are in front of this Committee for approval - that is a step before adoption at a future session. IACS has carefully studied the outcome from the SDC Sub-Committee and an additional proposal by the United States and Belgium in their document MSC 102/17/1, and we have a few comments and proposals. Those are split in two groups: on the draft regulatory text, and on the need to revise Performance Standards. Would you like me to introduce both or take the draft regulation first?"

Firstly, IACS suggests that in paragraph 2.1 of the draft regulation 25-1 contained in Annex 6 of document SDC 7/16, the reference to the cargo hold is slightly revised to read "the" cargo hold instead of "any" cargo hold. The reason for that suggestion is the need to be specific to the flooded hold, and to clarify that the tolerances specified for the water level detectors are specific for the cargo hold in which the detectors are fitted. If your Committee would like to see them on paper, we would be happy to arrange that.

As regards new paragraph 3 of the draft regulation, proposed by the United States and Belgium in document MSC 102/17/1, IACS thanks the submitters of the paper and appreciates the proposal to try and make the technical installation simpler. However, IACS has some concerns and comments on this proposal. In IACS' opinion, the purpose of the water level detectors and a bilge level alarm sensor is different; similarly, the typical installation height of the two sensors is different. This leads to the following two concerns:

Firstly, the alternative in the US/Belgium document makes the lower level height of 0.3m for water detection irrelevant, because level detectors may be fitted at any level lower than 0.3 m and termed as a bilge level alarm sensors.

Secondly, the place of detection could be a compromise which would mean that a correct alarm would be more unlikely or delayed. There is some possibility that the bilge level alarm may be more easily overridden by the crew due to its early and frequent detection of water in bilge wells As with the earlier mentioned

change, we have a proposal of the modification to the text of new paragraph 3. IACS intends to submit both proposals to MSC 103 unless your Committee prefers a different approach.

And lastly, the Committee may wish to consider the question of applicability of the regulation to certain types of ships within the scope of the draft regulation, for example specialised reefer ships carrying ultra-frozen tuna at temperatures below -50C, where such water level detectors in the insulated cargo holds may not operate.

Group 2 is on the Performance Standards in resolution MSC.188(79). Specifically, in IACS' understanding the Standards do not cover detectors for multiple hold cargo ships, as the current provisions are written to be pertinent to arrangements installed for compliance with chapter XII and regulation II-1/23-3.

Secondly, we believe that clarification will be needed on the measurement of distances when the cargo hold has a lining. Similarly, clarification would be needed regarding installation of the water detection system being intrinsically safe with appropriate group rating and temperature class, and the protection of the detection system from mechanical damage.

As such, IACS is of the opinion that the Performance Standards will require amendment to explicitly include detectors for multiple hold cargo ships and address those additional technical aspects. As with the amendments, IACS intends to present those comments to MSC 103 for the Committee to address follow up action, unless your Committee wishes to take an alternative route."

17.23 Subsequently, the Committee, having agreed to a minor modification proposed by IACS to draft SOLAS regulation II-1/25-1.2.1 and having incorporated the proposal in document MSC 102/17/1, approved draft new SOLAS regulation II-1/25-1, as set out in annex 14, and requested the Secretary-General to circulate it in accordance with SOLAS article VIII, with a view to adoption at MSC 103.

## **MSC 102/24/Add.1; Annex 14**

### **PART B-4**

#### **STABILITY MANAGEMENT**

3 The following new regulation 25-1 is added after existing regulation 25 with the associated footnote:

#### **"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.

\* 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)).

**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 the 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.

**3 As an alternative to the water level detector at a height of not less than 0.3 m, a bilge level alarm sensor may be fitted, located in the cargo hold bilge wells or other suitable location in the aft end of the cargo holds, serving the bilge pumping arrangements required by regulation 35-1 and giving audible and visual alarms at the navigation bridge."**

**Briefs for MSC 103.**

In paper MSC 103/3/3 by Belgium, US and IACS, there is a proposal to amend paragraph 3, above, to overcome concerns that the performance standards of bilge alarms shall not be inferior to those for water level detectors in the cargo holds. The following new version of paragraph 3 is proposed: -

- "3 As an alternative to the water level detector at a height of not less than 0.3 m as per sub-paragraph 2.1, a bilge level sensor\* serving the bilge pumping arrangements required by regulation 35-1 and installed in the cargo hold bilge wells or other suitable location, is considered acceptable, subject to:
- .1 the fitting of the bilge level sensor at a height of not less than 0.3 m in the aft end of the cargo hold; and
  - .2 the bilge level sensor giving audible and visual alarm at the navigation bridge which is clearly distinctive from the alarm given by the other water level detector fitted in the cargo hold."

\* Refer to the *Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers*, adopted by the Maritime Safety Committee by resolution MSC.188(79).

In addition, Belgium, United States and IACS further propose, in paper 103/3/4, that certain provisions in MSC.188(79) will require revision to explicitly include detectors for multiple hold cargo ships and to address the equivalency in standards applicable to bilge alarms and water level detectors. The paper proposes that SDC be "*instructed to review MSC.188(79) for application in time to allow manufacturers to approve their systems against new standards to be ready for installation on ships at the time of the application of the regulation in question.*" Still to be resolved ALS 6/4/23.

## **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 checking of the input data, the following should be submitted:*

- .1 main dimensions;*
- .2 lines plan, plotted or numerical;*
- .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 down flooding devices and the calculations thereof according to resolution MSC.362(92) with information about diameter, valves, pipes length 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.*

**MCA Guidance - Explanatory Notes Appendix Section 2.2****(1) General**

To determine whether the proposals relating to the construction of the ship comply with the requirements of the Regulations the surveyor should obtain from the shipbuilder, owner, or his consultant, all plans and particulars necessary for the consideration of the case. All plans, particulars and calculations should be in the English language, or should include an adequate English translation. Measurements should be in metric units.

**(2) Plans and particulars to be submitted**

The plans and particulars to be submitted should include the methods used to justify the arrangements, materials, constructional methods and scantlings proposed.

***Hull structural plans: -***

(i) All plans should identify the nature and physical properties of the materials being used and their means of connection.

(ii) Where the ship is to be classed with a recognised Classification Society, namely Lloyds Register of Shipping or the British Committees of Bureau Veritas, Det Norske Veritas, Germanischer Lloyd or Registro Italiano Navale or the British Technical Committee of the American Bureau of Shipping, it will be sufficient for the surveyor to obtain from the shipbuilder or consultant stamped approved copies of the drawings submitted to the Classification Society together with that Society's approval. The surveyor should ensure that the scantlings are approved for the required subdivision draught and the strength is sufficient for the service intended.

(iii) Watertight bulkheads are to be of sufficient strength and constructed so as to be capable of supporting, with an adequate margin of resistance, the pressure due to the maximum of head of water which might have to be sustained in the event of damage to the ship. See SOLAS 2009 Part A Regulation 2.18 for the definition of “design pressure”, Part B-2 Regulation 10.1 for watertight bulkhead construction and Part B-2 Regulation 11 for watertight bulkhead testing.

***Subdivision arrangements and calculations: -***

(i) Fully dimensioned outline elevation, plan and section views of the ship showing the bulkhead deck (or freeboard deck as defined in SOLAS 2009 Part A Regulation 2.19) ; all watertight transverse and longitudinal bulkheads, decks, inner skins, shaft and other tunnels, trunks and ventilators; the appropriation of spaces below the bulkhead deck; the position of equivalent plane bulkheads, the lengths of the main transverse compartments, and the weathertight arrangements above the bulkhead deck at the forward end. Tunnels, recesses and steps are to be shown in plan and elevation, and typical sections of the double bottom should be given.

(ii) Outline elevation, plan and section views of the ship showing the dimensions, number, location and type of all watertight doors and any other openings in watertight divisions which are closed only by portable bolted plates.

(iii) To enable an independent check to be undertaken, full details of the following are to be submitted: -

(a) Calculations to determine the permeabilities where they differ from the assumed values (see SOLAS 2009 Regulation 7-3 and associated explanatory notes). Particulars should be submitted at the earliest opportunity to enable the surveyor to determine whether a detailed calculation of permeability is appropriate; and

(b) Calculations to determine the position of equivalent plane bulkheads (see, for example, the explanatory notes for SOLAS 2009 Regulations 7.5, 7-1.1.1 and 7-1.1.2).

***Subdivision structural details: -***

Plans showing the scantlings and details of construction of all tanks forming part of the structure of the ship, e.g. oil fuel storage and settling tanks, water ballast tanks and fresh water tanks should be submitted. Details should also be supplied of the size, type and position of all air and overflow pipes serving these tanks, indicating the pressure head upon which the scantlings are based.

***Other structural arrangements below and above the bulkhead deck: -***

(i) Plans showing the positions, sizes, types and details of all side scuttles and windows. In the case of side scuttles below the bulkhead deck the height of the sill of the side scuttle above the summer load line and/or the deepest subdivision load waterline should be stated (see SOLAS 2009 Regulations 15.3.1 to 15.4).

(ii) Plans showing the arrangement and details of all gangway and cargo loading doors fitted in the shell or boundaries of enclosed super-structures, bow visors where fitted, weather-tight ramps used instead of doors for closing openings for cargo or vehicle loading, cargo loading doors in the collision bulkheads, and small doors used for pilot access, fuelling or other matters necessary for the operation of the ship.

(iii) Plans showing the arrangements and particulars of ship's side discharges including sewage systems, ash and rubbish chutes etc.

(iv) Plans showing the details of the oil fuel, fresh and feed water, bilge and ballast, salt water and sewage systems, and air, filling, sounding and scupper pipe arrangements.

(v) Plans showing the means of closing openings in the weather deck and means for clearing water from such a deck for compliance with SOLAS 2009 Part B-2 Regulation 17.2.

## 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 curves (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 above requirements in 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.*

## **MCA Guidance - Explanatory Notes Appendix Section 2.3**

### **(1) Stability**

- (i) Calculations are to be submitted as early as is practicable to show that for all anticipated conditions of loading, the intact and damage stability criteria required by the 2008 IS Code and SOLAS 2009 respectively are met. To help interpret an asymmetric damage stability investigation, a clearly labelled plan should be produced indicating by means of cross hatching or numbers, those portions and elemental blocks which are assumed flooded or counter-flooded for each case of damage investigated, and their respective permeabilities.
- (ii) If the ship is to carry permanent ballast, its type (solid or liquid), quantity and distribution should be indicated.
- (iii) A report of the Inclining Experiment (see Part B-1 Regulation 5, SOLAS 2009 and Chapter 8 with Annex 1 of the 2008 IS Code) and the stability information is required.
- (iv) A Damage Control Plan and Booklet in accordance with Part B-4 Regulation 19 of SOLAS 2009, is required (see MSC.1/Circ.1245).

### **(2) Importance of early submission of plans**

- (i) The shipbuilder or his consultant should be informed by the surveyor of the importance of the early submission of the drawings and particulars listed in the Guidance to Appendix Section 2.2 above. Work on the construction of the ship should await the acceptance of the submitted

plans and particulars as inconvenience and delay may arise if alterations to the proposals are considered necessary.

(ii) The shipbuilder, or his consultant, should be requested to submit amendments to all drawings which clearly show which part, or parts, of the drawing have been modified. The marking of such drawings should enable the surveyor to consider amendments quickly. If amendments are not clearly illustrated, the surveyor should advise the shipbuilder, or his consultant, that delays and an associated increase in fees may be required to re-consider the whole of the drawing.

(iii) The receipt of all plans and documents is to be acknowledged immediately.

(iv) As the construction of the ship proceeds, the surveyor should ensure that the arrangements and details are in accordance with the accepted plans and particulars.

### (3) Verification of watertight subdivision arrangements

When the watertight subdivision arrangements have been accepted, the surveyor should satisfy himself that the ship is built in accordance with the accepted arrangements. The procedure described below should generally be followed:

#### *(i) Spacing of watertight bulkheads*

The positions of the main transverse bulkheads should be checked at ship against the accepted subdivision plans, together with those of the accepted steps and recesses in the watertight bulkheads, and the arrangements of the longitudinal watertight and non-watertight bulkheads.

#### *(ii) Appropriation of spaces*

The surveyor should examine each space, and satisfy himself that it has been fitted out in accordance with the appropriation of spaces upon which any calculations for average permeabilities have been calculated, and as shown on the accepted plans. If it appears that a space will be used for another purpose, which would involve a higher average permeability throughout the portion of the ship in which the space is situated, the surveyor should draw the attention of the builders to the matter, and request updated calculations.

#### *(iii) Survey of watertight subdivision arrangement before painting, etc.*

The survey of a ship during construction is for the purpose of enabling the surveyor to form an opinion of the construction and workmanship and the surveyor should not undertake the survey of a new ship after the hull is painted, cemented or otherwise coated. Where such coatings have been applied prior to survey the surveyor should report full particulars to the lead surveyor for the ship in question, and await instructions about the action to be taken. Particular care should be exercised by the surveyor to satisfy himself that the integrity of the watertight subdivision, where pipes etc. pass through steps or recesses in watertight bulkheads, is not impaired.

## MCA Guidance on Quality and Tests of Materials

### General

The quality, strength and testing of steel and aluminium alloy plates and sections used in the construction of the hull, bulkheads, decks, superstructures and deckhouses; and steel, bronze, gunmetal, brass, etc. castings used in the attachments thereto, are to be in accordance with recognised standards such as the requirements of a recognised Classification Society, or BSI/ISO. Otherwise particulars are to be provided for consideration, as described in the Guidance to SOLAS2009 Explanatory Notes Appendix 2.2, above.

## PART C

### MACHINERY INSTALLATIONS Regulation 35-1

#### Bilge pumping arrangements

1 This regulation applies to ships constructed on or after 1 January 2009.

#### 2 Passenger ships and cargo ships

2.1 An efficient bilge pumping system shall be provided, capable of pumping from and draining any watertight compartment other than a space permanently appropriated for the carriage of fresh water, water ballast, oil fuel or liquid cargo and for which other efficient means of pumping are provided, under all practical conditions. Efficient means shall be provided for draining water from insulated holds.

2.2 Sanitary, ballast and general service pumps may be accepted as independent power bilge pumps if fitted with the necessary connections to the bilge pumping system.

2.3 All bilge pipes used in or under coal bunkers or fuel storage tanks or in boiler or machinery spaces, including spaces in which oil-settling tanks or oil fuel pumping units are situated, shall be of steel or other suitable material.

2.4 The arrangement of the bilge and ballast pumping system shall be such as to prevent the possibility of water passing from the sea and from water ballast spaces into the cargo and machinery spaces, or from one compartment to another. Provision shall be made to prevent any deep tank having bilge and ballast connections being inadvertently flooded from the sea when containing cargo, or being discharged through a bilge pump when containing water ballast.

2.5 All distribution boxes and manually operated valves in connection with the bilge pumping arrangements shall be in positions which are accessible under ordinary circumstances.

2.6 Provision shall be made for the drainage of enclosed cargo spaces situated on the bulkhead deck of a passenger ship and on the freeboard deck of a cargo ship, provided that the Administration may permit the means of drainage to be dispensed with in any particular compartment of any ship or class of ship if it is satisfied that by reason of size or internal subdivision of those spaces the safety of the ship is not thereby impaired. For ships subject to the provisions of regulation II-1/1.1.1.1, for the special hazards associated with loss of stability when fitted with fixed pressure water-spraying fire-extinguishing systems refer to regulation II-2/20.6.1.4.

2.6.1 Where the freeboard to the bulkhead deck or the freeboard deck, respectively, is such that the deck edge is immersed when the ship heels more than 5°, the drainage

shall be by means of a sufficient number of scuppers of suitable size discharging directly overboard, fitted in accordance with the requirements of regulation 15 in the case of a passenger ship and the requirements for scuppers, inlets and discharges of the International Convention on Load Lines in force in the case of a cargo ship.

2.6.2 Where the freeboard is such that the edge of the bulkhead deck or the edge of the freeboard deck, respectively, is immersed when the ship heels 5° or less, the drainage of the enclosed cargo spaces on the bulkhead deck or on the freeboard deck, respectively, shall be led to a suitable space, or spaces, of adequate capacity, having a high water level alarm and provided with suitable arrangements for discharge overboard. In addition it shall be ensured that:

- .1 the number, size and disposition of the scuppers are such as to prevent unreasonable accumulation of free water;
- .2 the pumping arrangements required by this regulation for passenger ships or cargo ships, as applicable, take account of the requirements for any fixed pressure water-spraying fire extinguishing system;
- .3 water contaminated with petrol or other dangerous substances is not drained to machinery spaces or other spaces where sources of ignition may be present; and
- .4 where the enclosed cargo space is protected by a carbon dioxide fire extinguishing system the deck scuppers are fitted with means to prevent the escape of the smothering gas.

2.6.3 Provisions for the drainage of closed vehicle and ro-ro spaces and special category spaces shall also comply with regulations II-2/20.6.1.4 and II-2/20.6.1.5.

### **3 Passenger ships**

3.1 The bilge pumping system required by paragraph 2.1 shall be capable of operation under all practicable conditions after a casualty whether the ship is upright or listed. For this purpose wing suction shall generally be fitted except in narrow compartments at the end of the ship where one suction may be sufficient. In compartments of unusual form, additional suction may be required. Arrangements shall be made whereby water in the compartment may find its way to the suction pipes. Where, for particular compartments, the Administration is satisfied that the provision of drainage may be undesirable, it may allow such provision to be dispensed with if calculations made in accordance with the conditions laid down in regulations 7 and 8 show that the survival capability of the ship will not be impaired.

3.2 At least three power pumps shall be fitted connected to the bilge main, one of which may be driven by the propulsion machinery. Where the bilge pump numeral is 30 or more, one additional independent power pump shall be provided.

The bilge pump numeral shall be calculated as follows:

$$\begin{aligned} \text{when } P_1 \text{ is greater than } P: \quad & \text{bilge pump numeral} = 72 \cdot \left[ \frac{M + 2P_1}{V + P_1 - P} \right] \\ \text{in other cases:} \quad & \text{bilge pump numeral} = 72 \cdot \left[ \frac{M + 2P}{V} \right] \end{aligned}$$

where:

- $L$  = the length of the ship (metres), as defined in regulation 2;
- $M$  = the volume of the machinery space (cubic metres), as defined in regulation 2, that is below the bulkhead deck; with the addition thereto of the volume of any permanent oil fuel bunkers which may be situated above the inner bottom and forward of, or abaft, the machinery space;
- $P$  = the whole volume of the passenger and crew spaces below the bulkhead deck (cubic metres), which are provided for the accommodation and use of passengers and crew, excluding baggage, store and provision rooms;
- $V$  = the whole volume of the ship below the bulkhead deck (cubic metres);
- $P_1$  =  $KN$ ,

where:

$N$  = the number of passengers for which the ship is to be certified;  
and

$$K = 0.056L$$

However, where the value of  $KN$  is greater than the sum of  $P$  and the whole volume of the actual passenger spaces above the bulkhead deck, the figure to be taken as  $P_1$  is that sum or two-thirds  $KN$ , whichever is the greater.

3.3 Where practicable, the power bilge pumps shall be placed in separate watertight compartments and so arranged or situated that these compartments will not be flooded by the same damage. If the main propulsion machinery, auxiliary machinery and boilers

are in two or more watertight compartments, the pumps available for bilge service shall be distributed as far as is possible throughout these compartments.

3.4 On a ship of 91.5 m in length  $L$  and upwards or having a bilge pump numeral, calculated in accordance with paragraph 3.2, of 30 or more, the arrangements shall be such that at least one power bilge pump shall be available for use in all flooding conditions which the ship is required to withstand, and, for ships subject to the provisions of regulation II-1/1.1.1.1, in all flooding conditions derived from consideration of minor damages as specified in regulation 8, as follows:

- .1 one of the required bilge pumps shall be an emergency pump of a reliable submersible type having a source of power situated above the bulkhead deck; or
- .2 the bilge pumps and their sources of power shall be so distributed throughout the length of the ship that at least one pump in an undamaged compartment will be available.

3.5 With the exception of additional pumps which may be provided for peak compartments only, each required bilge pump shall be so arranged as to draw water from any space required to be drained by paragraph 2.1.

3.6 Each power bilge pump shall be capable of pumping water through the required main bilge pipe at a speed of not less than 2 m/s. Independent power bilge pumps situated in machinery spaces shall have direct suction from these spaces, except that not more than two such suction shall be required in any one space. Where two or more such suction are provided, there shall be at least one on each side of the ship. The Administration may require independent power bilge pumps situated in other spaces to have separate direct suction. Direct suction shall be suitably arranged and those in a machinery space shall be of a diameter not less than that required for the bilge main.

3.7.1 In addition to the direct bilge suction or suction required by paragraph 3.6, a direct suction from the main circulating pump leading to the drainage level of the machinery space and fitted with a non-return valve shall be provided in the machinery space. The diameter of this direct suction pipe shall be at least two thirds of the diameter of the pump inlet in the case of steamships, and of the same diameter as the pump inlet in the case of motorships.

3.7.2 Where in the opinion of the Administration the main circulating pump is not suitable for this purpose, a direct emergency bilge suction shall be led from the largest available independent power-driven pump to the drainage level of the machinery space; the suction shall be of the same diameter as the main inlet of the pump used. The capacity of the pump so connected shall exceed that of a required bilge pump by an amount deemed satisfactory by the Administration.

3.7.3 The spindles of the sea inlet and direct suction valves shall extend well above the engine-room platform.

3.8 All bilge suction piping up to the connection to the pumps shall be independent of other piping.

3.9 The diameter  $d$  of the bilge main shall be calculated according to the following formula. However, the actual internal diameter of the bilge main may be rounded off to the nearest standard size acceptable to the Administration:

$$d = 25 + 1.68\sqrt{L(B + D)}$$

where:

$d$  is the internal diameter of the bilge main (millimetres);

$L$  and  $B$  are the length and the breadth of the ship (metres) as defined in regulation 2; and

$D$  is the moulded depth of the ship to the bulkhead deck (metres) provided that, in a ship having an enclosed cargo space on the bulkhead deck which is internally drained in accordance with the requirements of paragraph 2.6.2 and which extends for the full length of the ship,  $D$  shall be measured to the next deck above the bulkhead deck. Where the enclosed cargo spaces cover a lesser length,  $D$  shall be taken as the moulded depth to the bulkhead deck plus  $lh/L$  where  $l$  and  $h$  are the aggregate length and height respectively of the enclosed cargo spaces (metres). The diameter of the bilge branch pipes shall meet the requirements of the Administration.

3.10 Provision shall be made to prevent the compartment served by any bilge suction pipe being flooded in the event of the pipe being severed or otherwise damaged by collision or grounding in any other compartment. For this purpose, where the pipe is at any part situated nearer the side of the ship than one fifth of the breadth of the ship (as defined in regulation 2 and measured at right angles to the centreline at the level of the deepest subdivision load line), or is in a duct keel, a non-return valve shall be fitted to the pipe in the compartment containing the open end. For ships subject to the provisions of regulation II-1/1.1.1.1, the deepest subdivision load line shall be taken as the deepest subdivision draught.

3.11 Distribution boxes, cocks and valves in connection with the bilge pumping system shall be so arranged that, in the event of flooding, one of the bilge pumps may be operative on any compartment; in addition, damage to a pump or its pipe connecting to the bilge main outboard of a line drawn at one fifth of the breadth of the ship shall not put the bilge system out of action. If there is only one system of pipes common to all the pumps, the necessary valves for controlling the bilge suction must be capable of being

operated from above the bulkhead deck. Where in addition to the main bilge pumping system an emergency bilge pumping system is provided, it shall be independent of the main system and so arranged that a pump is capable of operating on any compartment under flooding condition as specified in paragraph 3.1; in that case only the valves necessary for the operation of the emergency system need be capable of being operated from above the bulkhead deck.

3.12 All cocks and valves referred to in paragraph 3.11 which can be operated from above the bulkhead deck shall have their controls at their place of operation clearly marked and shall be provided with means to indicate whether they are open or closed.

#### **4 Cargo ships**

At least two power pumps connected to the main bilge system shall be provided, one of which may be driven by the propulsion machinery. If the Administration is satisfied that the safety of the ship is not impaired, bilge pumping arrangements may be dispensed with in particular compartments.